JOURNAL OF RESEARCH IN ENGINEERING & COMPUTER SCIENCES

Vol. 1, No. 4, October-2023

JRECS

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 1-12

Image-based Plant Disease Classification for the Management of Crop Health

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Abstract:
The classification of plant diseases is essential for ensuring agricultural production and food security. In this research, we look into two distinct methods for classifying plant diseases: Convolutional neural networks for deep learning and logistic regression (LR) for machine learning and Random Forest Classifier (RFC). Using a collection of plant pictures that represent different diseases, we train and assess LR and CNN models. The CNN model automatically learns hierarchical representations, whereas the LR model uses manually created features retrieved from the images. Our analysis indicates that both LR and CNN models can classify plant diseases with high accuracy, with CNN outperforming LR due to its capacity to recognize complicated picture patterns. The conclusions drawn from the results of this experiment show how effective machine learning and deep learning approaches are in grouping plant diseases.

Keywords: Random Foresr Classifier, CNN, Logistic Regression, machine Learning.

INTRODUCTION

Agricultural production is negatively affected by disease in plants [1] direct negative impact on food security, which could make food insecurity [2] worse. Therefore, one of the most important steps in preventing a drop in agricultural productivity is the diagnosis of the spread of plant pathogens.Food products available on demand are crucial in the identification of plant diseases. The creation of a system for accurately and effectively classifying plant diseases using image analysis processes [3] is essential for the classificationof different plant diseases based on their visible symptoms. The tool must evaluate pictures of plant leaves or other plantcomponents, properly forecasting their appearance diseases, and offer suggestions in real-time [4] for appropriate treatment or preventive measures to mitigate the spread of diseases and ensures healthy growth of plants. Traditional plant disease identification methods involve visual observation of symptoms and signs [5] exhibited by plants. These methods rely on the expertise and experience of trained plant pathologists. Symptoms such as leaf discoloration, wilting, or necrosis are observed [6], while signs like fungal spores or bacterial ooze may be visible. Microscopic examination and laboratory tests may be conducted to identify the causal pathogen. Although effective, traditional methods can be time-consuming and require specialized knowledge [7], It drove advancement of faster and more advanced techniques in recent years. Utilizing traditionalimage recognition methods for identifying plant illnesses involves several studies focusing on different crops and diseases. Dubey and Jalal [8] used K-means clustering for lesion segmentation and extracted color and texture features using GCH, CCV, LBP, and CLBP. SVM achieved 93% accuracy for three apple diseases. Chai et al. [9] investigatedtomato leaf diseases, extracting 18 parameters, and achieving94.71% and 98.32% accuracy with stepwise discriminant andBayesian discriminant PCA. Li and He [10] focused on five apple leaf diseases, achieving 92.6% accuracy using BP neural networks. Guan et al. [11] classified R diseases with

97.2% accuracy using 63 extracted parameters. Recent approaches involve CNN, achieving high accuracy in recognizing various crops and diseases [12][13]. Successful adoption relies on user-friendly tools and providing training and support to stakeholders in the agricultural sector. Image segmentation is the procedure of dividing an image into moremanageable, smaller portions. This method is used mostfrequently to identify digital components in images. There are numerous methods for partitioning images, including threshold, color-based, transform, and texture-based techniques [14]. Taking away features lessens the number ofpixels in the image, retaining only those that are most significant and eye-catching components. Image matching and search can speed up using a reduced function representation and a high envision size with this strategy. - Tagging photos in one of several defined categories is known as "image classification"[15]. controlled and uncontrolledtwo subcategories of the classifier. The purpose of this investigation is to develop an accurate and reliable plant disease classification system [16] using ML and DL models such as Random Forest Classifier (RFC), Logistic Regression(LR) and Convolution Neural Network (CNN) [17][18]. The study will involve collecting a diverse dataset of labelled images of healthy plants and various diseased conditions. Computer vision techniques will be employed to extractrelevant features. ML algorithms, such as Logistic Regression, will be utilized for initial classification. DL models such as convolutional neural networks (CNN) will betrained on the dataset to improve accuracy in disease classification. Performance metrics like accuracy, precision, recall, and F1 score [19] is going to be used to assess the models. Using the methods of Logistic Regression (LR), Random Forest Classifier (RFC), and Convolutional Neural Network (CNN) models, the project's goal is to create a classification system for plant diseases. The Plant Village Dataset, comprising over 87,000 RGB visuals of healthy anddamaged leaves, will be utilised for training and evaluating the models [20] categorized into 38 classes. The dataset willbe divided into an 80/20 ratio of training and validation sets, maintaining the original directory structure for accurate classification and validation.

ML-DL ALGORITHMS USED

Machine Learning Algorithms

An analytical approach for binary classification is called logistic regression [21]. A logistic function is used to determine the likelihood that an instance belongs to a specificclass. By maximizing the likelihood of the observed data, the model iteratively learns the best coefficients through a process known as gradient descent. To create predictions, theRandom Forest Classifier [22] uses several different decisiontrees, which is an ensemble learning technique. On various subsets of the training data, it builds several decision trees [23], and then it averages the forecasts of all the trees to arriveat the final prediction. Tasks requiring both classification andregression [24] can be handled by Random Forest, which is proficient at handling complex interactions between features. Preprocessing the dataset, applying data augmentation to the training data, and, if necessary, extracting features [25] are all steps in the execution phase. By minimizing the logistic lossfunction, logistic regression calculates parameters that best suit the data, whereas random forest uses voting to join manydecision trees. Metrics including accuracy, precision, recall, and F1-score are used to assess model performance on the testing data [26]. With the use of this approach, the Plant- Village dataset [27] can be accurately separated into both healthy and unhealthy plants by logistic regression and random forest classifiers.

Deep Learning Algorithms

Convolutional neural networks, that are a type of deep learning method, were created specifically for processing and analyzing visual input [28] that is being used to implement out model. The CNNs are now the preferred method [29] for a variety of applications, including picture

classification, object detection, facial recognition, and even natural language processing [30]. The arrangement of the visual cortex in both humans and animals [31] serves as the model for CNN architecture. It is made up of numerous interconnected layers that take progressively complicated features [34] from the incoming data and learn them. CNN's primary building components are convolutional layers, pooling layers, and fully linked layers. Local patterns and spatial hierarchies [32] in the input data are captured by convolutional layers. The execution procedure for a CNN, or Convolutional Neural Network [33] involves several keysteps. Firstly, the dataset is prepared by preprocessing and dividing it into training, validation, and testing sets [34]. Then, the CNN architecture is designed, considering thenumber and types of layers. The model is trained using the training dataset, optimizing the weights through backpropagation [35]. For ML model's feature extraction, a pre-trained CNN model or a trained model is utilized and extracting features [36] from a specific layer. These featurescan be fed into traditional ML models. In DL models, a CNNis specifically designed for feature extraction, trained on a large dataset, and the features are extracted from desired layers. Finally, testing is performed by evaluating the ML orDL models' performance [37] on the testing set using appropriate metrics.

METHODOLOGIES

Database Creation

The dataset is created using offline augmentation from theoriginal dataset. Obtaining the original Plant Village Datasetfrom the Kaggle website [38] consists of about 87K RGB pictures of good and diseased leaves which are categorized into 38 different classes**.** Out of the total dataset, we have carefully selected and utilized 70,295 images specifically fortraining and validation purposes. The number of classes and number of images per class is given in table1 below. We collected 1050 test samples apart from the training and validation images.

Table 1: Classes and Number of Images

No ofclasses	Class names	No ofimages
1	AppleApple_scab	2016
2	Apple___Black_rot	1987
3	Apple___Cedar_apple_rust	1760
4	Apple___healthy	2008
5	Blueberry___healthy	1816
6	Cherry_ (including sour)_ P o w d e r y mildew	1683
7	Cherry_(including_sour)_ h e a l t h y	1826
8	Corn_(maize)_____Cercospora_leaf_spotGray_leaf_spot	1642
9	Corn_(maize)_ C o m m o n rust_	1907
10	Corn_(maize)_ N o r t h e r n _Leaf_Blight	1908
11	Corn_(maize) h e a l t h y	1859
12	Grape___Black_rot	1888
13	Grape___Esca_ (Black Measles)	1920
14	Grape___Leaf_blight_(Isariopsis_Leaf_Spot)	1722
15	Grape___healthy	1692
16	Orange___Haunglongbing_(Citrus greening)	2010
17	Peach___Bacterial spot	1838
18	Peach___healthy	1728
19	Pepper, _bell_____Bacterial spot	1913
20	Pepper, bell___healthy	1988
21	Potato Early blight	1939

22	Potato Late blight	1939
23	Potato healthy	1824
24	Raspberry healthy	1781
25	Soybean healthy	2022
26	Squash Powdery mildew	1736
27	Strawberry Leaf scorch	1774
28	Strawberry healthy	1824
29	Tomato Bacterial spot	1702
30	Tomato Early blight	1920
31	Tomato Late blight	1939
32	Tomato Leaf Mold	1882
33	Tomato Septoria_leaf_spot	1745
34	Tomato Spider_mites_Two- spotted_spider_mite	1741
35	Tomato Target Spot	1827
36	Tomato Tomato_Yellow_Leaf_Curl_Virus	1961
37	Tomato Tomato_mosaic_virus	1790
38	Tomato healthy	1926

Data Augmentation

To improve the generalization and performance of the models for logistic regression and random forest classifiers [39], data augmentation techniques can be applied. Data augmentation [40] involves applying transformations to the existing dataset, creating new samples with diverse variations. This increases the quantity and diversity of the training data, leading to improved model performance.

Image Preprocessing

To increase the quality and usability of images for analysis or further processing, image preprocessing techniques [41] are used. These methods include operations like cropping, rotation, flipping, edge detection, thresholding, normalization, noise reduction, contrast enhancement, and filtering [42]. Resizing, scaling, and noise reduction procedures change the size of an image while reducing pixel values' random fluctuations. Methods for increasing contrast boost visual quality, whereas normalization [43] uniformizes pixel value ranges. Color space conversion makes visual representation easier [44] while cropping concentrates attention on areas of significance. Correct alignment or orientation by rotation and flipping. While thresholding converts images to binary format [45] for segmentation, edge detection highlights boundaries. To enhance or reduce certain picture aspects, filtering employs specialized filters [46]. The Sample image before resizing is given in the following image Fig 1 below.

Fig 1: Sample Image Before Resizing

The image as shown in Fig 2 is the resized image of the same image as Fig 1. The image shown below in Fig 3 is an image that's being created because of a thresholding technique called Binary Inverse [47] on plant images. It converts the images into a binary representation where foreground pixels are set to 0 and background pixels are set to the maximum value of 255. This method is useful for segmenting objects of interest from the background [48], allowing further analysis or processing on the extracted plant regions.

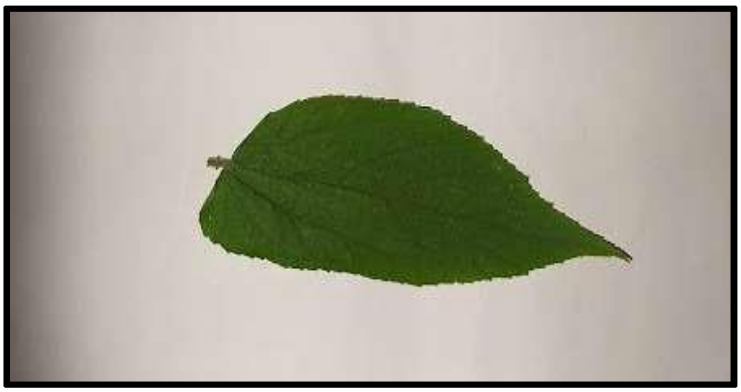

Fig 2: Sample Image after Resizing

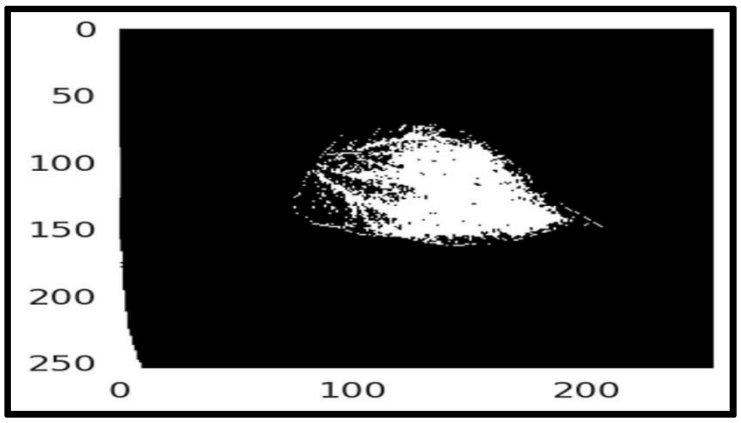

Fig 3: Original Image before LBP Feature Extraction

Feature Extraction

Local Binary Patterns (LBP) feature extraction [49] is a widely used technique in computer vision for texture analysis. LBP captures local patterns in an image by comparing the intensity [50] between an inner pixel and the neighbouring pixels. These comparisons are encoded into binary patterns that represent the local texturing info. Different machine learning approaches, notably the Random Forest classifier, Convolutional Neural Networks (CNN), and Logistic Regression, can use LBP features [51]. In Random Forest, LBP features can contribute to decision-making based on texture information. In CNN, LBP features can be used as input channels or concatenated with other features toenhance [52] texture representation. In Logistic Regression, LBP features can help model the relationship between the texture patterns and the target variable [53], enabling classification based on texture characteristics. The Image before LBP feature extraction is given in Fig 4 below.

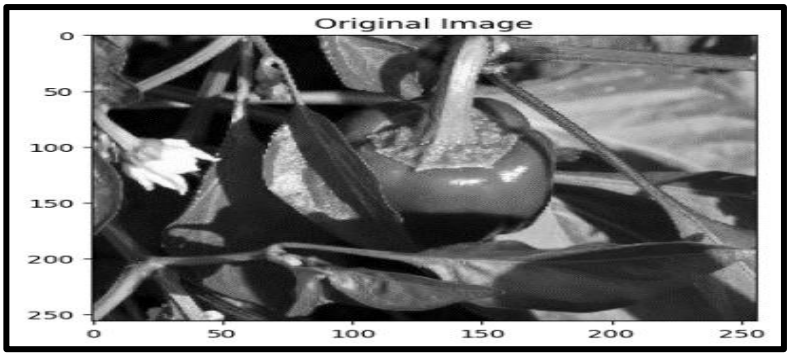

Fig 4: Original Image after LBP Feature Extraction

In the above Fig 5 the image that is being obtained afterfeature extraction is given.

Training

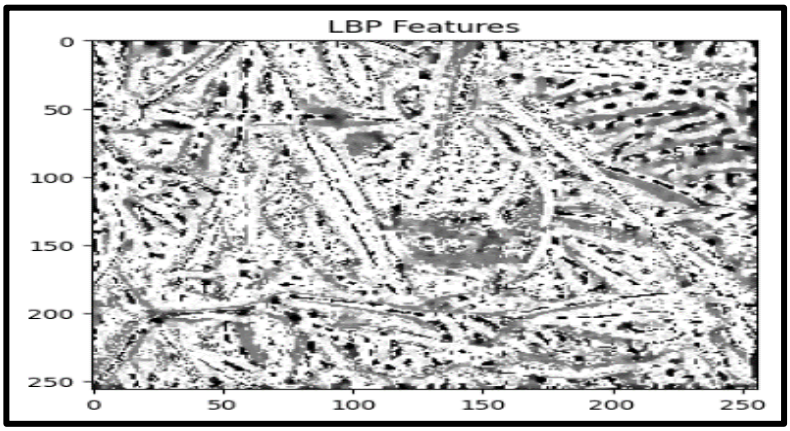

Fig 5: Original Image after LBP Feature Extraction

In the experiment, a total of 70,295 images were trained using the specified hardware and software components. To leverage the computational power of the GPU, the CUDA toolkit [54] was installed, facilitating more effective computation for deep and machine learning models. The training procedure was made simpler by the experimental platform's use of a combination of hardware and software resources. The details of the experimental setup, including the specific components and configurations, are provided in Table 2, showcasing the environment where the training of the images took place.

Table 2: Details of Experimental Platform

Hardware Platform		**Software Platform**	
CPU	Intel(R) Core (TM) i5-6500 CPU @ 3.20GHz 3.19 GHz	OS	Windows 1164-bit
GPU	Nvidia Geforce GTX1650 Ti	Framework	Logistic Regression, Random Forest Classifier, Convolution Neural Network
RAM	8GB	Programming	ATLAB o2020a o64-bit

Testing

To get the prediction scores for each class, the test data isused to evaluate the previously acquired data model. The bestguess of the test data's class will be determined by the class with the greatest prediction score. The test dataset is utilized to assess how well the trained model performs on

unobserved data. Based on the characteristics found in the test data the model forecasts the likelihood scores for each class. These prediction scores represent the model's level of assurance in classifying each data point. The best guess for that particular data point is the class with the highest prediction score. By comparing the prediction scores between classes, the model can determine the most likely class for each instance of test data, enabling accurate classification and decision-making.

RESULTS AND DISCUSSIONS

The testing process produced the results displayed in table 2.

Table 2: Results of ML Algorithms

	Random Forest Classifier	Logistic Regression
Accuracy	67%	58.63%
F1-Score	66%	32%
recall	67%	56%
precision	68%	82%

The table displays the accuracy, F1-score, recall, and precision values [55] for two different classifiers: Random Forest and Logistic Regression. Random Forest Classifier achieved an accuracy of 67% and a relatively high F1-score of 66%, indicating a balanced performance. Logistic Regression had a lower accuracy of 58.63% and A 32% F1- score indicates overall performance. The highest accuracy was achieved by CNN (99.39%), demonstrating its superior case-classification abilities accurately. When comparing the results obtained from logistic regression (58.63% accuracy), random forest classifier (67% accuracy), and CNN (99.39% accuracy) in plant disease classification, it's clear that the CNN method performs better than the conventional picture recognition methods cited in the literature. Previous research has used techniques like K-means clustering, SVM, stepwise discriminant analysis, Bayesian discriminant PCA, BP neural networks, and feature extraction techniques such as GCH, CCV, LBP, and CLBP. These studies achieved accuracies ranging from 92.6% to 98.32% for specific crop diseases. However, the recent approach using CNN has shown remarkable accuracy in recognizing various crops and diseases, surpassing the traditional techniques mentioned in the literature.

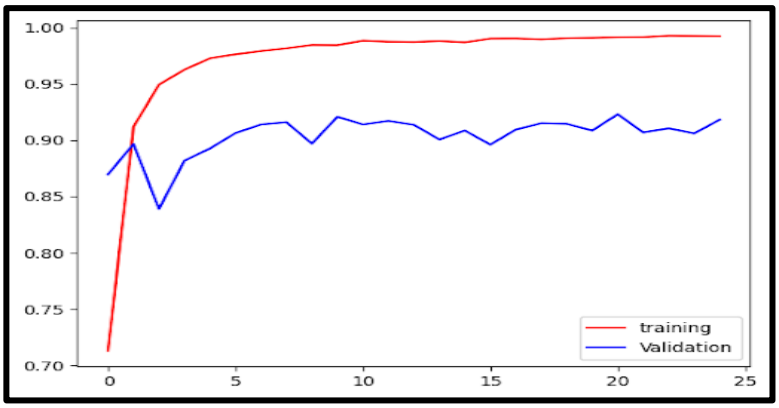

Fig 6: Accuracy curve

The accuracy curve for training and validation visuals is shown in Fig. 6. It displays the model's accuracy performance for a classification job with 37 classes during training and validation. The curve demonstrates the model's learning progress and potential overfitting or underfitting.

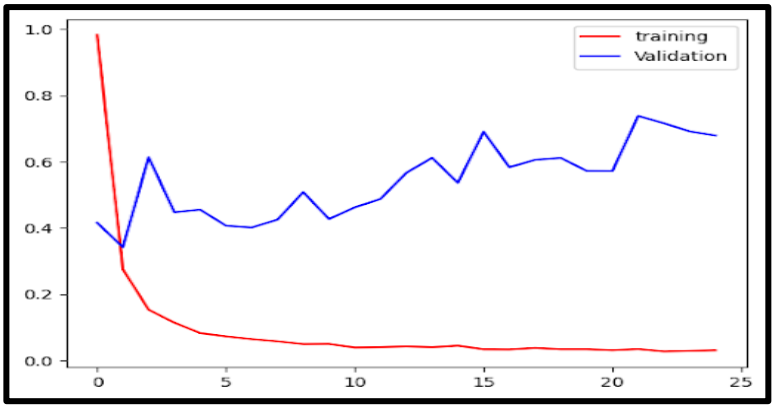

Fig 7: Loss curve

The following Table 4 produced the data for accuracy curve and loss curve for the CNN model.

Table 4: Data for Accuracy and Loss Curves for CNN

	1st epoch	25th epoch
training accuracy	71.27%	99.30%
loss	0.9822	0.0305
validation accuracy	86.94%	91.80%
val_loss	0.4155	0.6787

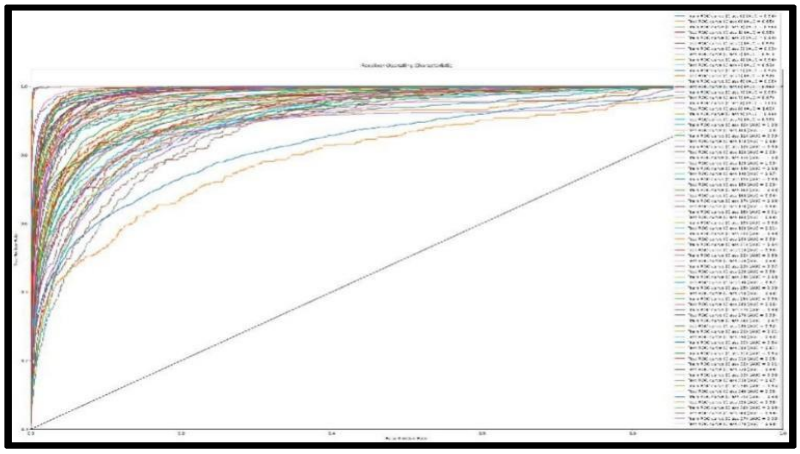

Fig 8: ROC curve

In Figure 8, the ROC curve represents the performance evaluation of a classification model for 37 different classes. It provides a graphical representation of thetrade-off between true positive rate and false positive rate across multiple classes.

CONCLUSION

By developing two ML and DL models we have learnt that DL model is efficient in classifying images ratherthan using ML models. We were able to predict most of the images in DL models using Convolution Neural Network (CNN). The classification of plant diseases using image- based methods is expected to make significant strides in the future. Several important fields are projected to experience major advancements thanks to continuous research and technological development. The development of deep learning models, particularly CNN architectures, for the categorization of plant diseases is one such topic. The development of more complex network architectures that canextract even more nuanced characteristics from plant photos in the future

may be the focus to improve the accuracy and resilience of the system. Additionally, improvements in dataaccess and collecting will be very important. Machine learning models will have access to more comprehensive data when larger, more varied, and well-annotated datasets are accumulated, improving generalization and performance. theincorporation of multi-modal data, such as spectral or hyperspectral data with image-based information.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 13-20

Development of Cost-Effective Inverter for Homes and Offices

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Abstract:
There are lots of imported inverters in the Nigerian markets which are reliable, but the costs of importing foreign inverters is very high for the average Nigerian and have problems associated with performance and maintenance spare parts. Hence, the need for cost effective transformer voltage source conversion inverter using locally available materials. A cost-effective transformer voltage source conversion that has a high efficiency as well as compact in size was designed and developed. The techniques for the design and construction of the low-cost automatic inverter system capable of converting 12V DC to 220V AC, 50 – 60 Hz with a power handling capacity of 650-volt ampere or Watts (VA or W) is presented with emphasis on the step-up transformer specification. The major modules of the inverter system consist of a driver and switching circuit; an automatic battery charger circuit; a battery voltage level indicator circuit; and a capacitive inductive filter. The proliferation of the gadget, apart from enhancing the local market, offers an instrument with readily available spare parts which can be repaired and maintained by our local technicians.

Keywords: Electricity, Inverter, Cost, Effective, Local, Spare parts, Maintenance

INTRODUCTION

During the past three decades, researchers have shifted their quest for abundant energy from fossil fuel sources and focused their concentration on renewable energy and actively looking for cost effective solutions to this problem. Solar energy is the one of the potential sources which is preferred over other renewable sources due to availability, ingenuousness, lower maintenance and reliability. Photovoltaic (PV) arrays drastically reduce energy expenditure and dependability on other non-renewable energy sources. It can provide a worthy, cost-effective solution for consumers requiring large amount of power. Inverter is an inevitable component of PV module. There are lots of inverters available in the markets which are reliable, but the cost of these inverters is high because of the micro-controller based SPWM generator. Average Nigerians find it difficult to afford these inverters. Again, many of the peoples are using inverter-less PV module with Direct current (DC) Light-emitting diode (LED) light. The brightness of LED is not enough to eradicate darkness. (Haque *et al.*, 2017).

An inverter can be taken as a crude form of Uninterrupted Power Supply (UPS). Obviously, the main use of an inverter is only for powering common electrical appliances like lights and fans during a power failure or the transmission of DC Solar power to Alternating Current (AC) for conventional use. As the name suggests "inverter" the basic function of an inverter is to invert an input direct voltage (12V DC) into a much larger magnitude of alternating voltage (generally 110VAC or 220VAC).

The following fundamental elements of an inverter and its operating principle are as follows:

1. **Oscillator:** An oscillator converts the input DC (Direct Current) from a lead acid battery into an oscillating current or a square wave which is fed to the secondary winding of a power transformer.
2. **Transformer:** Here, the applied oscillating voltage is stepped up as per the ratio of the windings of the transformer and an AC much higher than the input DC source becomes available at the primary winding or the output of the inverter.
3. **Charger:** During power backups when the battery gets discharged to a considerable level, the charger section is used to charge the battery once the AC mains are restored.

Despite its primary function, the roles of inverters have begun to expand as most has a display unit for monitoring the system as well as ease of diagnoses to help improve stability and efficiency. Some inverters are embedded with a build-in charge controller. Others have a smart circuitry feature for low battery indicator, temperature, overload and short circuit detection system. Inverters are of different types and can also be classified based on their output wave form. The three common types of inverters are the micro, string and central inverter which can come in any form as square, modified sine wave and pure or full sine wave. Generally, pure sine wave inverters remain the most preferred choice though most expensive over others because of its numerous benefits; its current is same as that of the grid; hence it guarantees the safety of motor, inductive device (microwave), and every sensitive electronic device. It eliminates the irritating audible electrical humming sound from fans, fluorescent lights, audio amplifiers, and televisions.

An Inverter system could be applied in our homes, offices, industries and remote areas. It could also find its applications on Recreational Vehicles (RV) marines, portable devices and emergency backups. A great deal of research has been done to improve the efficiency of inverters. Though the market is flooded with varieties of the inverters, they are very costly and some of them are very complicated to use while some are not efficient. The primary goal of this work is to develop an efficient cost-effective inverter that can store conventional electricity in the battery or convert solar direct current (DC) power to alternating current (AC), which every average person can use in their homes. In this research, only the essential switching and amplifying components to minimize the cost and losses are used.

OBJECTIVE

The main objective of this project is

1. To design a cost-effective inverter for homes and offices use in Nigeria.
2. To produce an inverter capable of converting 12v dc to 220v ac; using locally available materials.

STATEMENT OF THE PROBLEM

Incessant power failure is endemic to the power supply system in Nigeria today causing disruptions in almost all spheres of life including research institutions, in particular. Most experiments in our university laboratories and research institutes are not finalized and concluded due to the epileptic nature of our public power supply system. To curb power shortage problems occasioned by the Nigeria erratic power supply, energy is stored in power inverters and utilized during power outage. Also, there are lots of imported inverters in the markets which are reliable, but the costs of importing foreign inverters is so high and have problems associated with performance. Also, maintenance of imported inverters requires highly skilled personnel as they are mainly square wave and modified sine wave inverters. Hence, the need for cost effective

transformer voltage source conversion inverter using locally available materials. A method of generating pure sine wave with Pulse Width Modulation (PWM) can be implemented in order to enhance efficient performance and lower costs.

LITERATURE REVIEW

Many engineers, technologist, and scientist have designed and tested several inverters of various capacities for different purposes used to convert DC to variable AC. This variation can be in the magnitude of voltage, number of phases, frequency or phase difference. Omitola, *et al.,* (2014), designed and constructed a 1000Watts (1KW) 220 Volts Inverter at a frequency of 50Hz. This device is constructed with locally sourced components and materials of regulated standards. The basic principle of its operation is a simple conversion of 12V DC from a battery using integrated circuits and semiconductors at a frequency of 50Hz, to a 220V AC across the windings of a transformer. An additional power supply to the public power supply with the same power output is thus provided at an affordable price. Musa and Galadanci (2009), designed and simulated 5 kVA power inverter base on two topologies; Boost converter and Half-bridge inverter topology. A 555 timer IC was used as the control at fixed frequencies of 25 kHz and 50 Hz for the two stages. The results of the simulation were obtained. The graphs for both stages were plotted and the results show a significant increase in the voltage and duty cycle. The wave form of the output gives a square wave form. Hamid *et al.* (2020) designed and simulated a single-phase inverter using sinusoidal pulse width modulation (SPWM) unipolar technique. The circuit has been designed and simulated using the Matlab/Simulink program. Metal Oxide Semiconductor Field Effect Transistor (MOSFET) was used as a switch. The project aims were to use Matlab/Simulink program to design, analyze and control switching for inverter circuits. Single-phase inverter circuits are divided into three main divisions which are the inverter part that consists of the MOSFET switch, the control circuit which generates switching pulses generated through the microcontroller and filter parts that contain inductors, capacitors and resistors to reduce harmonic. The results of the experiment show the output of the sine wave with the output voltage of 230 V and 50 Hz.

Also, Muttalib *et al.,* (2012), designed and simulated an inverter with high frequency sinusoidal PWM switching technique for harmonic reduction in a standalone/ utility grid synchronized photovoltaic system Inverters are one of the major parts of any Photovoltaic Systems which are intended to feed power to any isolated standalone ac loads or to synchronize with the utility power grid systems. Akhikpemelo *et al.,* (2016), developed an inverter circuit based on the operation of the IC CD4047. 12V AC is stepped up to 230V AC by using a step-up transformer. The assembled composite unit worked well. The oscilloscope measurement tallied with the set frequency of 50Hz and the square wave oscillator output. The inverter system is capable of providing power to the appropriate load for up to eight hours; depending on the state of the 12V batteries. Akpan and Ewetumo (2010), designed and constructed a low-cost automatic inverter system capable of converting 24Vdc to 220Vac 60Hz with a power handling capacity of 2 kVA have been presented with emphasis on the step-up transformer specification. The major modules of the inverter system consist of a driver and switching circuit; an automatic battery charger circuit; a battery voltage level indicator circuit; and a capacitive–inductive filter. Both solid-state and electromechanical relays were employed to provide automatic fast switching capabilities both in the presence or absence of public power supply (PPS) without voltage fluctuations supplied to the loads during the power switching process. Several experiments have been conducted with the automatic inverter system using different equipment with different power

requirements. Analysis and results show that the designed and constructed inverter system has negligible output resistance with low power consumption and it is highly suitable for use in

Haque *et al.,* (2017), designed and implemented a 100 Watt, 220 and 50 Hz Voltage Cost Effective Inverter. The system was designed without any microcontroller and it has a cost-effective design architecture. The elementary purpose of this device was to transmute 12 V DC to 220 V AC. Snubber technologies was used to diminish the reverse potential, transients and excessive heat of transformer winding and transistor switches. Switching pulse generated by NE 555 timer circuit and comparator circuit was used to take signal strength input from its rear as well as from both sides for triggering the MOSFET switches. Another switch is used to invert pulse between two switching circuitries. A 5 volts regulator (IC: 7805) was used to supply fixed 5V for biasing the switching and amplifying circuitry. Rashid *et al.* (2017), designed and implemented a Low-Cost Solar Inverter for Home Uses and Agriculture System. Further, AL-Rawi (2019), designed and developed a low-cost transformer-less voltage source conversion that has a higher efficiency as well as compact in size. The complete design consists of DC-DC converter and a DC-AC inverter. The converter is dependent on switched capacitor techniques and steps 12Vdc to 240Vdc. The inverter is dependent on a full-bridge configuration which produces a 240Vac output from 240Vdc. To achieve the improvement in inverter efficiency and a reduction in cost, the power transformer and magnetic components such as inductors are eliminated. In addition, inverter voltage control techniques such as pulse width modulation (PWM) and switching of MOSFETs are optimized through digital control using ATtiny26L microcontroller unit.

The foregoing and other literature shows that lots of work have been done in the area of inverter development and simulation. The main purpose of this project is to design a solar inverter that will enable the inversion of a DC power source, supplied by Photovoltaic (PV) Cells, to an AC power source that will be either used to supply a load or connected directly to the utility grid. The benefit of this project is to give access to an everlasting and pollution free source of energy. It offers the user the option to use the system in two possible operating modes; the stand-alone mode which is used to satisfy his needs, and the grid connected mode which used to sell electricity to utility when in excess; thus, eliminating the need of battery storage. The local need to fashion a cost-effective inverter produced from available local materials in Nigeria informed this work. It is also crafted in readily available technologies for ease of production and maintenance.

MATERIALS AND METHOS

Figure 1 depicts the block diagram of the cost-effective inverter. The computer aided drawings of the assembly are shown in Figure 2. ICs, capacitors, variable resistors, transistors, transformer, relay and circuit board were selected in the design of this inverter. IC 4047 produces the oscillation. It performs the primary function of supplying square waves to the inverting section.

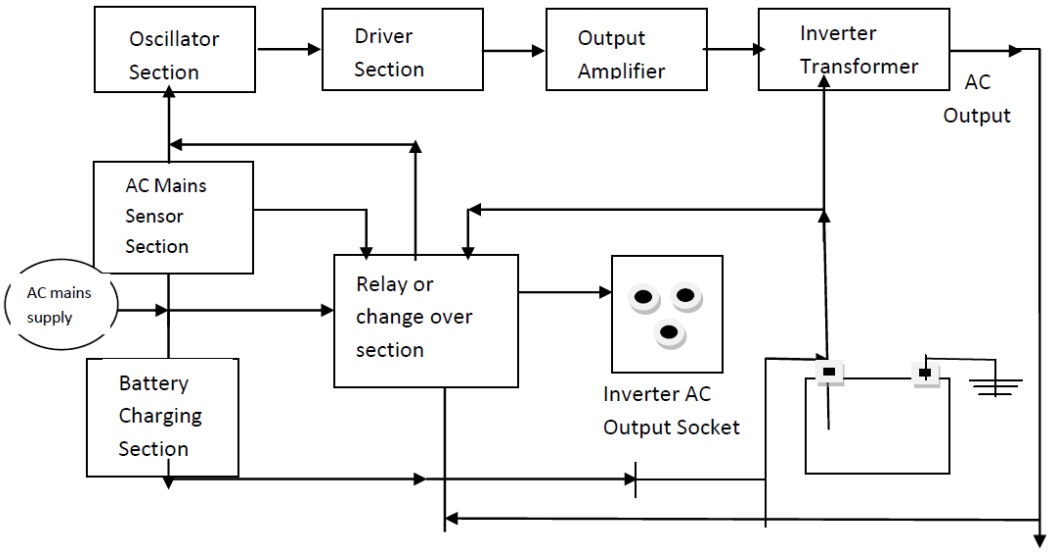

Figure 1: Block diagram of a low-cost inverter

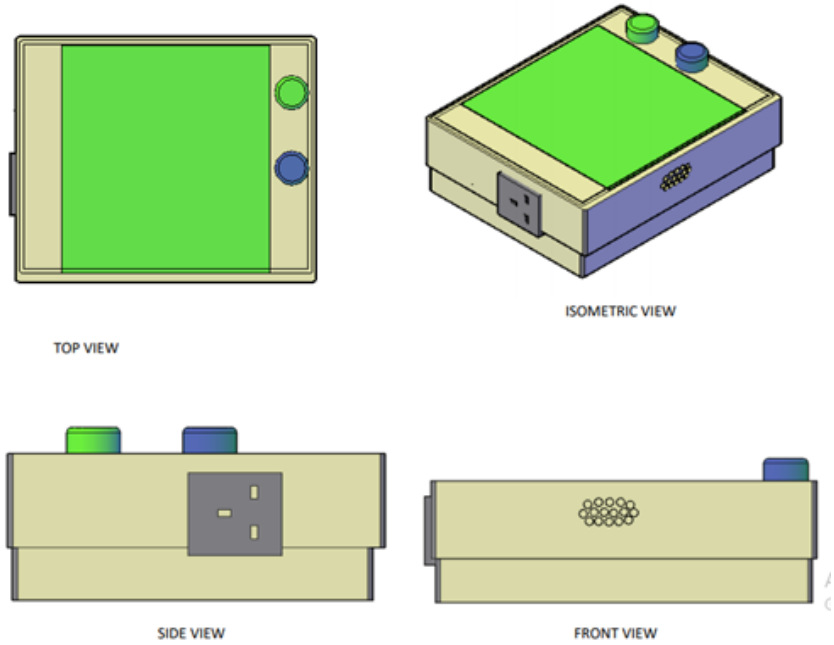

Figure 2: CAD diagram of a low-cost inverter

A voltage regulator is employed as buffers so that the circuit is not load dependent. In other words, absorb surge during the operation of the system. Variable resistor is used for the biasing of the IC to produce the required signal for the MUSFET multi vibrating state. Alternating voltage from the buffer stage is applied to the base of the current amplifier transistors which conduct in accordance with the applied alternating voltage and amplify it to the transformer. These output power transistors oscillate at a full swing, delivering the entire battery voltage into secondary winding of the transformer alternately. The secondary voltage is induced in the primary winding of the transformer and is stepped-up into a powerful 220 volts (AC). The voltage is used to power the output load. A 12V relay was incorporated for switching over from grid supply to inverter to power needed load. The components that were used to construct the inverter consist of, MOSFET and a center tap transformer. Few capacitors, resistors, and variable resistor port were also used. The design and development were done using locally sourced components. The basic principle of

operation was based on an oscillator designed to produce an alternating EMF of known frequency of about 50 - 60HZ and wave form using IC 4047 whose frequency is set to 50Hz and 12V DC from a regulated DC power supply to produce a 220V AC at the output of a transformer. A 10W bulb was connected as load to the inverter. A digital multi meter reads 220V AC. Overall, the circuit performed.

RESULTS

The coupling and installation of the various components sourced from the electrical/ electronic market in Nnewi, Anambra State are shown in Plate 1 and Plate 2. The three circuit of the pure sine wave with Pulse Width Modulation (PWM) Cost effective inverter, are independent. The use of locally sourced materials is to enhance reproducibility and easy maintainability. The Inverter is therefore highly adaptable. Plate 3 is the picture of the Cost-effective Inverter while Plate 4 depicts the instrument during testing.

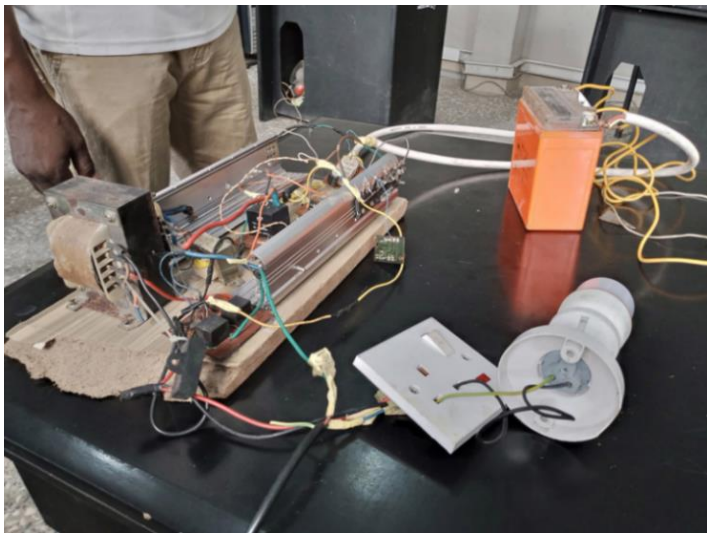

Plate 1: Picture showing skeletal assembly of the inverter on the circuit board.

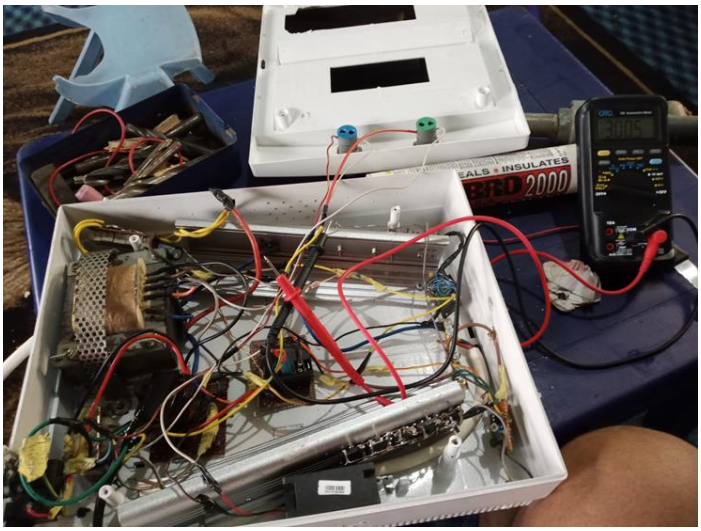

Plate 2: Picture showing the assembly being transferred to its casing

Plate 3: The completed Cost-effective inverter

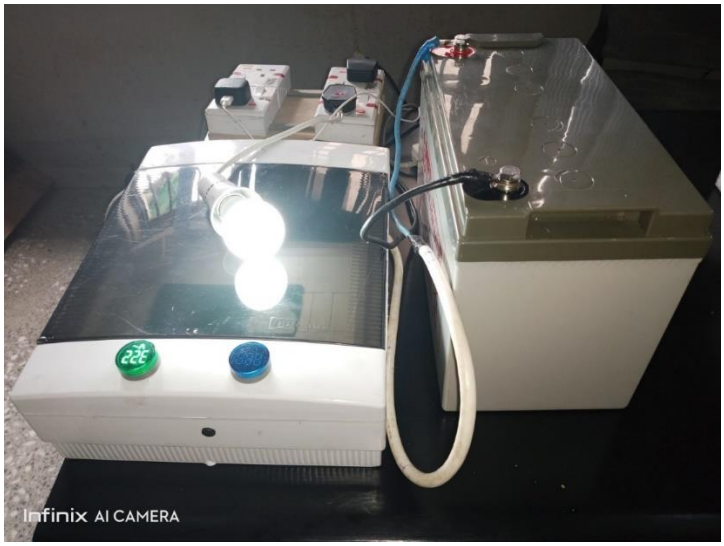

Plate 4: Completed Cost-effective inverter undergoing testing

CONCLUSION

The Department of Electrical/Electronic Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli Campus, Anambra State in collaboration with the National Board for Technology Incubation (NBTI), Federal Secretariat designed and produced a Cost-effective Inverter for home and office use in Nigeria. The components employed in design and building of the inverter were sourced locally from the Electrical/Electronics market in Nnewi, Anambra State. Testing and evaluation of the instrument shows: Overall Dimension: 110 mm x 350 mm x 285 mm while operational Efficiency is 87.6%. It is hoped that the work will enhance the local production of cost-effective inverters in Nigeria thereby saving much in foreign reserve.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 21-33

Information Technology Advancements Shaping the Evolution of Modern Accounting Systems

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Abstract:
Accounting systems have evolved from manual methods of bookkeeping to computerized systems, resulting in reduced risks, time requirements, and human resources for bookkeeping tasks. This transition has also facilitated the seamless and efficient generation of reports and access to data. This research explores the significant influence of advancements in information technology on the development of modern accounting systems. Recent technological progress has brought about substantial changes in accounting practices, enhancing the efficiency and effectiveness of financial processes. The research delves into key technological advancements such as cloud computing, big data analytics, and artificial intelligence and examines how they impact various aspects of accounting systems, including financial reporting, auditing, and decision-making. Through the analysis of case studies and empirical data, the research sheds light on the advantages and challenges associated with the adoption of these technologies in accounting practices. The findings emphasize the transformative potential of information technology in shaping the future of accounting systems, providing valuable insights for professionals and policymakers as they navigate the ever-evolving landscape of modern accounting. The proposed techniques exhibit enhanced precision, with SVM achieving an accuracy of 72.32% and Decision Tree achieving an accuracy of 79.34%. These results surpass the performance of the current system, indicating notable improvement in accuracy.

Keywords: Accounting systems evolution, Information technology advancements, Modern accounting systems, Technological impact on accounting, financial processes efficiency, and Technology Adoption in accounting.

INTRODUCTION

The progression from manual bookkeeping to computerized accounting systems has brought about a revolutionary change in the management of financial information. This shift has not only reduced the risks, time commitments, and human resources associated with bookkeeping tasks but has also streamlined the generation of reports and access to data. The rapid advancements in information technology have played a pivotal role in shaping the development of contemporary accounting systems [1,2]. In recent times, technology has had a profound transformative effect on accounting practices, enhancing the efficiency and effectiveness of financial processes [3,4]. The research studies track the significant progress made in information technology, including cloud computing, big data analytics, and artificial intelligence, and how they impact different aspects of accounting systems. These advancements have brought about major changes in important areas such as financial reporting, auditing, and decision-making, opening up a new era of limitless opportunities [5,6].

By analyzing case studies and empirical evidence, the researches shed light on both the advantages and challenges that arise from incorporating these technologies into accounting practices. Through an examination of real-world implementations and their outcomes, valuable perspectives will be gained regarding the transformative potential of information technology in shaping the future of accounting systems [7,8]. The progress made in the modern accounting has implications for accounting professionals and policymakers, offering practical insights to navigate the constantly changing landscape of modern accounting, optimize procedures, and leverage technology for superior outcomes. The progress in the accounting field delves into the evolution of accounting systems, advancements in information technology, modern accounting systems, the impact of technology on accounting, the efficiency of financial processes, and the adoption of technology in accounting, contributing to the growing body of knowledge in this critical field [9,10].

LITERATURE REVIEW

The shift from manual bookkeeping to computerized accounting systems has resulted in a fundamental transformation in the way financial information is managed. This transition has yielded numerous advantages, such as minimizing risks, reducing time commitments, and optimizing the utilization of human resources associated with traditional bookkeeping methods [10,11]. Additionally, it has streamlined the process of generating reports and facilitated easier access to data. Undoubtedly, the rapid advancements in information technology have played a central role in shaping the evolution of modern accounting systems. In recent years, technology has had a profound impact on accounting practices, leading to significant improvements in the efficiency and effectiveness of financial processes [12,13]. There are significant advancements in information technology, such as cloud computing, big data analytics, and artificial intelligence, and analyze how they impact different components of accounting systems [14]. These advancements have triggered transformative shifts in crucial domains of accounting, such as financial reporting, auditing, and decision-making procedures, introducing novel possibilities and avenues for the discipline [15,16].

To obtain a comprehensive comprehension of the advantages and challenges related to the integration of these technologies into accounting practices, this research employs a thorough methodology. By examining real-world case studies and empirical evidence, a deeper understanding of the transformative potential of information technology in shaping the future of accounting systems will be obtained. The information technology has implications for accounting professionals and policymakers, providing practical insights to navigate the constantly evolving landscape of modern accounting, optimize procedures, and leverage technology for superior outcomes. By contributing to the growing knowledge base in this crucial field, this present research enhances our understanding of the dynamic relationship between technology and accounting, offering valuable insights for professionals and policymakers alike [17,18].

EXISTING SYSTEM

The accounting system has undergone a notable transformation, transitioning from manual bookkeeping to computerized accounting systems. This change has brought about a multitude of advantages that have fundamentally transformed how financial information is managed. Through the adoption of computerized systems, the risks associated with manual processes have been minimized, time commitments have been reduced, and the utilization of human resources has been optimized. Furthermore, this transition has streamlined the report generation process and enhanced the accessibility of data. The rapid advancements in information technology have

played a central role in shaping the evolution of modern accounting systems. Technologies such as cloud computing, big data analytics, and artificial intelligence have had a profound impact on accounting practices, revolutionizing the way financial processes are executed. These advancements have notably enhanced the efficiency and effectiveness of financial operations. This research delves into these significant advancements and examines their impact on different facets of accounting systems, scrutinizing the ways in which they have revolutionized essential elements of the discipline [19,20].

The integration of information technology into accounting has brought about transformative changes in crucial domains such as financial reporting, auditing, and decision-making processes. These changes have not only opened up new possibilities and opportunities for the field of accounting but have also made the system more adaptable, efficient, and responsive to the evolving needs of businesses. In order to gain a comprehensive understanding of the benefits and challenges associated with the incorporation of these technologies, this research employs a comprehensive methodology. By analyzing real-life case studies and empirical evidence, we aim to deepen our understanding of the transformative potential of information technology in shaping the future of accounting systems. The outcomes of this research hold great significance for professionals in the accounting field as well as policymakers, providing practical knowledge to navigate the ever-changing environment of modern accounting. The research particularly concentrates on various vital areas, such as the development of accounting systems, advancements in information technology, modern accounting systems, the influence of technology on accounting, the effectiveness of financial processes, and the adoption of technology in accounting. By contributing to the expanding knowledge base in this crucial domain, this research enhances our understanding of the dynamic relationship between technology and accounting, offering valuable insights for both professionals and policymakers [17,18].

PROPOSED SYSTEM

Expanding on the shift from manual bookkeeping to computerized accounting systems, our proposed system takes the management of financial information to the next level. By harnessing the benefits associated with computerized systems, such as reduced risks, decreased time commitments, and optimized utilization of human resources, our system aims to further improve financial information management. Additionally, we propose streamlining the process of generating reports and enhancing data accessibility, thereby increasing overall efficiency. The proposed system capitalizes on the swift progress in information technology that has played a pivotal role in shaping the evolution of contemporary accounting systems. Our system incorporates crucial elements such as cloud computing, big data analytics, and artificial intelligence, which have brought about revolutionary changes in financial processes, augmenting their efficiency. These technological advancements considerably enhance the effectiveness of financial operations, unlocking fresh opportunities for growth and optimization within the accounting field.

This research undertakes a thorough examination of these crucial technological advancements, delving into their impacts on various aspects of accounting systems. We analyze key components such as financial reporting, auditing, and decision-making processes to assess how these advancements revolutionize and improve these fundamental areas of accounting. By exploring the intricate relationship between technology and accounting, our objective is to uncover practical insights and provide actionable recommendations. To gain a comprehensive

understanding of the benefits and challenges associated with the integration of these technologies, our research employs a comprehensive methodology. Through an extensive analysis of real-life case studies and empirical evidence, the study aim to deepen our understanding of the transformative potential of information technology in shaping the future of accounting systems. The findings derived from this research carry significant implications for accounting professionals and policymakers, offering practical insights to navigate the constantly evolving landscape of modern accounting.

The primary focus of the proposed research lies in examining the progression of accounting systems, advancements in information technology, modern accounting systems, the influence of technology on accounting, the effectiveness of financial processes, and the integration of technology in accounting. By adding to the expanding knowledge base in this essential field, our research aims to enhance understanding of the dynamic relationship between technology and accounting, providing valuable insights for both professionals and policymakers.

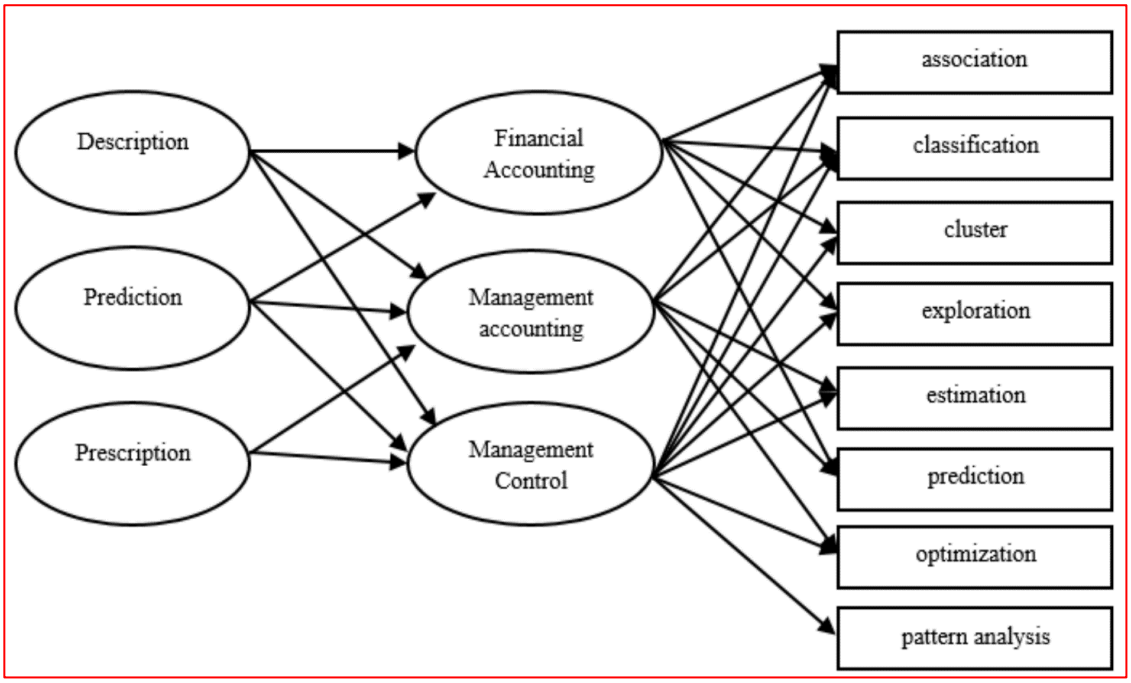

Fig 1: A Proposed Architecture for the Evolution of Modern Information Technology

Proposed Model Steps

The proposed model steps aim to guide the research process, providing a framework to gain valuable insights and make recommendations for enhancing financial information management. The proposed model uses SVM and a Decision tree The research focuses on integrating information technology into accounting systems to drive advancements in this field:

1. **Identify the Current Landscape:** Initiate the process by conducting a thorough examination of the prevailing manual bookkeeping and computerized accounting systems to gain a comprehensive understanding of the present state of financial information management. Evaluate the strengths and weaknesses of these systems, focusing on aspects such as potential risks, time requirements, and the effective utilization of human resources.
2. **Harness Benefits of Computerized Systems:** Delve into the advantages offered by computerized systems, including the mitigation of risks, reduction in time commitments,

and optimization of human resource utilization. Explore the specific domains where these benefits can effectively enhance the management of financial information.

3. **Streamline Report Generation:** Put forth strategies to enhance the efficiency of report generation within the accounting system. Propose approaches that streamline the process, such as automation and effective data capture, with the aim of optimizing the reporting process and minimizing the need for manual effort.
4. **Enhance Data Accessibility:** Formulate tactics to improve the accessibility of data within the proposed system. Explore the utilization of cloud computing solutions that facilitate instant access to financial information from various devices and locations.
5. **Incorporate Key Technological Advancements:** Integrate essential technological advancements, including cloud computing, big data analytics, and artificial intelligence, into the proposed system. Investigate the transformative potential of these technologies in revolutionizing financial processes and augmenting their efficiency.
6. **Evaluate the Impact on Essential Components:** Evaluate the influence of technological advancements on crucial elements of accounting systems, such as financial reporting, auditing, and decision-making processes. Examine how these advancements bring about transformations and improvements in these fundamental areas of accounting.
7. **Uncover Practical Insights and Recommendations:** Undertake thorough analysis and evaluation to delve deeply into the interplay between technology and accounting, aiming to reveal valuable insights and provide actionable recommendations. Explore the implications of these advancements for accounting professionals and policymakers, considering the practical implications that arise from the relationship between technology and the field of accounting.
8. **Comprehensive Methodology:** Utilize a comprehensive methodology in the research, integrating real-life case studies and empirical evidence. Conduct meticulous analysis and in-depth research to acquire a more profound comprehension of the transformative capacity of information technology in shaping the future of accounting systems.
9. **Implications for Professionals and Policymakers:** Illuminate the discoveries uncovered in the research and delve into their substantial implications for accounting professionals and policymakers. Offer practical insights to assist in navigating the constantly changing terrain of modern accounting, providing valuable guidance for professionals in the field.
10. **Focus Areas:** Place emphasis on the key areas of research, encompassing the evolution of accounting systems, advancements in information technology, modern accounting systems, the impact of technology on accounting, the efficiency of financial processes, and the adoption of technology in accounting. Make a valuable contribution to the expanding body of knowledge in this crucial field, advancing the understanding of the dynamic interplay between technology and accounting.

Input Dataset of Accounting Data

The dataset utilized for anomaly detection in this research is a real-life accounting dataset obtained from a microcredit organization in Bosnia and Herzegovina. The dataset comprises the general ledger, encompassing all transactions recorded during the year 2017. To safeguard client privacy, personal user data has been removed. The dataset contains approximately 4.5 million rows of data, and a portion of the dataset is depicted in Figure 1. The following information was extracted from the database: unique identifier (ID), transaction date, account number, encoded client ID, transaction type, organization ID, accounts receivable, accounts payable, and transaction description.

ID	ACCOUNT	RECEIVABLE	PAYABLE	ORGANIZA...	TYPE_OF...	YEAR	DATE	CLIENT	DESCRIPT...
3419100	6876113	0	161.600	011	IC	2017	05-SEP-17	53224	21361/223-...
3419101	204011014	78.300	0	011	IC	2017	05-SEP-17	192214	21361/224-...
3419102	6876113	0	78.300	011	IC	2017	05-SEP-17	192214	21361/224-...
3419103	204011014	129.700	0	011	IC	2017	05-SEP-17	195981	21361/225-...
3419104	6876113	0	129.700	011	IC	2017	05-SEP-17	195981	21361/225-...
3419105	204011014	105.500	0	011	IC	2017	05-SEP-17	159131	21361/226-...
3419106	6876113	0	105.500	011	IC	2017	05-SEP-17	159131	21361/226-...
3419107	204011014	67.900	0	011	IC	2017	05-SEP-17	27696	21361/227-...
3419108	6876113	0	67.900	011	IC	2017	05-SEP-17	27696	21361/227-...
3419109	204011014	197.200	0	011	IC	2017	05-SEP-17	111366	21361/228-...
3419110	36901126	88.400	0	0105031201	AU	2017	15-SEP-17	59883	Obracun GL...
3419111	36901116	0	88.400	0105031201	AU	2017	15-SEP-17	59883	Obracun GL...
3419112	180611214	28.100	0	0105030901	AU	2017	15-SEP-17	55781	Obracun KA...

Fig 2: Essential Accounting Information Dataset

COMPUTATIONAL METHODS

The computational methods outlined below offer solutions to address the problems or challenges associated with "Information Technology Advancements Shaping the Evolution of Modern Accounting Systems." These computational methods offer practical solutions to address the challenges and leverage the benefits of information technology advancements in shaping the evolution of modern accounting systems. Employ computational methods to analyze data and gain insights into the effects of information technology advancements on accounting systems. Utilize computational techniques to optimize resource allocation, risk management, and time utilization in accounting systems. Implement computational methods to automate manual tasks and streamline processes in accounting systems. Develop computational approaches to leverage cloud computing for enhanced data accessibility and real-time financial information management. Apply computational methods to handle large volumes of financial data and extract valuable insights for decision-making in accounting systems. Employ computational modeling to assess the impact of technology advancements on essential components of accounting systems. Utilize computational techniques for machine learning and artificial intelligence to enhance decision-making and provide intelligent recommendations in accounting systems. Conduct computational-based empirical analysis using real-life case studies to understand the effects of technology advancements on accounting systems. Design and develop computational decision support systems that assist accounting professionals and policymakers in navigating the changing landscape of modern accounting. Utilize computational modeling techniques to represent the interplay between technology and accounting and contribute to the knowledge base in this field.

1. **Data Analysis:** Leverage computational methods to analyze data extracted from both manual and computerized accounting systems. Employ statistical techniques to evaluate the benefits, drawbacks, risks, time requirements, and utilization of human resources associated with these systems.
2. **Optimization Algorithms:** Utilize computational optimization algorithms to pinpoint specific areas within accounting systems where the advantages of computerized systems can be effectively harnessed. Optimize resource allocation, risk management, and time utilization to enhance the management of financial information.
3. **Automation Techniques:** Utilize computational methods to implement automation techniques that streamline the process of report generation. Design algorithms to

automate data capture, analysis, and report generation, reducing the need for manual intervention and enhancing overall efficiency.

4. **Cloud Computing Solutions:** Leverage computational methods to conceive and execute cloud computing solutions that enhance the accessibility of data. Create algorithms that enable real-time access to financial information from various devices and locations, fostering efficient decision-making and facilitating seamless collaboration.
5. **Big Data Analytics:** Utilize computational methods, specifically big data analytics, to integrate significant technological advancements into accounting systems. Design algorithms capable of processing and analyzing large volumes of financial data, aiming to uncover patterns, trends, and insights that can drive optimization of financial processes.
6. **Impact Assessment Models:** Construct computational models aimed at evaluating the influence of technological advancements on critical elements within accounting systems. Utilize simulation techniques to assess how advancements in financial reporting, auditing, and decision-making processes bring about transformations and enhancements in these fundamental areas.
7. **Machine Learning and Artificial Intelligence:** Utilize computational methods encompassing machine learning and artificial intelligence to extract valuable insights and generate recommendations. Create algorithms capable of learning from data and making intelligent predictions or providing recommendations specifically tailored for accounting professionals and policymakers.
8. **Empirical Analysis:** Perform empirical analysis based on computational methodologies, employing real-life case studies as the foundation. Utilize computational techniques to analyze and interpret empirical data, thereby acquiring a more profound comprehension of the transformative capacity of information technology in shaping the future of accounting systems.
9. **Decision Support Systems:** Create and construct computational decision support systems tailored for accounting professionals and policymakers. Utilize computational methods to deliver practical insights, recommendations, and guidance that aid in effectively navigating the ever-changing landscape of modern accounting.
10. **Computational Modeling:** Utilize computational modeling techniques to depict the primary areas of focus in the research, comprising the evolution of accounting systems, advancements in information technology, modern accounting systems, the impact of technology on accounting, the efficiency of financial processes, and the adoption of technology in accounting. Develop computational models that contribute to the expanding knowledge base in this essential field, furthering the understanding of the dynamic interplay between technology and accounting.

DISCUSSION OF RESULTS

By utilizing SVM and Decision Tree algorithms, we applied advanced computational techniques to examine the accounting dataset and achieve optimal business analytics. The dataset used in the analysis was sourced from a microcredit organization in the banking sector, specifically focusing on accounting data. It encompassed the complete ledger and included all transactions recorded throughout the year 2023. To ensure privacy and confidentiality, any personally identifiable information was removed from the dataset. In total, the dataset comprised around 4.5 million rows of data. The extracted key information from the dataset included unique identifiers, transaction dates, account numbers, encoded client IDs, transaction types, organization IDs, accounts receivable, accounts payable, and transaction descriptions. This

dataset proved to be an invaluable resource for conducting anomaly detection analysis and gaining insights into the financial activities of the microcredit organization.

Performance Evaluation Methods

The overall trial outcomes are estimated and presented using commonly used statistical methods such as accuracy, precision, recall, F1-score, sensitivity, and specificity. For Research One, due to the limited sample size, the statistical results are represented with a 95% confidence interval, which is consistent with previous studies that also employed a small dataset [19, 20]. In our dataset, Prostate cancer can be classified as true positive (Tp) or true negative (Tn) if individuals are accurately diagnosed, and it can be classified as false positive (Fp) or false negative (Fn) if misdiagnosed. The specific statistical metrics employed are further elaborated below.

Accuracy:

Accuracy refers to the overall count of accurately recognized events across all instances. The precision is not completely determined using the formulas provided.

$$Accuracy = \frac{Tp + Tn}{Tp + Tn + Fp + Fn}$$

Precision:

Precision is calculated by determining the ratio of correctly predicted positive outcomes to the total predicted positive outcomes.

$$Precision = \frac{Tp}{Tp + Fp}$$

Recall:

Recall refers to the ratio of relevant results that the algorithm accurately identifies.

$$Recall = \frac{Tp}{Tn + Fp}$$

Sensitivity:

Sensitivity refers to the primary measure of accurately identified positive cases relative to the total number of cases, and it can be calculated using the following method.

$$Sensitivity = \frac{Tp}{Tp + Fn}$$

Specificity:

It identifies the number of accurately recognized and predicted true negatives and can be found using the following formula.

$$Specificity = \frac{Tn}{Tn + Fp}$$

F1-score:

The F1 score represents the harmonic mean of precision and recall. The highest possible F score is 1, indicating excellent recall and precision (73.34%).

$$F1 - Score = 2X\frac{PrecisionXRecall}{Precision + Recall}$$

The Area Under Curve (AUC):

The area under the curve (AUC) represents the performance of the models across various situations. AUC can be calculated using the following formulas.

$$AUC = \Sigma ri(Xp) - Xp$$

Evaluation Methods

The following are measurements of evaluation methods or metrics.

$$Quality = \frac{BP + VM}{BP + VP + BM + VM}$$

$$Preciseness = \frac{BP}{BP + VP}$$

$$Callback = \frac{BP}{BP + VM}$$

$$F - measure = \frac{2xPrecisenessxCallback}{Preciseness + Callback}$$

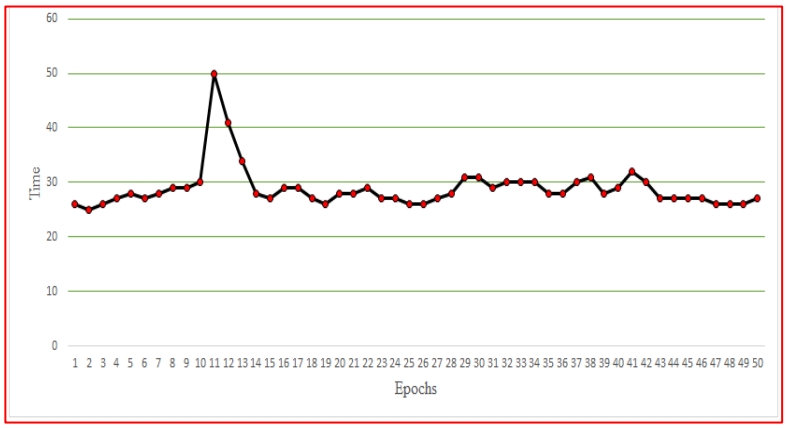

Figure 3: SVM Model Graph comparing Epochs vs. Time

The graph in Figure 3 illustrates the duration required to complete each iteration of epochs.

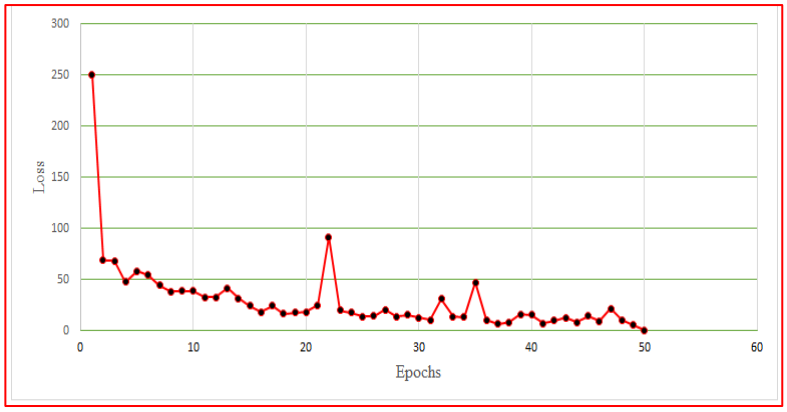

Figure 4: Comparison of Loss vs. Epochs in SVM Model Graph

The depicted Figure 4 illustrates the loss ratio associated with each epoch throughout the execution.

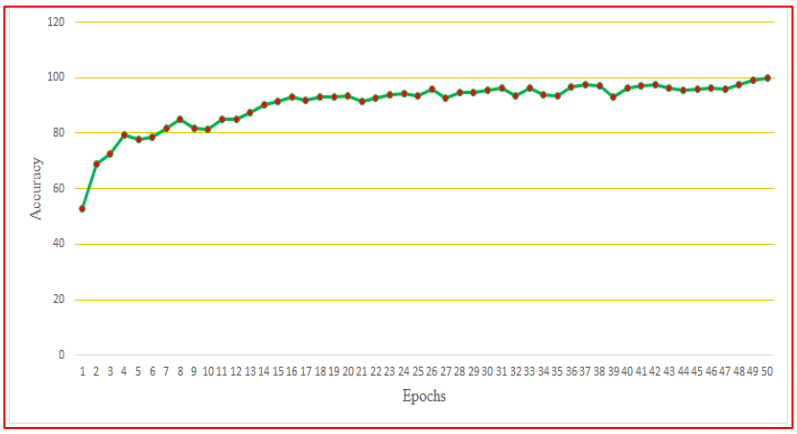

Figure 5: SVM Model graph comparing Accuracy vs. Epoch

Figure 5 depicts the accuracy (72.34%) attained for each epoch during the execution.

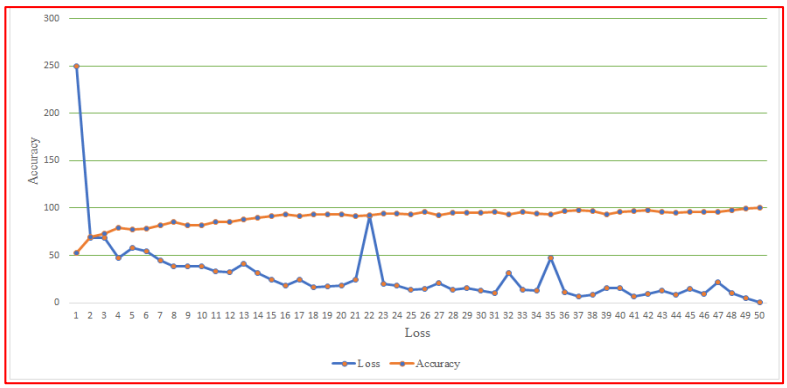

Figure 6: Decision Tree graph comparing Accuracy vs. Loss

Figure 6 showcases the reduction in loss and the corresponding accuracy achieved during each iteration of the training model for the Decision Tree.

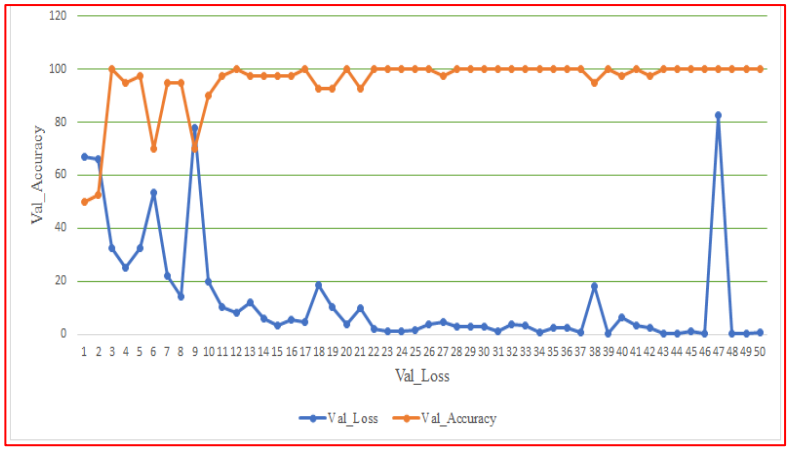

Figure 7: Decision Tree graph comparing Val_Accuracy vs. Val_Loss

The above-mentioned Figure 7 provides an explanation of the value loss and value accuracy obtained from the Decision Tree model during the training process.

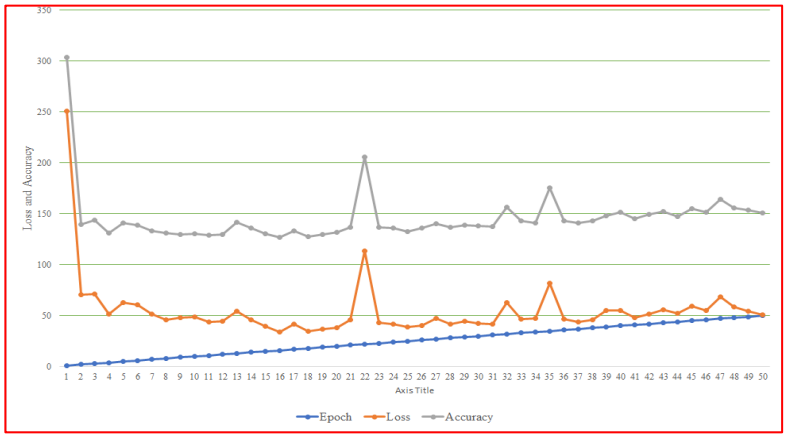

Figure 8: Decision Tree Model graph comparing Epoch vs. Loss vs. Accuracy

Figure 8 presents a concise overview of the comparison among epochs, loss, and accuracy of the Decision Tree model.

CONCLUSION

In summary, the proposed system capitalizes on the transition from manual bookkeeping to computerized accounting systems, aiming to elevate financial information management to new heights. By leveraging the advantages of computerized systems, such as risk reduction, time efficiency, and optimized resource utilization, our goal is to further enhance financial information management. The system aims to streamline report generation and improve data accessibility to maximize overall efficiency. Incorporating pivotal technological advancements such as cloud computing, big data analytics, and artificial intelligence, our system revolutionizes financial processes and enhances their efficiency. Our analysis encompasses critical aspects like financial reporting, auditing, and decision-making processes, as we delve into the interaction between technology and accounting, seeking practical insights and actionable recommendations. Employing a comprehensive methodology that includes the examination of real-life case studies and empirical evidence, our research deepens the understanding of the transformative potential of information technology in shaping the future of accounting systems. The findings of this research hold significant implications for accounting professionals and policymakers, offering

practical insights to navigate the ever-evolving landscape of modern accounting. By contributing to the growing body of knowledge in this essential field, our research advances the comprehension of the dynamic interplay between technology and accounting, providing valuable insights for professionals and policymakers alike. The proposed techniques exhibit improved precision, with SVM achieving an accuracy of 72.32% and Decision Tree achieving an accuracy of 79.34%. These results outperform the current system, indicating notable enhancement in accuracy.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 34-56

Analysis of the Influence of the Water/Graphene Nanofluid as Working Fluid on the Thermal Performance of Finned Heat Pipes Used in Air Conditioning

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Abstract:
This is a theoretical analysis of the influence of fractions of graphene nanoparticles associated with distilled water as a working fluid in a heat exchanger used in an air conditioning system for operating rooms. The heat exchanger consists of a set of finned heat pipes. Theoretical results are confronted with experimental results for water as the working fluid. The analysis is restricted to the evaporator since the nanoparticles do not influence the results in the condenser heat exchanger. The thermal efficiency method is applied to obtain the results. The analysis presents results for air velocity, Nusselt number for air, overall evaporator heat exchange coefficient, evaporator Nusselt number, evaporator thermal effectiveness, and the air outlet temperature. It was determined that the influence of fractions of graphene nanoparticles is not significant on the evaporator heat exchanger analyzed. Despite this, it is observed that smaller fractions of nanoparticles have a greater influence on thermal performance and there is an upper limit for volume fractions.

Keywords: Finned heat pipes, water/graphene nanofluid, air conditioning, boiling heat transfer correlations, thermal efficiency method.

INTRODUCTION

The objective is to apply the analytical thermal efficiency method to analyze the influence of graphene particles on the performance of the heat pipe system in the evaporator of the heat exchanger studied by Ragil Sukarno [1]. The Figures below show the heat pipe system in the evaporator and condenser, and how they are in a staggered configuration in rows of 4 pipes. The original working fluid is water and has a saturation temperature of 27°C.

The system used in the experiment carried out for the thermal analysis of the heat exchanger consists of sets of 12, 24, and 36 finned heat pipes, as shown in Figure (1.a), Figure (1.b) and Figure (1. c). The experiment was carried out by Ragil Sukarno et al. [1], who used the effectiveness method (ε-NTU) for global analysis of the heat exchanger. The finned heat pipe heat exchanger (FHPHE) has a staggered configuration consisting of three, six, and nine rows of heat pipes. The air inlet temperature in the evaporator ranges from 30.0°C to 45°C. The airflow ranges from 0.05 kg/s to 0.095 kg/s.

Nandy Putra et al. [2] experiment with heat recovery using finned heat pipes, with water as the working fluid, in an air conditioning system. They analyze the influence of the number of heat pipes, inlet temperature, and inlet air velocity. They determine that finned heat exchanger performance strongly depends on air velocity and that higher inlet velocity enables better performance.

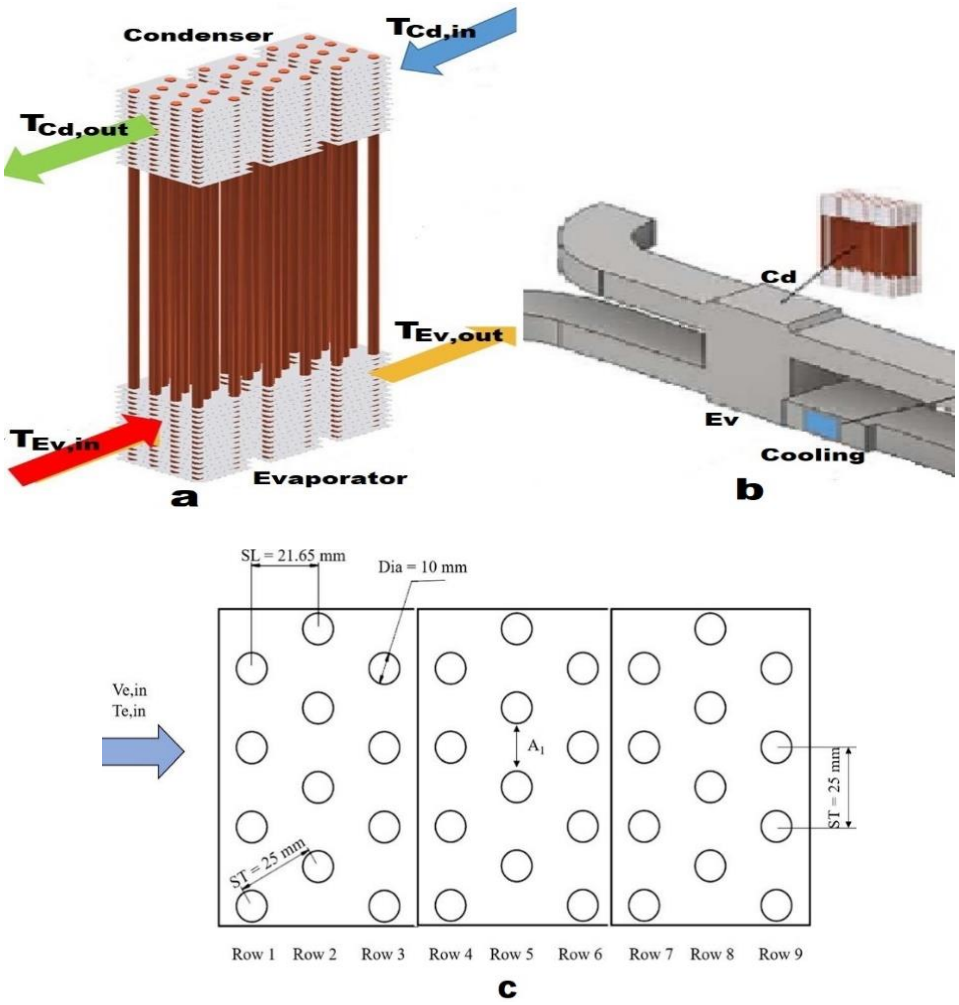

Figure (1. a) represents the set of finned heat pipes [1]; Figure (1. b) represents the evaporator (pre-cooling), conventional cooling, condenser (energy recovery), and air circulation pipes [1]; Figure (1. c) schematically represents the set of finned heat pipes arranged in the heat exchanger shell [1].

Grzegorz Górecki et al. [3] study a small air-conditioning system consisting of individually finned heat pipes using R404 refrigerant as the working fluid. Theoretical-experimental work makes it possible to conclude that individual fins are an alternative to conventional heat exchangers and that they are less susceptible to deformation and easy to replace and clean.

H. Jouhara et al. [4] uses a finned tube heat exchanger consisting of multiple passes. The theoretical-experimental study aims at heating water using heated air, that is, recovery of residual energy. They use two theoretical methods for determining thermal quantities and comparing them with experimental results. It is a global implementation of the heat exchanger, and the methods used by them were the Log Mean Temperature Difference Method (LMTD) and the Effectiveness Method (ε-NTU). They report the significant importance of the Reynolds number in thermal performance.

Khaled Elsaid et al. [5] present a discussion related to the use of graphene as a nanofluid component with a focus on thermophysical properties. They argue that nanofluids using graphene have higher thermal conductivity than most nanofluids using metallic oxides and present a table of properties for comparison. However, they point out that there are major

challenges related to its use. They cite cost, stability, higher values for density and viscosity, environmental impacts, and preparation methods. They conclude that such challenges require careful investigation.

Naser Ali [6] studies characteristics related to graphene, such as thermophysical properties, and dispersion stability. It presents values for density, thermal capacity, thermal conductivity, and viscosity, in graphic form, for a nanofluid composed of water and graphene, with percentage values of volume fraction equal to 0.01%, 0.05%, and 0.10%. He argues that a feasibility study of the presented nanofluid is necessary before being used in real applications. Emphasizes cost, performance evaluation, and environmental impact aspects. It also analyzes the use of surfactants related to the stability of the nanofluid and concludes that stability of 45 days can be reached when using higher-weight surfactants.

The performance of thermosiphons can be improved with the use of nanofluids, as argued by A. Kamyar et al. [7]. They present a study to corroborate their statements and use two nanofluids using water mixed with Al_2O_3 and $TiSiO_4$ nanoparticles, with volume fractions equal to 0.01%, 0.05% and 0.07%. The results presented demonstrate that there is a reduction in thermal resistance and an improvement in the performance of the thermosiphons. They emphasize that the boiling coefficient increases with the use of nanoparticles in thermosiphons and, as a numerical argument, they use the Merit number that makes it possible to determine the relative effect of the properties of the nanofluid. However, they consider that the performance of thermosiphons depends on particle size, particle type, bubble nucleation size, and base fluid.

Agnieszka Kujawska et al. [8] state that the performance of the condenser is not influenced by the nanofluids used in the heat pipe and that the performance analysis should be concentrated on the evaporator. They analyze the surface tension and contact angle of silica and graphene oxide nanofluids and argue that nanoparticles tend to deposit on the surface of the evaporator during the boiling process. This deposit alters the conditions in the wall and in the region close to it, and the effect this may have on the nanofluid properties is unknown. It is known, however, that changes in surface tension and wettability affect the boiling regime. The study presents numerical results for the surface tension of graphene oxide before and after the boiling process, with water as the base fluid. They also analyze the influence of surfactants on the surface tension associated with the nanofluid. They conclude that graphene has surface tension and contact angle similar to water, when in small concentrations and state, citing references, that the impact of graphene oxide on heat transfer capacity is not related to surface tension or wettability. However, they add, more research is needed to determine the influence of the use of nanofluids in thermosyphons at the boiling process, and that the studies carried out are rarely associated with real applications, especially in low-pressure devices.

Amir Akbari et al..[9] state that the use of nanofluids related to an increase in nucleated boiling has aroused great interest. They carried out an experimental study conducted under atmospheric pressure to compare the effects of graphene nanoplatelets and multi-walled carbon nanotubes on the heat transfer coefficient associated with pool boiling and the critical heat flux. They verified that nanoparticles with percentage concentrations in weight equal to 0.01, 0.05, and 0.1% altered the heat transfer coefficient and the critical heat flux, about deionized water. Concentrations above 0.01% by weight decreased the heat transfer coefficient and increased the critical heat flux. Furthermore, they experimentally demonstrated that the thermal conductivity of nanofluids and

the functionalization method (non-covalent and covalent) directly affect the heat transfer coefficients and the critical heat flux.

Jaqueline Barber et al. [10] published a review related to recent advances in pool boiling and convective boiling related to the use of nanofluids. The review work focused on the improvement and degradation in the nucleate boiling heat transfer coefficient and critical heat flux and concluded that there are conflicting data published in the literature presented in tabular form. They found that most of the work reports that the deposition of nanoparticles on the surface of the heat exchanger is related to an increase in the critical heat flux with the use of nanofluids.

K. N. Shukla et al. [11] present experimental work with a cylindrical copper heat pipe filled with different working fluids. They performed tests with deionized water, and nanofluids composed of silver-aqua and copper-water. They found a 14% increase in heat pipe efficiency with the use of nanofluids compared to deionized water as the working fluid. They observed an increase in the thermal conductivity of nanofluids with 0.1% by weight of nanoparticles. They find that nanoparticles can create several active nucleation sites, enabling an increase in heat transfer by boiling, with a consequent decline in the temperature profile.

Kapilan Natesan and Shashikantha Karinka[12] argue that the use of energy in its various forms is vital for the development of any country. They add that it is one of the most used devices in heat transfer applications and that any effective improvement of heat exchange between fluids brings benefits. They claim that the solid particles have higher thermal conductivity than the usual working fluids used in heat pipes and can improve the efficiency of heat exchangers. They mention that graphene-based nanoparticles have high thermal conductivity, low erosion, and enable an increase in the heat transfer rate. This improvement in heat transfer can lead to equipment downsizing in different types of applications. In this sense, the review highlights the advantages of using graphene, for example, in electronic devices.

Mohammed Salah Hameed [13] recognizes that there are four correlations frequently used to simulate nucleate boiling and that each of them is differentiated by the variables used in its implementation. With the objective of improving the precision in the determination of the boiling heat transfer coefficient, they develop a generalized empirical correlation that satisfies a wide range of experimental data available in the literature. They use the least squares multiple regression techniques to determine a correlation that allows minimum deviation. They test the correlation developed by the linear and non-linear programming solution and using a wide range of literature data presented by Rohsenow, Forster and Zuber, Forster and Greif, and Gupta and Varshney.

Suriyawong et al. [14] present a study where they developed a new correlation for predicting the nucleate pool boiling heat transfer coefficient of TiO_2-Water nanofluids for low concentrations. The proposed correlation considers several relevant factors. They use data obtained from studies that show correlations associated with nanofluid properties and develop a correlation that predicts results with good accuracy for the copper surface but with poor accuracy for the aluminum surface.

Élcio Nogueira [15] applied the second law of thermodynamics through the concepts of thermal efficiency, thermal effectiveness, and thermal irreversibility in a shell and tube heat exchanger

utilizing a water-ethylene glycol associated with fractions of nanoparticles. Volume fractions equal to 0.01, 0.10, and 0.25 were considered for analysis for nanoparticles of Ag and Al_2O_3. He concluded that, when the Reynolds number is relatively small in a laminar regime, high effectiveness, associated with high thermal irreversibility, leads to heat transfer rates that approach the maximum possible.

Élcio Nogueira [16] states that the thermal efficiency method, associated with viscous irreversibility and the thermodynamic Bejan number, enables analysis of the optimization of heat exchangers. It applies the method to the cooling of machine oil in a heat exchanger with external fins associated with the tubes. He includes spherical nanoparticles of Boehmite Alumina in the analysis, concluding that the inclusion of nanofluid presents a significant improvement in thermal performance, associated with an increase in viscous dissipation, and a decline in the Bejan number.

Élcio Nogueira [17] analyzes the influence of the thermal performance of a shell and tube-type condenser, with water and aluminum oxide (Al_2O_3) nanoparticles flowing into the tube. The principles parameters used to analyze the thermal performance are thermal efficiency and thermal effectiveness, and the results demonstrate that efficiency is high and that the effectiveness can be increased by introducing fractions of nanoparticles in the water.

METHODOLOGY

The formulation below, Equations (1) – (91) is related to the thermal performance of the heat exchanger analyzed by Ragil Sukarno et al. [1], represented through Figures 1.a, 1.b and 1.c. Graphene volume fractions are represented by the parameter ϕ which ranges from 0.001 to 0.100.

$$T_{sat} = 27.0\,^{o}C \;\; fixed \tag{1}$$

$$T_{airin} = 30\,^{o}C \;\; default, \;\; 30^{o}C \le T_{airin} \le 45^{o}C \tag{2}$$

$$T_{W} = T_{airin} \;\; by\ definition \tag{3}$$

T_{sat} is the saturation temperature of the working fluid, T_{airin} is the air inlet temperature, T_W is the surface temperature of the heat pipe.

$$\phi = 0.01 \;\; default, \;\; 0.001 \le \phi \le 0.100$$

ϕ is the volume fraction of the nanofluid.

$$k_{air} = 6.9174418610^{-5} Tair_{in} + 0.02462173663 \tag{4}$$

$$\mu_{air} = 1.954836211 10^{-5} + 2.735058039\,10^{-9} Tair_{in} + 2.309587479\,10^{-10} Tair_{in}^{2} - 4.5058823510^{-13} Tair_{in}^{3} \tag{5}$$

$$Cp_{air} = 1003.728948 + 0.06727399886 * Tair_{in} + 3.565918367\,10^{-6} Tair_{in}^2 + 8.222222222\,10^{-7} Tair_{in}^3 \quad (6)$$

$$\rho_{air} = 1.219135515 - 0.002152770329 Tair_{in} - 3.64047479\,10^{-7} Tair_{in}^2 + 1.705882353\,10^{-9} Tair_{in}^3 \quad (7)$$

$$\nu_{air} = \frac{\mu_{air}}{\rho_{air}} \quad (8)$$

$$\alpha_{air} = \frac{k_{air}}{\rho_{air} Cp_{air}} \quad (9)$$

$$\mathrm{Pr}_{air} = \frac{\nu_{air}}{\alpha_{air}} \quad (10)$$

Equations (4-10) represent the properties of air at the air inlet temperature.

$$k_W = 0.5521904762 + 0.002561507937 T_W - 1.8720238\,10^{-5} T_W^2 + 5.902777778\,10^{-8} T_W^3 \quad (11)$$

$$Cp_W = 4217.8 - 3.412833333 T_W + 0.109375 T_W^2 - 0.0016890625 T_W^3 + 1.34375\,10^{-5} T_W^4 - 4.088541667\,10^{-8} T_W^5 \quad (12)$$

$$\rho_W = 1002.676071 - 0.06559821429 T_W - 0.003582589286 T_W^2 \quad (13)$$

$$\nu_W = 1.787666667\,10^{-6} - 5.532222222\,10^{-8} T_W + 9.82708333\,10^{-10} T_W^2 - 8.965277778\,10^{-12} T_W^3 + 3.17708333\,10^{-14} T_W^4 \quad (14)$$

$$\mu_W = \rho_W \nu_W \quad (15)$$

$$\alpha_W = \frac{k_W}{\rho_W Cp_W} \quad (16)$$

$$\mathrm{Pr}_W = \frac{\nu_W}{\alpha_W} \quad (17)$$

Equations (11-16) represent the properties of water at the heat pipe.

$$P_{sat} = 216.7691429 - 5.927342857 T_{sat} + 0.04774285714 T_{sat}^2 \quad (18)$$

P_{sat} is the saturation pressure of the working fluid.

$$\nu_l = 0.001585485714 - 1.831904762\,10^{-5} T_{sat} + 1.957142857\,10^{-7} T_{sat}^2 - 6.666666667\,10^{-10} T_{sat}^3 \quad (19)$$

$$\rho_l = \frac{1}{\nu_l} \quad (20)$$

$$\nu_V = 21.45466571 - 0.3398517143 T_{SAT} + 0.001419714286 T_{sat}^2 \quad (21)$$

$$\rho_v = \frac{1}{\nu_v} \quad (22)$$

Equations (19-22) represent the properties of the saturated liquid and saturated vapor in the heat pipe.

$$h_l = 2.184 + 4.2124 T_{sat} \quad (23)$$

$$h_v = 1.540666667 T_{sat} + 2521.596667 \quad (24)$$

$$h_{lv} = h_v - h_l \quad (25)$$

h_{lv} represents the latent heat of vaporization.

$$NHP = 12\ default; 12 \le NHP \le 36 \quad (27)$$

NHP is the number of heat pipes associated with the heat exchanger.

$$NFin = 30\ default;\ 0 \le NFin \le 30 \quad (28)$$

$NFin$ is the number of fins per heat pipe.

$$NHP_{byrows} = 4 \quad (29)$$

NHP_{byrows} is the number of heat pipes per row.

$$Nrows = \frac{NHP}{NHP_{byrows}},\ 3 \le Nrows \le 9 \quad (30)$$

$Nrows$ is the number of rows in the heat exchanger.

$$Vair_{inlet} = 1.5\ m/s\ default\ ;\ 1.5 \le Vair_{inlet} \le 2.5 \quad (31)$$

$Vair_{inlet}$ is the air velocity at the evaporator inlet.

$$\dot{m}_{air} = 0.050\ kg/s\ default;\ 0.050 \le \dot{m}_{air} \le 0.095 \tag{32}$$

$\dot{m}_{air}$ is the mass flow rate of air.

$$TEv_{in} = T_{airin};\ 30.0^{o}C \le TE_{in} \le 45.0^{o}C \tag{33}$$

$$\sigma_{Water} = 0.07275\left(1 - 0.002\left(368.15 - 291.15\right)\right) \rightarrow \textit{valid for water} \tag{34}$$

σ_{Water} is the surface tension associated with water.

$$r = 0.33 \tag{35}$$

$$C_{sf} = 0.015 \tag{36}$$

$$C_{sf}^{*} = 1503 \tag{37}$$

$$l^{*} = \sqrt{\left(\frac{\sigma_{Water}}{g(\rho_l - \rho_v)}\right)} \tag{38}$$

l^{*} is the characteristic length.

$$q'' = \mu_W h_{lv} l^{*} \left(\frac{1}{Csf}\right)^{0.33} Pr_W^{\,1/r} \left(\frac{\sigma_{Water} \Lambda T_{sat}}{h_{lv}}\right)^{1/r} \tag{39}$$

q'' is the heat flux associated with the boiling process based on the equation obtained by Rhosenow [18].

$$h_{boil} = 1.39\left(\frac{k_W}{l^{*}}\right)\left(\frac{q'' \rho_W Cp_W l^{*}}{\rho_W h_{lv} k_W}\right)^{0.7} \left(\frac{\rho_l}{\rho_v}\right)^{0.21} \left(\frac{\mu_W Cp_W}{k_W}\right)^{-0.21} \rightarrow \text{valid for water} \tag{40}$$

h_{boil} Equation (40), an expression developed by Gupta and Varshney, is the heat transfer coefficient associated with the boiling process valid for water [13].

$$\rho_{Grap} = 3000\ kg/m^3 \tag{41}$$

$$k_{Grap} = 2500\ W/(mK) \tag{42}$$

$$Cp_{Grap} = 711\ J/(kgK) \tag{43}$$

$$\mu_{nano} = (1-\phi)^{-2.5} \mu_W \tag{44}$$

$$\rho_{nano} = \phi\rho_{Grap} + (1-\phi)\rho_W \tag{45}$$

$$Cp_{nano} = \frac{\phi\rho_{Grap}Cp_{Grap} + (1-\phi)\rho_W Cp_W}{\rho_{nano}} \tag{46}$$

$$k_{nano} = [\frac{k_{Grap} + 2k_W + 2(k_{Grap} - k_W)(1+0.1\phi)^3\phi}{k_{Grap} + 2k_W - 2(k_{Grap} - k_W)(1+0.1\phi)^2\phi}]k_W \tag{47}$$

$$\mu_{nano} = \rho_{nano}\nu_{nano} \tag{48}$$

$$\alpha_{nano} = \frac{k_{nano}}{\rho_{nano}Cp_{nano}} \tag{49}$$

$$\mathrm{Pr}_{nano} = \frac{\nu_{nano}}{\alpha_{nano}} \tag{50}$$

$$\sigma_{nano} = 0.0726505555 - 1.621336444d-5*Tsat - 1.367231268d-6*Tsat**2.0 \tag{51}$$

σ_{nano} is the surface tension associated with nanofluid [7].

$$\varepsilon = 0.210^{-6} \tag{52}$$

ε is the surface roughness [15].

$$h_{boil} = 28.85\,Pr_{nano}^{0.59}(\frac{q''\varepsilon}{\mu_{nano}h_{lv}})^{0.70}(\varepsilon^2 g(\frac{\rho_{nano} - \rho_v}{\sigma_{nano}}))^{0.16}(\frac{k_{nano}}{\varepsilon(\phi + 0.001)}) \rightarrow \text{valid for nanofluid} \tag{53}$$

h_{boil} Equation (53) is the heat transfer coefficient associated with the boiling process valid for nanofluid [14].

$$\Delta T_{Evsat} = TEv_{in} - T_{sat} \tag{54}$$

$$D_{ext} = 10.3\,10^{-3}\ m \tag{55}$$

$$D_{\mathrm{int}} = 10.0\,10^{-3}\ m \tag{56}$$

D_{ext} is the outer diameter of the heat pipe. D_{int} is the inner diameter of the heat pipe.

$$kW = 401.0\,W/(mK) \tag{57}$$

kW is the thermal conductivity of the heat pipe material (copper).

$$LEv = 160.010^{-3} \tag{58}$$

LEv is the length of the evaporator.

$$LEv_H = N_{Rows}\frac{LEv}{9.0} \tag{59}$$

LEv_H is the horizontal length of the heat exchanger.

$$t_{Fin} = 0.10510^{-3} \tag{60}$$

t_{Fin} is the thickness of the fins.

$$k_{Fin} = 235.0 \tag{61}$$

k_{Fin} is the thermal conductivity of the fin material.

$$Sp_{Fin} = 2.0\,10^{-3}\ by\ definition \tag{62}$$

Sp_{Fin} is the distance between fins.

$$LEv_{effec} = LEv - (NFin\,t_{Fin} + 4\pi D_{ext} Sp_{Fin}) \tag{63}$$

LEv_{effec} is the effective length of the evaporator.

$$Dh_{EV} = \frac{4\,LEv_H\ LEv_{effec}}{2(LEv_H + LEv_{effec})} \tag{64}$$

Dh_{EV} is the hydraulic diameter of the evaporator.

$$\mathrm{Re}_{Ev} = \frac{4\dot{m}_{air}}{\pi Dh_{Ev}\mu_{air}} \tag{65}$$

Re_{Ev} is the Reynolds number associated with the evaporator.

$$A\sec_{Ev} = \frac{\dot{m}_{air} Dh_{Ev}}{\mathrm{Re}_{air}\ \mu_{air}} \tag{66}$$

$A\sec_{Ev}$ is the cross-sectional area associated with the evaporator.

$$V_{Ev} = \frac{\dot{m}_{air}}{A\sec_{Ev}\ \rho_{air}} \tag{67}$$

V_{Ev} is the air velocity in the evaporator.

$$ST = 25.010^{-3} \tag{68}$$

$$SL = 21.6510^{-3} \tag{69}$$

ST and SL are lengths associated with the set of heat pipes (Figure 1.c).

$$Vair_{\max} = \frac{ST}{SL - Dext} Vair_{inlet} \tag{70}$$

$Vair_{\max}$ is the maximum air velocity in the evaporator.

$$Atr_{EvFin} = NFin\, LEv_H\, LEv \tag{71}$$

Atr_{EvFin} is the heat rock area associated with fins.

$$Atr_{EvHP} = NHP\, \pi D_{ext} (LEv - NFin\, Sp_{Fin}) \tag{72}$$

Atr_{EvHP} is the heat exchange area associated with the heat pipes.

$$A_{EvTotal} = Atr_{EvFin} + Atr_{EvHP} \tag{73}$$

$A_{EvTotal}$ é a área de troca de calor total no evaporador.

$$Nu_{Ev} = F\, 0.71 \mathrm{Re}_{Ev}^{0.5}\, \mathrm{Pr}_{Ev}^{0.36} (\frac{\mathrm{Pr}_{Evair}}{\mathrm{Pr}_{EvSurf}})^{0.25} \tag{74}$$

Nu_{Ev} is the Nusselt number associated with the evaporator, where F=0.98 by definition.

$$h_{Ev} = \frac{Nu_{Ev} k_{air}}{Dh_{EV}} \tag{75}$$

h_{Ev} is the convection heat exchange coefficient.

$$mL_{EvFin} = \sqrt{\frac{2h_{Ev}}{k_{Fin} t_{Fin}}}\, LEv_H \tag{76}$$

mL_{EvFin} dimensionless parameter associated with the fins.

$$\eta_{EvFin} = \frac{\mathrm{Tanh}(mL_{EvFin})}{mL_{EvFin}} \tag{77}$$

η_{EvFin} is the efficiency associated with fins.

$$\beta_{Ev} = \frac{Atr_{EvFin}}{A_{Total}} \tag{78}$$

β_{Ev} is the ratio between the heat exchange area of the fins in relation to the total area.

$$\eta'_{EvFin} = \beta_{Ev}\,\eta_{EvFin} + (1 - \beta_{Ev}) \tag{79}$$

η'_{EvFin} is the effective efficiency associated with the set of fins.

$$Uo_{Ev} = \frac{1}{\frac{1}{h_{boil}} + \frac{D_{ext} - D_{int}}{kW} + \frac{1}{\eta'_{EvFin} h_{Evair}}} \tag{80}$$

Uo_{Ev} is the overall heat transfer coefficient associated with the evaporator.

$$C_{Air} = \dot{m}_{air} Cp_{air} \tag{81}$$

$$C_{Ev} = C_{air} \tag{82}$$

C_{Air} is the heat capacity of air.

$$NTU_{Ev} = \frac{Uo_{Ev} A_{EvTotal}}{CEv} \tag{83}$$

NTU_{Ev} is the number of thermal units associated with the evaporator.

$$Fa = \frac{NTU\sqrt{1 + C^{*2}}}{2}\ for\ cross - flow \tag{84}$$

Fa is a dimensionless parameter called "Analogy of Fins", associated with the efficiency method [16-18]. $C^* = \frac{C_{min}}{C_{max}} = 0$ to the evaporator ($C_{max} \to \infty$).

$$\eta_T = \frac{tanh(Fa)}{Fa} \tag{85}$$

η_T is the thermal efficiency associated with the heat exchanger.

$$\varepsilon_T = \frac{1}{\frac{1}{\eta NTU} + \frac{1 + C^*}{2}} \tag{86}$$

ε_T is the thermal effectiveness associated with the heat exchanger.

$$Fa_{Ev} = \frac{NTU_{Ev}}{2} \tag{87}$$

$$\eta_{TEv} = \frac{tanh(Fa_{Ev})}{Fa_{Ev}} \tag{88}$$

$$\varepsilon_{TEv} = \frac{1}{\frac{1}{\eta_{TEv} NTU_{Ev}} + \frac{1}{2}} \tag{89}$$

$$\dot{Q}_{Ev} = \frac{C_{Ev} \Delta T_{Evsat}}{\frac{1}{\eta_{TEv} NTU_{Ev}} + \frac{1}{2}} \tag{90}$$

$\dot{Q}_{Ev}$ is the rate of heat transfer in the evaporator.

$$TEv_{out} = TEv_{in} - \frac{\dot{Q}_{Ev}}{C_{Ev}} \tag{91}$$

TEv_{out} is the outlet temperature of the air in the evaporator.

RESULTS AND DISCUSSION

The results presented below are related to the following parameters for analysis of the formulated problem: the number of heat pipes, the number of fins per heat pipe, air flow rate, air inlet temperature, and graphene volume fraction. The quantities of interest obtained in the analysis were the air velocity in the evaporator, the global heat transfer coefficient, the number of thermal units associated with the evaporator, the effectiveness of the evaporator, and the outlet temperature in the evaporator.

Figure 2 presents theoretical and experimental results [1] for air velocity in the evaporator, as a function of mass airflow rate. The parameters that vary are the number of heat pipes and the number of fins per heat pipe. The air velocity decreases with the increase of heat pipes and increases with the number of fins per heat pipe, that is, the area of the fins has a significant influence on the air velocity. The theoretical results are below the maximum experimental velocity value and the experimental evaporator velocity results are between the valid results for 12 and 24 heat pipes. There is, therefore, theoretical-experimental consistency in the results obtained.

Figure 3 shows values for the overall heat transfer coefficient, with air mass flow rate and graphene nanoparticle volume fraction as parameters. An increase in the coefficient is observed with the increase in the number of fins, and with the imposition of nanoparticles in the working fluid, with a volume fraction equal to 0.01%.

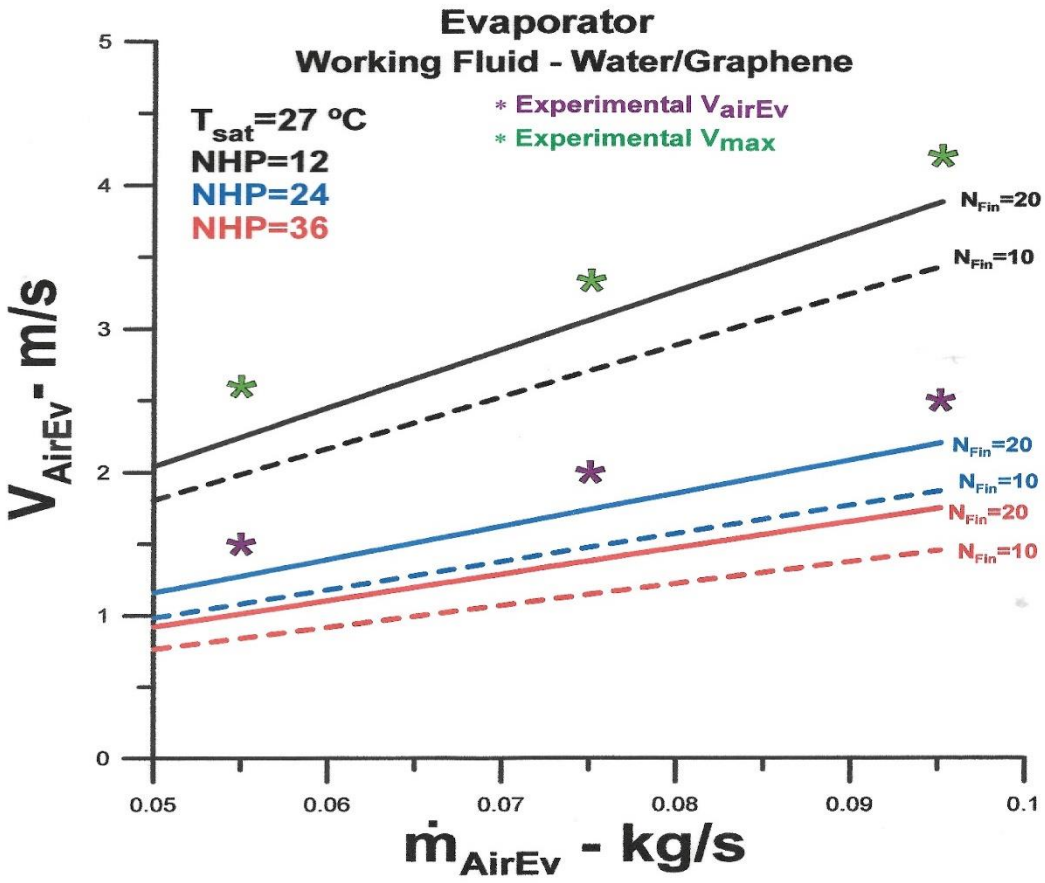

Figure 2: Evaporator air velocity versus mass air flow rate

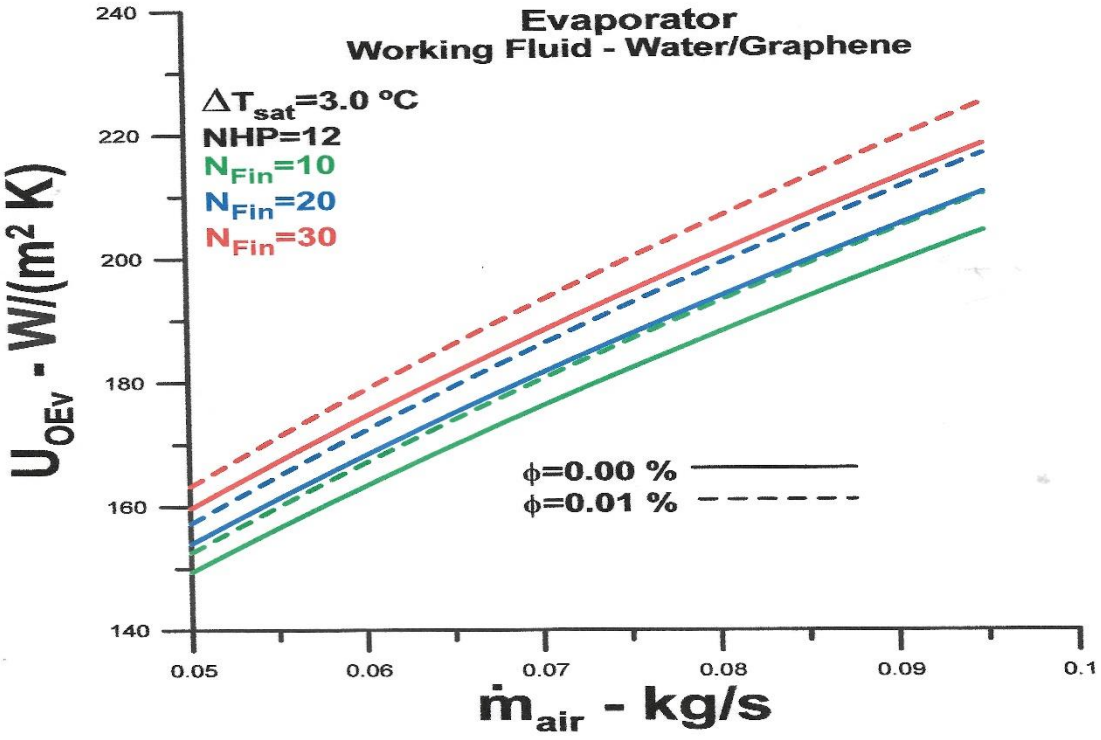

Figure 3: Evaporator Overall heat transfer coefficient versus mass air flow rate

Figure 4 shows that the number of thermal units in the evaporator grows with the number of fins and with the volume fraction of the nanofluid. The influence of nanoparticles, with a volume fraction equal to 0.01%, is more significant when there is an increase in the number of fins per heat pipe, that is when there is an increase in the heat exchange area. However, even for a larger number of fins, the relative difference between results with and without nanoparticles is small.

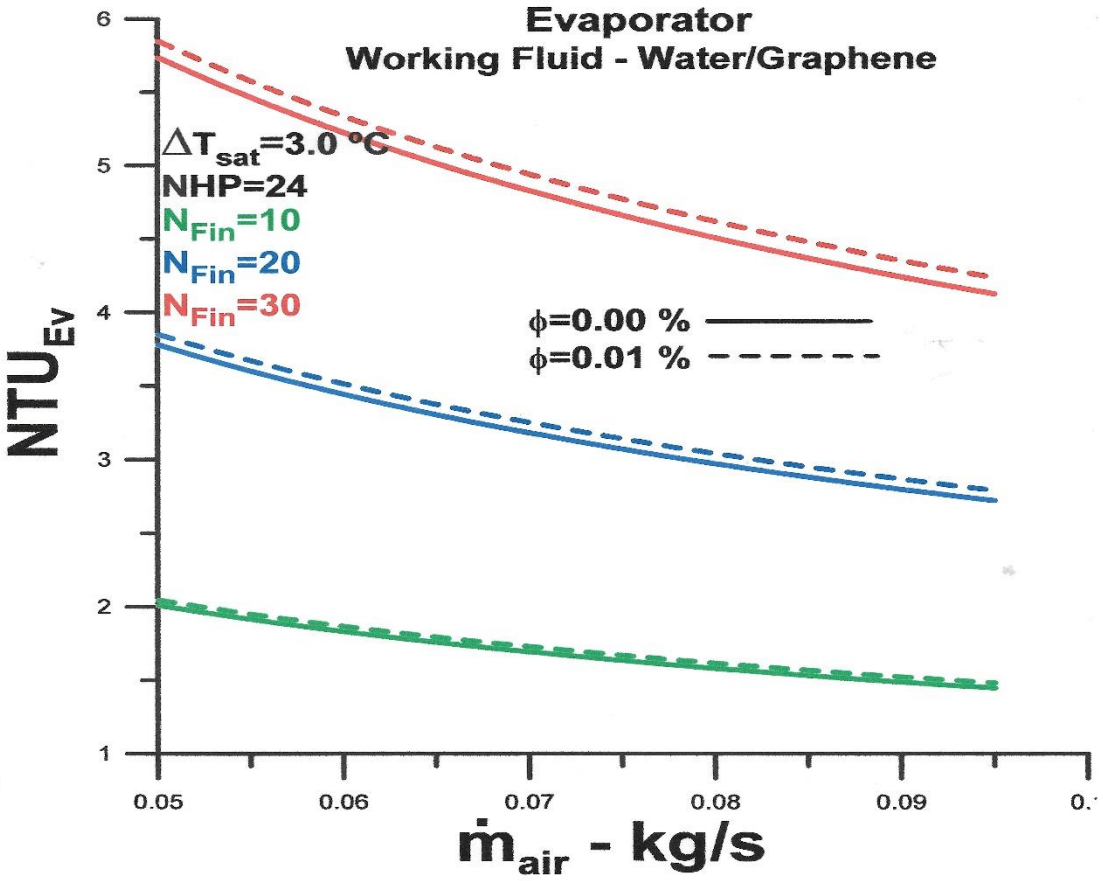

Figure 4: Evaporator number of thermal units versus mass air flow rate

Figure 5 presents results for effectiveness as a function of air mass flow rate and nanoparticles volume fraction, ϕ =0.01. Effectiveness decreases with increasing mass airflow rate. The effectiveness reaches a value very close to the maximum for NHP=24 and N_{Fin}=30, and there is no difference between with and without nanofluid. However, a slight difference can be observed when NFin=10. In practical terms, there is no advantage in using heat pipe values above 24, with 30 fins.

Figure 6 shows theoretical and experimental results for thermal effectiveness, with variation in air inlet temperature and ϕ =0.01. Effectiveness grows with the number of heat pipes and with the number of fins. When comparing situations with and without graphene nanoparticles, a slight increase in effectiveness is observed for lower inlet temperature values. However, the difference becomes almost imperceptible for a larger number of fins. Experimental results [1] are consistent with values obtained through the theoretical procedure.

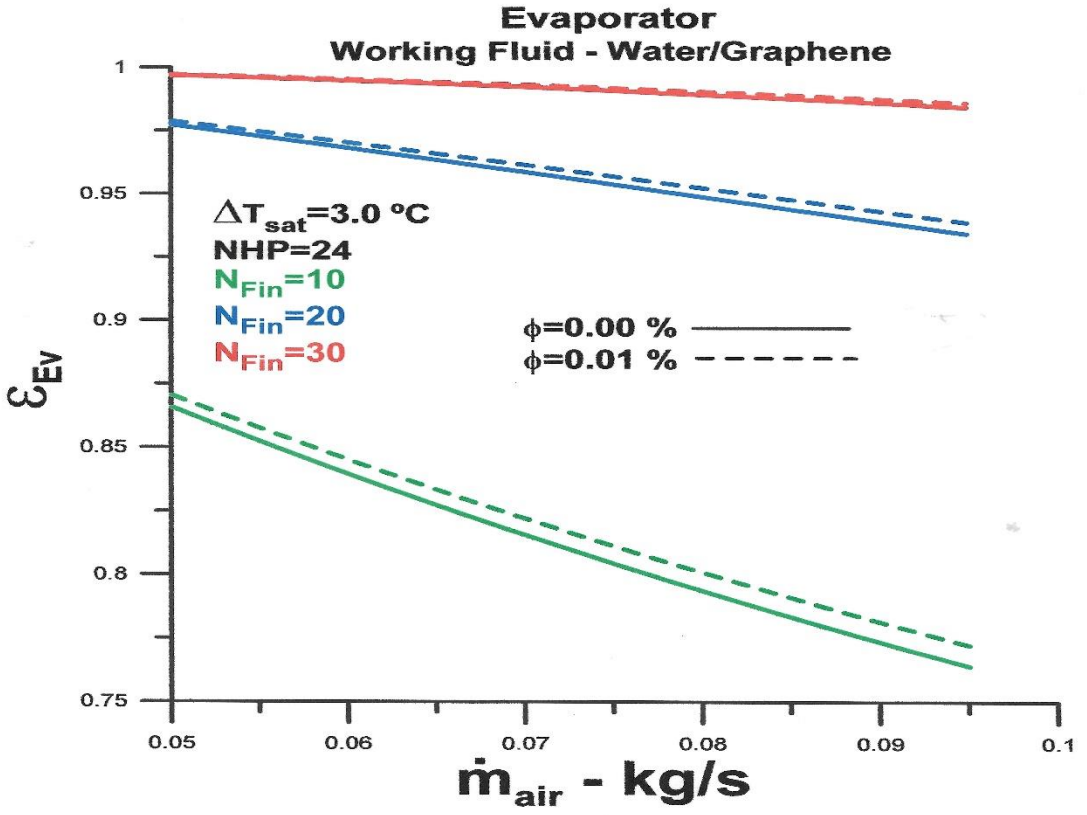

Figure 5: Thermal effectiveness number versus mass air flow rate

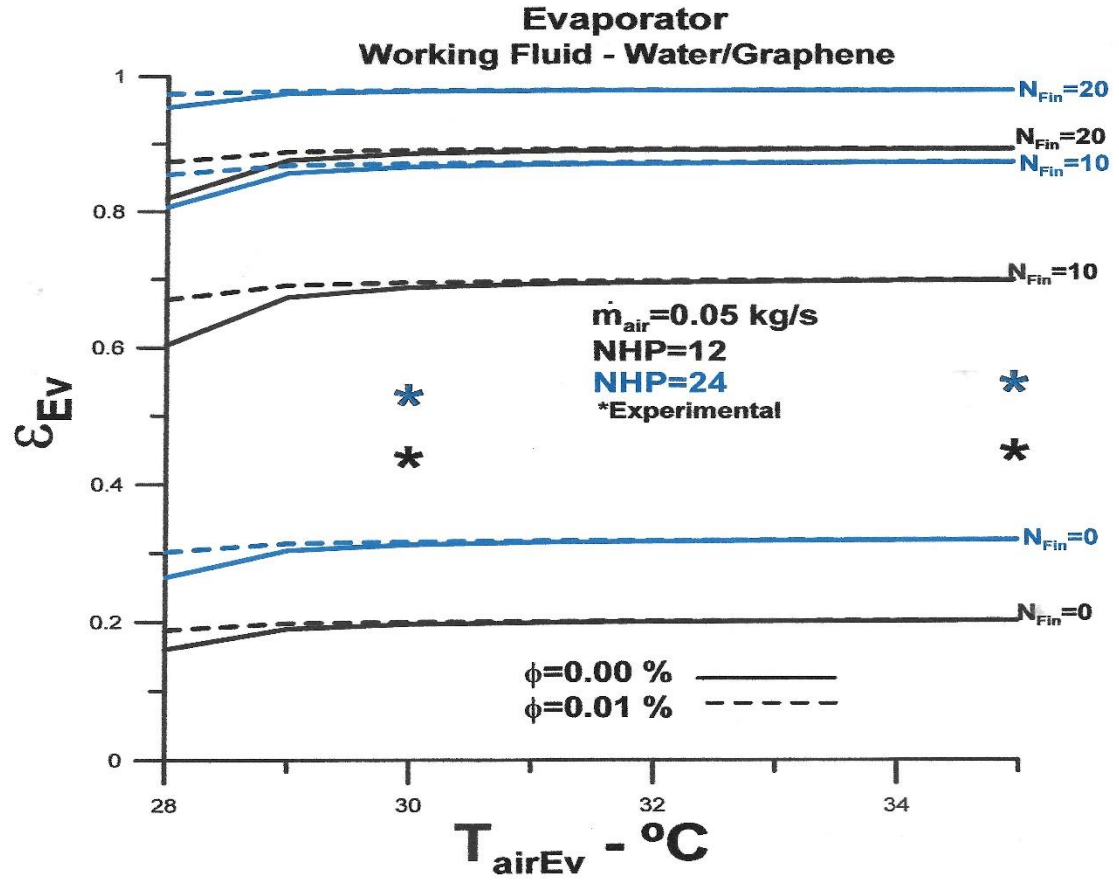

Figure 6: Evaporator thermal effectiveness versus inlet air temperature

The effectiveness versus volume fraction of the nanofluid is shown in Figure 7. Again, the effectiveness grows with the number of heat pipes and with the number of fins. However, there is no graphically perceptible variation in the effectiveness value in the analyzed volume fraction range. This result indicates that there is a saturation in the volume fraction value, that is, for the smallest volume fraction, equal to ϕ =0.01, the effectiveness has reached its highest possible value and there is no advantage in increasing the volume fraction. The questions raised by these results are: 1. Is there an advantage in decreasing the volume fraction value? 2. If so, what is the physical factor that causes the observed saturation, even for a low number of fins?

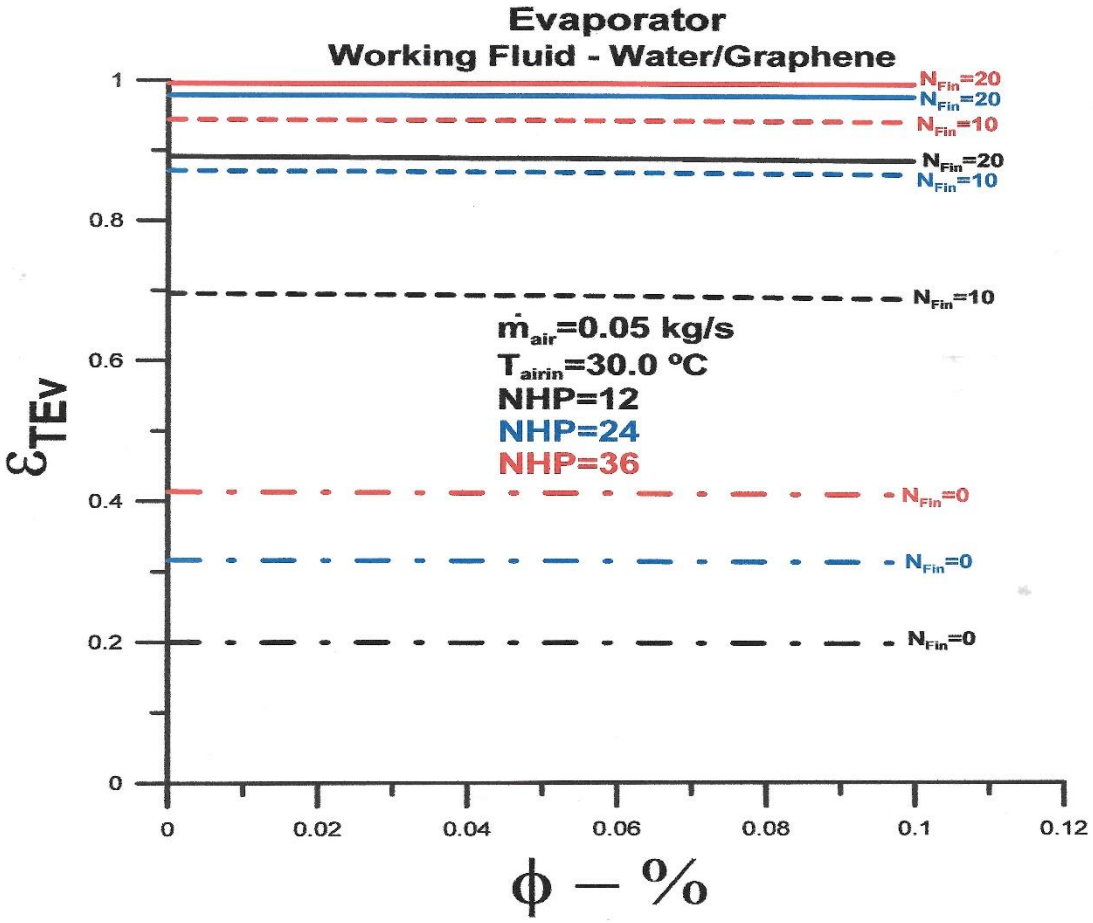

Figure 7: Evaporator thermal effectiveness versus nanofluid volume fractions

In order to try to answer the first question, values for effectiveness with lower values of fraction in volume are presented, in Figure 8. The results obtained are conclusive and demonstrate that lower values of fraction in the volume of the nanofluid allow higher values for effectiveness and that the value ϕ =0.01 is very close to the saturation point. Another interesting factor in the results presented in Figure 8 is that there is also a minimum limit for the volume fraction and that ϕ =0.005 is close to the lower limit for the analyzed configuration. Regarding the second question above, we can speculate, as there is evidence in the literature, that a possible cause for lower heat exchange performance lies in the deposition of nanoparticles on the heat pipe surface, thus increasing the thermal resistance.

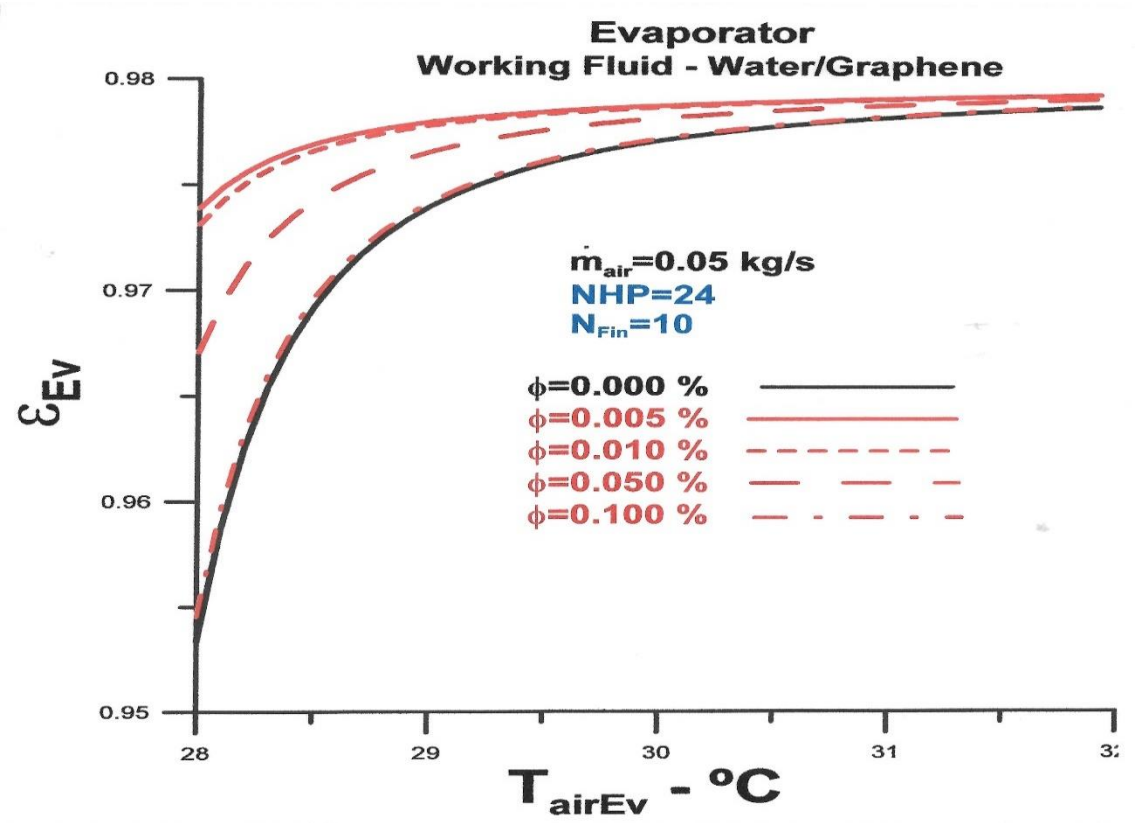

Figure 8: Evaporator thermal effectiveness versus inlet air temperature with nanofluid volume fractions as parameter

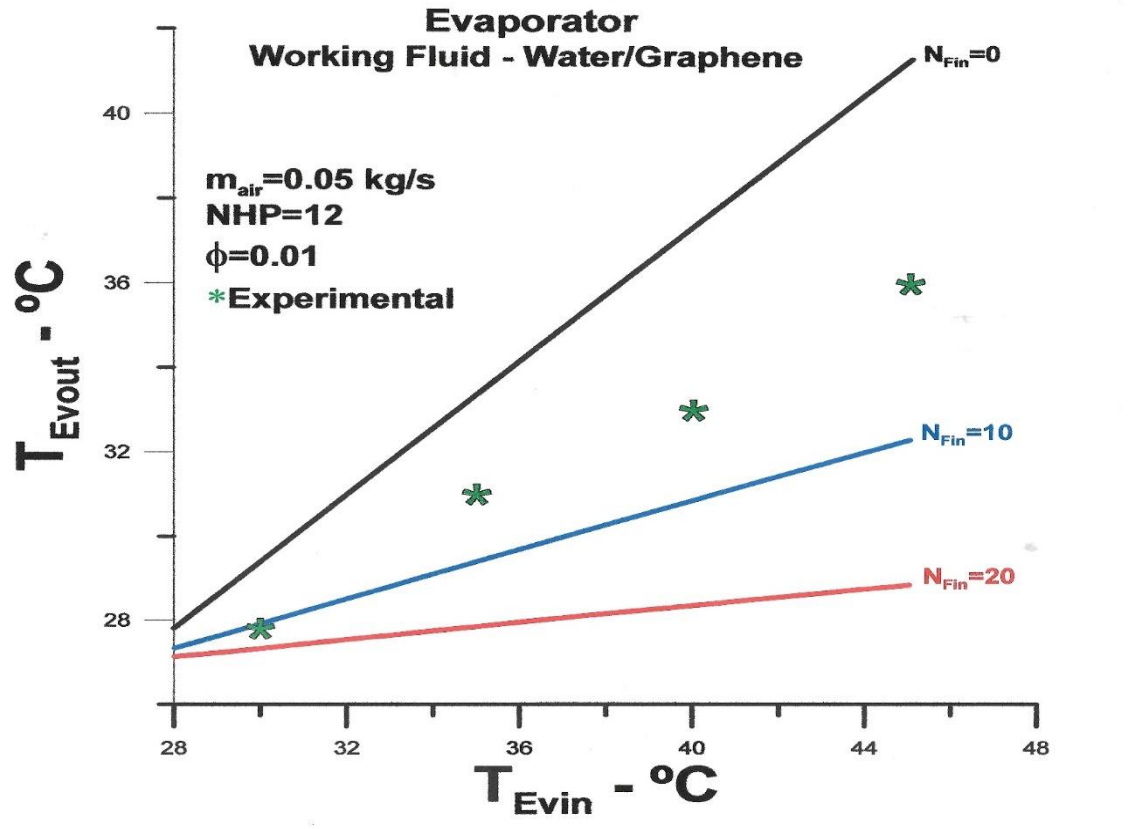

Figure 9: Outlet air temperature versus inlet air temperature

As expected, the results shown in Figure 9 corroborate the results obtained in Figure 5. The theoretical results in Figure 9 are associated with the volume fraction ϕ =0.01. Lower values for the outlet temperature of the air in the evaporator can be observed with the increase in the number of heat pipes and fins. The experimental results [1] demonstrate consistency with the theoretical procedure.

Results from Figure 10 corroborate the results from Figure 7, as greater effectiveness lowers outlet temperature.

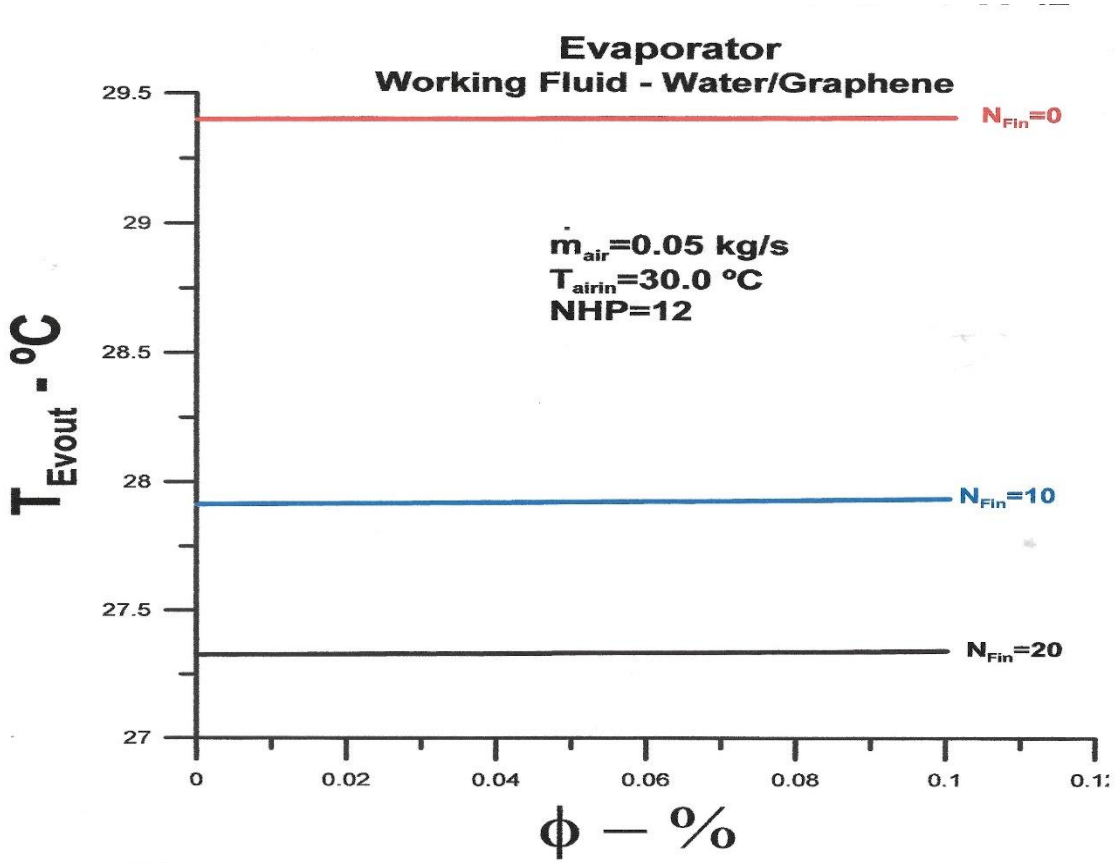

Figure 10: Outlet air temperature versus nanofluid volume fractions

Figures 11, 12, and 13 present results for outlet temperature for numbers of heat pipes respectively equal to 12, 24 and 36. The mass flow rates analyzed are 0.050 kg/s and 0.075 kg/s, with variations in volume fraction of 0.001 to 0.080. The results reinforce what has already been observed, that is, a smaller volume fraction allows a lower air outlet temperature. Although the values obtained for the three analyzed situations did not vary significantly, they demonstrate the importance of the number of heat pipes, associated with the number of fins. Furthermore, the data in Figure 13 demonstrate how the influence of the nanoparticle fraction in the working fluid occurs.

As already mentioned in the introduction, the evaluation of the role of nanofluids associated with heat pipes requires further studies that contribute to the various factors that affect thermal performance, especially for applications where the pressure field and the heat exchanged between the fluids are relatively low.

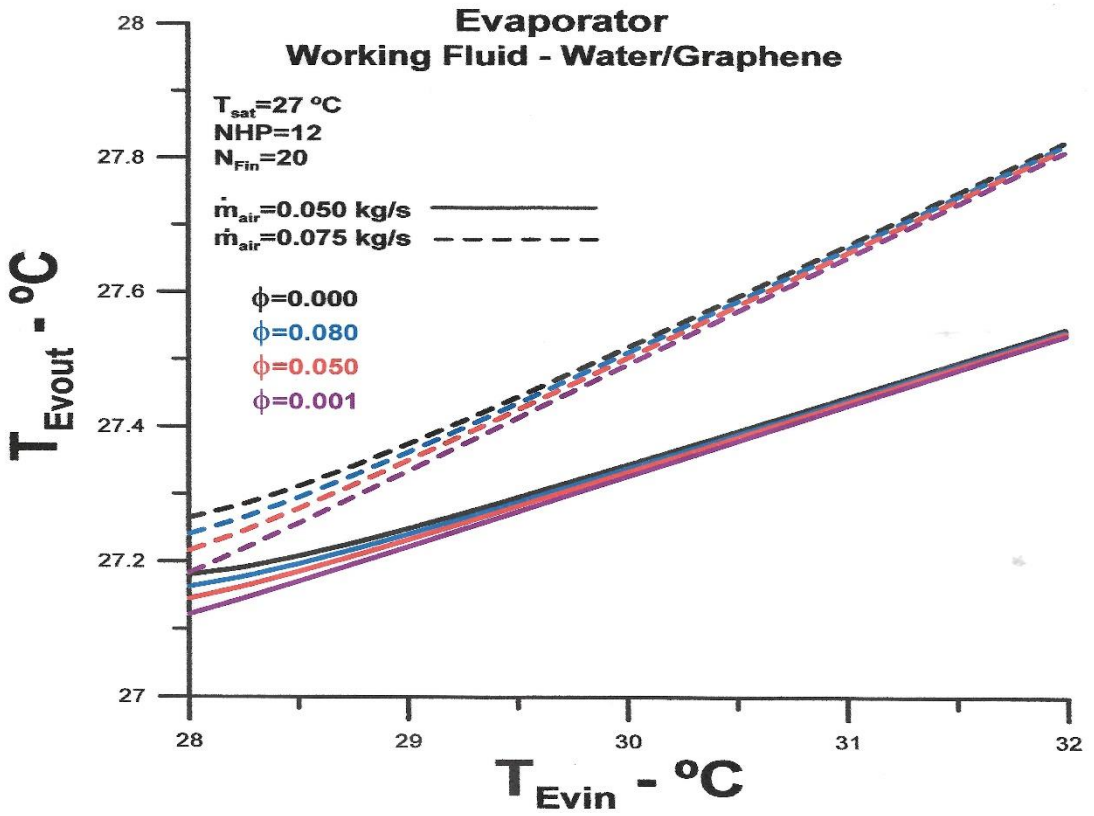

Figure 11: Outlet air temperature versus inlet air temperature for NHP=12 and N_{Fin}=20

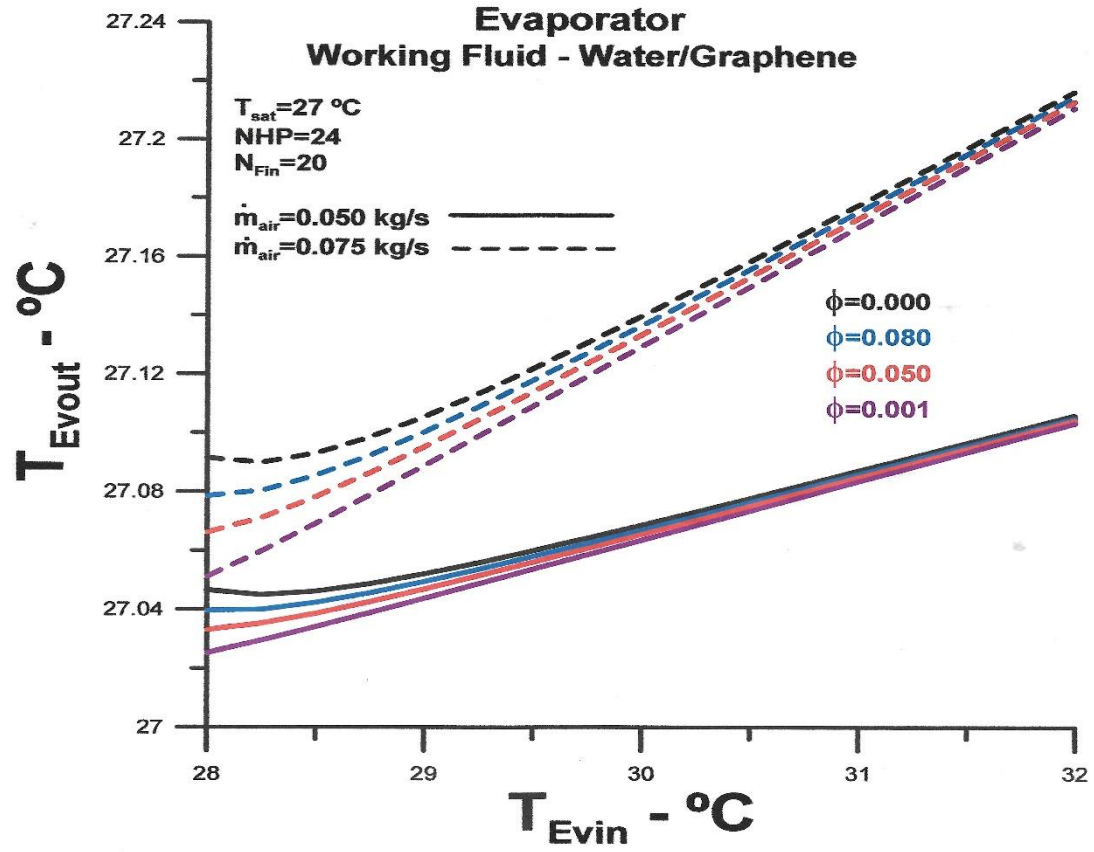

Figure 12: Outlet air temperature versus inlet air temperature for NHP=24 and N_{Fin}=20

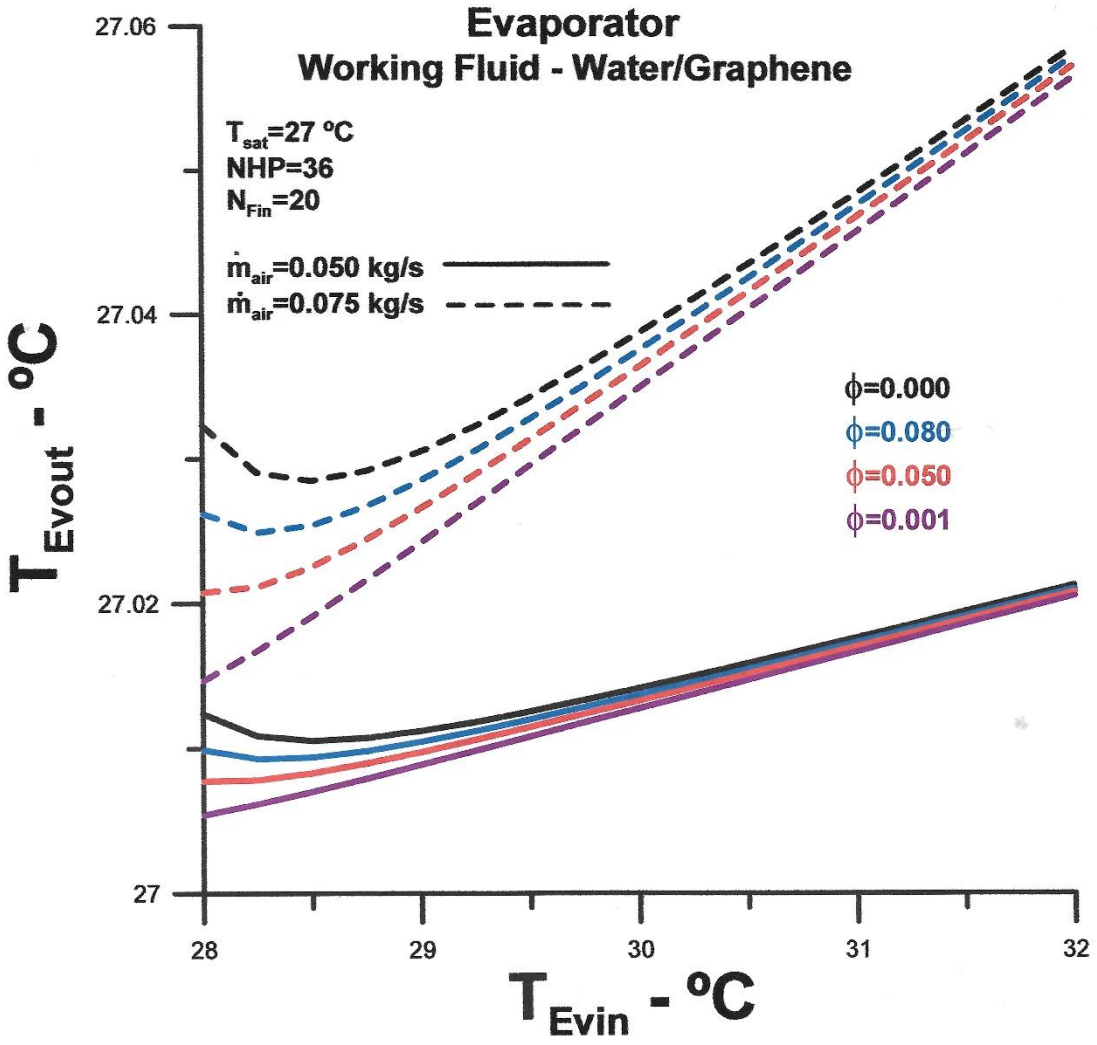

Figure 13: Outlet air temperature versus inlet air temperature for NHP=36 and N_{Fin}=20

CONCLUSION

The aim is to theoretically analyze the influence of the volume fraction of the nanofluid consisting of distilled water and graphene nanoparticles on the thermal performance of an evaporator made up of sets of heat pipes. The original evaporator uses distilled water as the working fluid and is part of a heat exchanger designed to work as an air conditioning system in operating rooms [1].

It is concluded that the nanofluid affects the heat exchange between the working fluid and the hot air entering the evaporator.

The most important conclusion of the performed analysis is that there is a volume fraction range for the nanofluid to work to improve the thermal performance of the heat exchanger. The results demonstrate that from a certain minimum value, there is greater heat exchange between the fluids until a certain volume fraction of the nanofluid is reached where the heat exchange is equal to the heat exchange of the original evaporator. Above this upper limit value in the volume fraction of the nanofluids, the heat exchange is lower than the heat exchange of the original evaporator.

According to the literature [1-15], many factors can lead to a high thermal resistance between the working fluid and the surface of the heat pipe, impairing the heat exchange. One is the deposition of nanoparticles on the surface, and another, also feasible and related, is low pressure and the energy level involved in the process, that is, small heat exchangers are more affected.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 57-64

Performance Evaluation of Monocrystalline Solar PV Panel for ICT Office, Federal University Wukari

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Abstract:
The basic operation of the monocrystalline photovoltaic panel was conducted on daily bases for one week. The open circuit voltage (V_oc), short circuit current (I_sc), maximum voltage (V_m), and current (I_m) were measured and power and efficiency were computed. The monocrystalline solar module efficiency computed was 11.34% lower than the theoretical efficiency value with 7.66%. The open circuit voltage in the early hours was higher this indicates a better solar cell which depends on the technology and climate conditions. The variation of daily average time with maximum voltage and current as shown from the data obtained, that as the intensity of sunlight increased, the was a corresponding increase in the measured parameters. The maximum voltage and current obtained were 30.50 (V_m) and 5.70 (I_m) at 14pm the power computed was 173.85 W. The total amount of power obtained on 20 PV panels during daylight hours was 38.4 kw and the power utilized in ICT was 110 W. The result shows that monocrystalline photovoltaic panel impact positively, the Federal University Wukari ICT and its environmental energy mix and promote non-polluted energy source. With this, small and medium-scale companies and even individuals could be offered a simple, cheaper, and cleaner energy choice over which they have more control.

Keywords: Monocrystalline, Photovoltaic solar panel, Series connection, and solar module

INTRODUCTION

The need for energy played the most significant role for developing and developed countries. Energy takes various forms and diverse ways of harnessing it and consumption, every city, organization, and nation requires a simple eco-friendly source of energy [1]. The fossil fuel source will be exhausted after a certain period and the extraction process is complex and expensive. Because of these, it has become imperative to decide which energy source to investigate and to consider the simplicity of obtaining high efficiency. In addition, non-renewable sources of energy to a considerable extent played a key role in the increased environmental challenges negatively [2]. Therefore, working toward a renewable energy foundation that exceptionally low economical factor that is beneficial in every area is important.

The entire renewable energy bases on earth start up from the impact of solar radiation which can be without delay transformed to energy via using distinctive technologies. Even though it is maximum-price renewable energy technology, photovoltaic technology is the simple, easiest, and fast-growing area of renewable source [1].

Photovoltaic (PVs) constitute a key technological option to implement, the shift toward a decarbonized energy supply. Solar resources in Africa and most parts of the world are abundant and cannot be monopolized. Furthermore, as technology advances and production volumes

increase dramatically every year, market prices for PVs will further decrease, following the trend of the past years. Yearly growth rates over the last decade were on average more than 40% making PVs one of the fastest-growing industries at present [3]. Business analysts predict the market volume reached N40 billion in 2010 and anticipate decreasing prices for consumers [3]. With relevant technology advancing, the scope of available PV modules is constantly expanding. There are two broad technological categories when it comes to commercially available PV cells: crystalline silicon and thin film [4]. These two covers all available solutions currently in the PV market.

The advent of PV modules makes it conceivable to adventure into this valuable resource and convert it to electricity and these modules make use of sun energy to generate electrical energy. Throughout the past decade, photovoltaic modules have been making tremendous progress in technical and economic areas. Consequently, this technology is one of the most surd after and the mounting capacity of diverse types of photovoltaic modules has been expanding in every sector. There are varied factors that impact the operations and performance of photovoltaic modules ranging from component type to operating conditions [5]. Many factors determine the performance of photovoltaic modules, and it can be grouped into two atmospheric and photovoltaic module arrangement parameters. Atmospheric parameters are the ambient temperature, the intensity of sunlight, the rate of wind, and moisture in the air however, the photovoltaic system arrangement parameters include photovoltaic arrangement parameters are inverter, interconnections, and controller [6]. [7], observed that the effect of dust scattering on the surface of the photovoltaic panel significantly lowers the output voltage performance than the PV panel with less dust or the neat panel in the same arrangement. [8], they also observed that heat transfer mode affects the photovoltaic system's general output. [9], equally reported that the angle of tilt or angle of inclination affects PV performance.

The solar radiation in the Federal University Wukari is approximately 892W/m^2 and on the coordinate of latitude and longitude 7.87723 and 9.779 respectively and at the temperature of 36°C as in June which is rainy season.

The performance of a PV system is determined by the performance and failure of the individual components. Though, the performance of a photovoltaic module is affected by the strength and duration of sunlight [6].

The monocrystalline solar cells used in this work were bought from RUBITEC solar company limited in Lagos, Nigeria.

The monocrystalline photovoltaic cell comprises P-type and N-type semiconductor materials with different electrical properties combined. Each cell is composed of two layers of silicon. The joint between these two semiconductors is known as P-N junction. Photons in the sunlight hitting on the solar cell's front side are absorbed by semiconducting materials due to which electron-hole pairs are produced, after the solar cell is linked to a load electrons and holes close to the junctions moved away from each other [10]. [11] They added that the hole is collected at the positive terminal and electrons at the negative terminal. The difference between the electric potentials at the terminals causes the voltage across the terminals. The generated voltage at the terminals of the silicon solar cell is used to drive the current in the circuit.

Table 1: Some properties of monocrystalline solar panels compared with polycrystalline panel solar [13]

S/n	Parameters	Monocrystalline	Polycrystalline
1	Space	Less space to reach requires capacity	More space to reach the required capacity
2	Efficiency	About 16-21% depending on the weather condition	About 14-17 also depends on the weather condition
3.	performance	Perform better even in low sunlight	Deficient performance with low sunlight
4.	Temperature coefficient	High heat resistance	Low heat resistance
5.	Cost	expensive	Less expensive
6.	Appearance	Black color panel	Bluish color panel

This is because of its production technology. The disadvantages of this type of solar panel if set to form a solar panel will leave some empty spaces. A solar cell of this nature is round in structure [12]. One of the major challenges with the use of monocrystalline solar panel modules that have been widely used in various organizations today is the performance index, with respect to its daily variation of time in hourly efficiency. The type of photovoltaic solar panel and the intensity of solar radiation varies with time because of these, the analysis performance of solar PV systems for the information and communication technology office, Federal University Wukari becomes necessary so that it can serve as enlightenment and promotion on the use of the solar photovoltaic system within the university community and the public, also to promote the campaign for green energy sources within the university community.

MATERIALS AND METHODS

The figure below shows the monocrystalline solar panel used for the study. The system consists of 6-volt batteries and 12-volt battery connections, the monocrystalline silicon solar panels were placed between angel 39^{0} to 43^{0}(degrees) southward. the total number of photovoltaic panel and batteries used was 20 and 10, respectively. The dimension of the solar panel was 1580 mm x 808 mm x 40 mm, and the area of the solar panels was 1.380 mm x 0.808 m. The RUBITEC solar panel was mounted on each of the poles facing south at an optimum angle of tilt. The solar panels related to 6 mm diameter wire and about 10 m length to a solar charger controller of the rated voltage of direct current (DC) of 12V/24 attached to each pole by the side. The solar modules were connected in series to obtain maximum voltage. The charge controller displays the solar ampere, load ampere, battery volt, and discharge voltage. The charge controller was connected to a 12V, 100AHr battery. The batteries were connected through the charge controller to the GACIA LED 36W-12 which will automatically power it on at 19:00pm daily at this time the batteries were fully charged. Multimeter (Dg5274D) was used to measure voltage and current (A) from 8:00 am to 18:00 pm at every one-hour interval for the period of one week in the month of June 2021. A pyranometer was used to measure the amount of solar radiation. On a sunny day at noon, the direct beam radiation recorded on the coordinate surface is approximately $892W/m^{2}$ this was a result of the period the research was conducted. The values obtained were used to compute the efficiency and power generated by the solar photovoltaic system in the experiment.

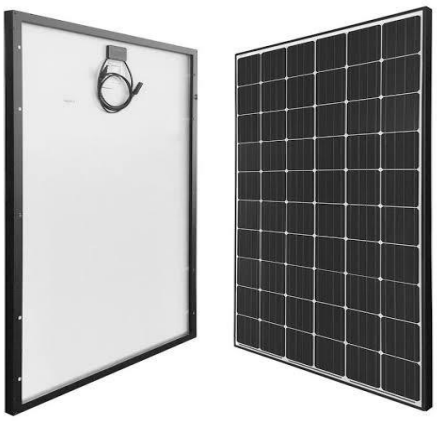

Figure 1: Monocrystalline Photovoltaic Panel used.

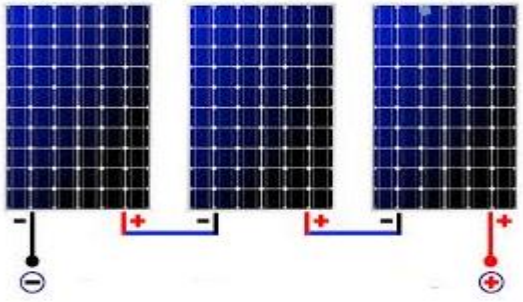

Figure 2: PV panel in series connection

The efficiency of the PV module was computed using eqn. 1 below [14]

$$Efficiency\ of\ solar\ panel\ (\eta) = \frac{current\ x\ voltage}{incident\ solar\ flux(w/m^2)\ x\ area\ of\ solar\ panel\ (m)^2}\ x\ 100\% \qquad (1)$$

RESULTS

Table 2: Average daily reading of voltage and current of monocrystalline PV module at average temperature 36℃ and radiation intensity of 892W/m^2 for a week in month June 2021.

Time (GMT)	Open circuit voltage (V_{oc})	Maximum Voltage (V_m)	Short circuit current (I_{sc})	Maximum Current (I_m)	Power (W)
8:00	35.82	30.30	2.43	1.82	55.15
10:00	35.53	30.40	2.05	1.53	46.51
12:00	34.66	30.42	5.81	4.50	136.89
14:00	34.43	30.50	6.54	5.70	173.85
16:00	33.76	30.30	6.08	4.83	146.35
18:00	32.87	30.20	4.07	2.33	70.37

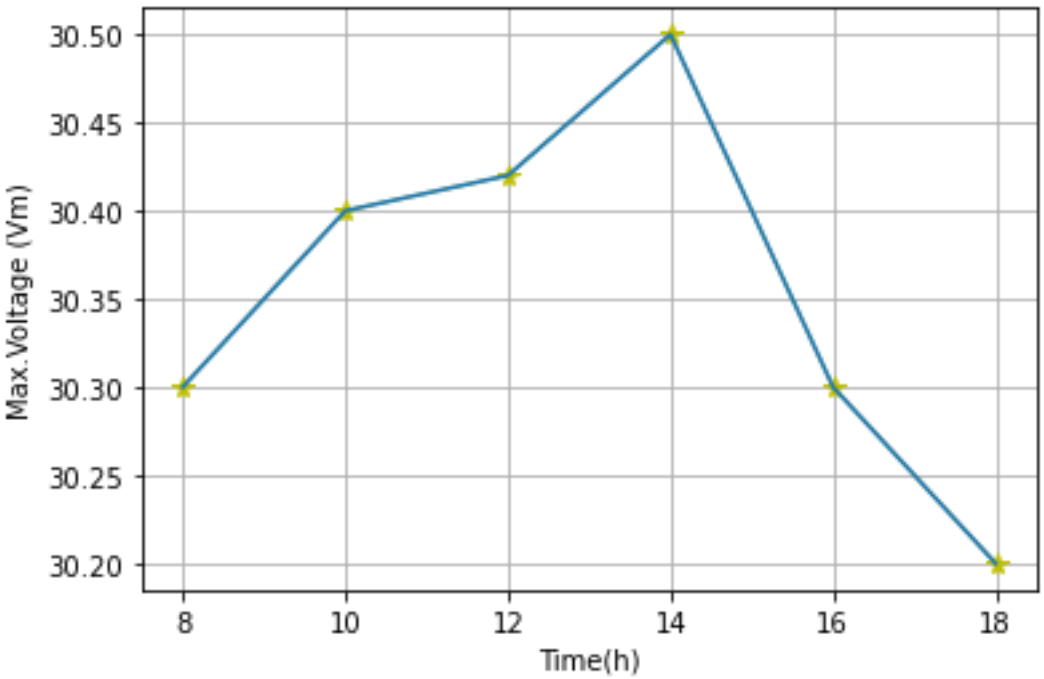

Figure 3: V_m versus h as sunlight intensity changes with time

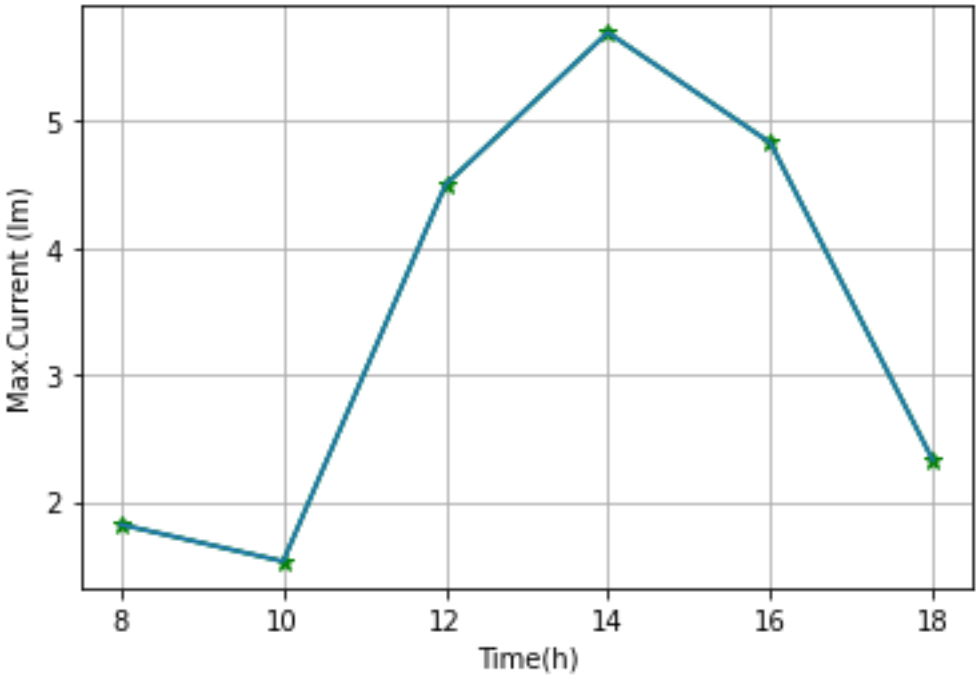

Figure 4: I_m versus h as sunlight intensity changes with time

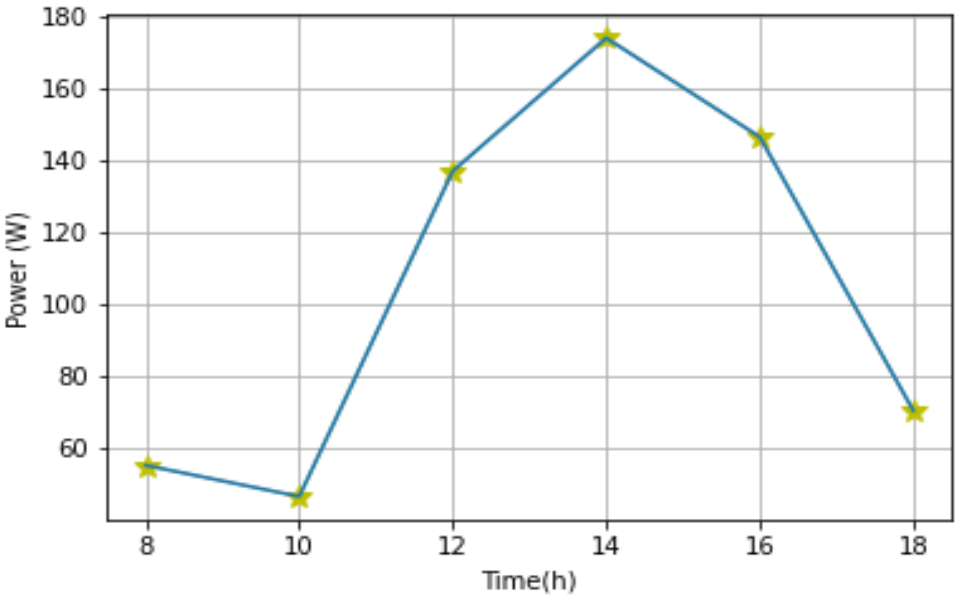

Figure 5: W versus h as the sunlight intensity with time

DISCUSSION

As the sunlight intensity gradually increases at the early hour of the day, the open circuit voltage, and short circuit current also increases steadily till 14pm that was where the maximum power voltage and current of 30.50 V_{mp} and 5.70 I_{mp} were obtained. More so gradual decrease of sunlight energy was observed from 14pm to 18pm and the open circuit voltage, short circuit current, maximum voltage, current equally drop as shown in Table 2 above. These observations were consistent with the study of photovoltaic systems that, solar panels are nonlinear energy foundations and the action points of the system also change along with the change in climate state. Therefore, the maximum voltage (V_m), current (I_m), power (W) output values and performance of photovoltaic systems depend on climate parameters [15]. The figure 3, 4 and 5 shows the daily average variation of time with maximum voltage (V_m), current (I_m), and power (W). These graphs follow the same trend with the open circuit voltage (V_{oc}) and short circuit current (I_{sc}) these shows the characteristic of a monocrystalline PV module at an average temperature of 36℃ and intensity of solar radiation of $892 W/m^2$.

When the distance of the sun is the shortest and when the sun is at its peak, that is directly at the center of the sky. The efficiency of the photovoltaic module with an area of 1.28 m^2 was obtained as 11.34%, this is close to the manufactural standard efficiency of the monocrystalline photovoltaic module of 16-19%, and the maximum power computed for each panel during the day was 1920W, and the maximum power and voltage obtained was 38.4k and 240oV. The data obtained below shows the raw data of the electrical open circuit voltage, and short circuit current for a week, for the KC125 and EPV-50 modules achieved daily for a period of a week. The power utilizes by ten (10) computer systems in the ICT was 110 W. The physical limits of the measured voltage and current can be seen below.

Parameter	Range/Limit
Voltage (V)	0-3
Current (A)	0-7
Module power (W)	P>0

The results above correlate with the values obtained in this research work.

CONCLUSION

This study has shown that the practical efficiency of the monocrystalline photovoltaic panel was lower than the theoretical efficiency of the solar panels. On a clear weather day as the sun rises from 7:00am within an interval of three hours, the amount of solar radiation is low but from 12 noon to 14:00pm the solar radiation increases steadily to around 17:300pm and it decreases to zero at about 18:00pm. The research work was also compared to data obtained from the KC125 and EPV-50 modules archived daily for a period of a week. The performance of the photovoltaic system is highly affected by weather conditions and the types of solar cells. It is recommendable that more research be done on other photovoltaic modules in the same environmental conditions and compare it efficiency with the monocrystalline solar panel used in this work.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 65-84

Analysis of the Impact of Climate Change on Countries' Fragility

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Abstract:
"Fragility" is a comprehensive index that measures different indicators, which is used to assess the degree of instability of a country. Mathematical models such as evaluation, regression and prediction are comprehensively used to explore the relationship between climate change and national fragility in this paper. Based on the conditions given in each question, the impact of climate changes on each factor and the total index was analyzed in this paper, accordingly, giving the specific index system to define the national vulnerability. After verifying, the model of this paper is reasonable and has practical significance.

Keywords: National fragility, Climate change, Integrated assessment, Regression modeling, GM (1,1) prediction

INTRODUCTION

Problem Background

With the advent of the blooming economy, the government of different countries tends to neglect environmental preservations [1] and society harmony [2] to some degree. The increase impacts of climate changes namely droughts, famine do increasingly harm to people's livelihoods as well as the sustain abilities of country's development [3-6]. It is a global emergency and one of the greatest challenges facing humanity today. Nevertheless, so many elements have something to do with such a situation that barely have people could find an effective way to tackle it, if we feel like finding a significant method to mitigate the danger of climate changes and keep a country from becoming a fragile state, there is no denying that a model which could define and handle the fragility is inexorable.

Restatement of the Problem

Climate change is dedicated to the totality of the problem of climatic variability and change. Meanwhile, climate change is the main factor to determine the degree of fragile state of the country. Given the background information and requirements in the problem description, we need to tackle the following problems step by step:

Task1. Build up a model system to identify factors which could affect fragility.

Task2. Use one of the top 10 the most fragile states whose datum we utilized to settle the model to experiment the flexibility of the model system.

Task3. Use the datum from other resources to figure out the Fitting degree of the model system.

Task4. Intervene human factors one by one to see the trend of the climate change risk, then making full use of those indicators to find out the country which could have the optimum with

interventions taking effect.

Task5. Decrease or increase the scope of space we used as a date to experiment whether the system works. If not, modify the model to prompt the universality.

Our Work

On the whole, all the tasks require us to build relationships between climate change and countries' fragility from different perspectives in order to analyze the impacts by using mathematical model.

Firstly, task 1 requires us to build a comprehensive assessment model of national vulnerability. We should define which indicators would influence vulnerability including climate change and the weight of each indicator.

Next, we should continue to make research on how climate change influences regional instability based on the built model before. The impacts would be divided into two parts. For one thing, the temporal connection based on the time factor was explored. The grey prediction model is mainly used to predict Kenya's vulnerability by defining tipping points according to the actual situation.

For another, a regression model to explore the significance of the association between various indicators was built, human intervention for the salient indicators was proposed, taking Afghanistan as an example, and how to prevent the impact of climate change on national vulnerability was reasonably explained. The structure of our work is shown in Fig. 1.

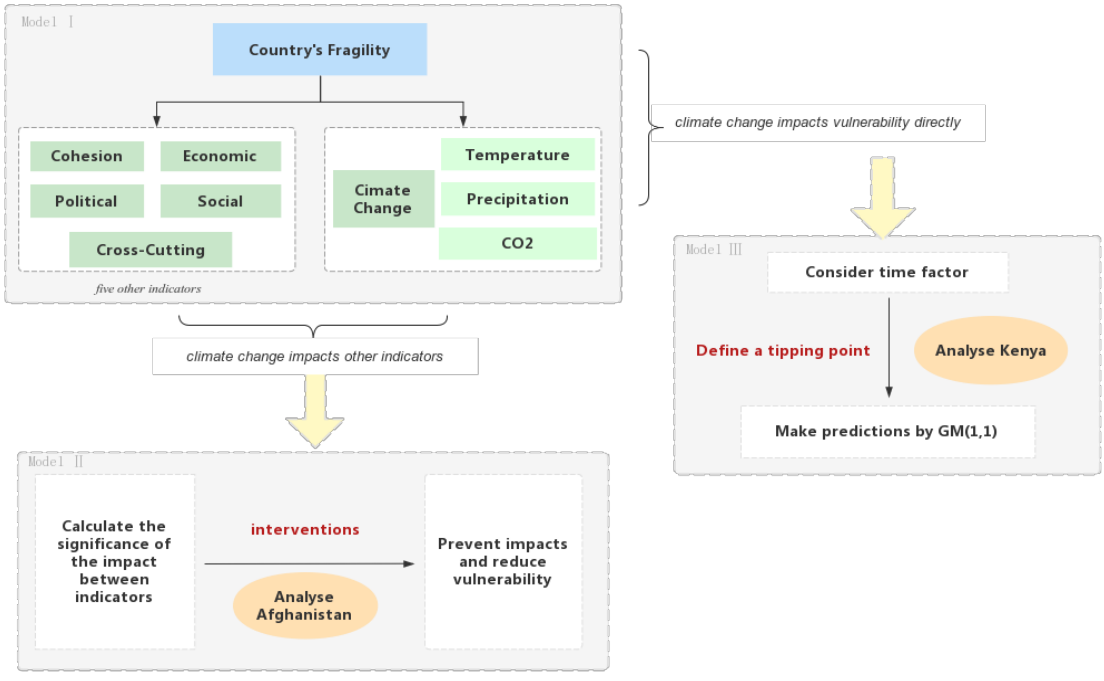


Fig. 1: The structure of our work.

ASSUMPTIONS AND JUSTIFICATIONS

We Assume That Only Temperature, Precipitation And Per Capita CO_2 Emissions Affect the Climate Change of Each Country

The factors that affect the climate and environment are complex and profound, including latitude, atmospheric circulation, land and sea distribution, ocean current and topography. We select the

main characteristics of climate (i.e., temperature and water), and consider that carbon emissions have a serious impact on climate, which together determine the climate.

We Assume That the Extreme Weather Only Occurs in The Six Months of Summer and Winter Include Extremely Hot or Severely Cold

Considering that the impact of temperature on vulnerability is often the higher the temperature or the lower the temperature, the higher the vulnerability, so these extreme temperatures are our key analysis objects.

We Assume That All Data Comes from Authentic Sources

Most of the data in this paper come from online sources and literature, including countries' vulnerability indices, temperature, precipitation, and CO_2 emissions. Through this assumption, the results of our model can be more objective and authoritative, and the correctness of our model can be verified from a positive perspective.

We Assume That the Value of Country Vulnerability Follows a Normal Distribution Globally as A Whole

Normal distributions are a very common type of data distribution and are relatively natural. With this assumption, we can better use models such as regression for analysis, and we can also classify data more objectively.

NOTATIONS

The key mathematical notations used in this paper are listed in Table 1.

Table 1: Notations used in this paper

Symbol	Description	Unit
a_{ij}	Actual value of each indicator	1
x_i	Secondary indicators	1
ω_i	Weight of factors	1
$\widehat{x_i}$	Secondary indicator estimator	1
β_i	Constant corresponding to each indicator	1
R^2	Goodness of fit	1
CF	Representation of countries' fragility results	1

MODEL I: NATIONAL FRAGILITY ASSESSMENT SYSTEM MODEL

Modeling Ideas

Determine Evaluation Indicators:

A model to determine a country's fragility based on AHP has been established and evaluation indicators should be determined at first. The structure of AHP is shown in Fig. 2.

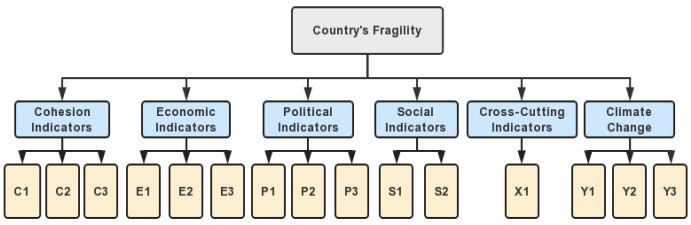


Fig. 2: The structure of AHP.

Evaluation indicators consist of primary indicators and secondary indicators. There are many influencing factors and we could not put all into consideration, so five main factors *(Cohesion, Economic, Political, Social and Cross-cutting)* as primary indicators according to the information online (fragilestatesindex.org/) were chosen. Meanwhile, task1 requires us to measure the impact of climate change simultaneously and we also define *Climate Change* as a primary indicator here. Next, we determine secondary indicators in the same way.

Description of Secondary Indicators in Table 2.

Table 2: Description of secondary indicators

Cohesion Indicators	C1	Security Apparatus	Political Indicators	P1	State Legitimacy
	C2	Factionalized Elites		P2	Public Services
	C3	Group Grievance		P3	Human Rights
Economic Indicators	E1	Economy	Climate Change	Y1	Temperature
	E2	Economic Inequality		Y2	Precipitation
	E3	Human Flight and Brain Drain		Y3	CO_2 Emission
Social Indicators	S1	Demographic Pressures	Cross-Cutting Indicators	X1	External Intervention
	S2	Refugees and IDPs			

Determine the Weight [7]:

In order to analyze a country's fragility, determining the weight of every indicator is significant in this model. ***Entropy Weight Method combining subjective and objective*** was used to determine the weight.

Entropy Weight Method combining subjective and objective means that we should combine the results both from Entropy Weight Method subjectively and Expert Scoring objectively.

Expert Scoring:

Through the form of expert scoring, the scale value of the comparison between the elements is determined by the nine-point scale method, and the judgment matrix is established, and the eigenvalues and eigenvectors of the matrix are solved by MATLAB software, and the consistency test of the matrix is carried out. The process of Expert Scoring is shown in Fig. 3.

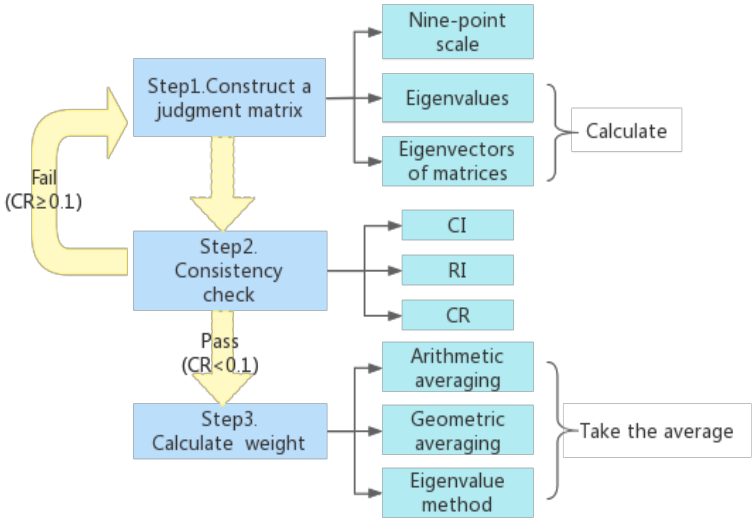


Fig. 3: The process of expert scoring.

Consistency Check: Check whether the judgment matrix and the consensus matrix we construct are too different.

Step 1: Calculate consistency metrics (CI)

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{1}$$

Step 2: Find the corresponding average random consistency indicator RI table

n	2	3	4	5	6	7	8	9	10	11
RI	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51

Step3: Calculate the consistency scale CR

$$CR = \frac{CI}{RI} \tag{2}$$

If CR<0.1, the consistency of the judgment matrix can be considered acceptable. Otherwise, the judgment matrix needs to be corrected.

Entropy Weight Method:
The principle of entropy weight method is a method of quantifying and synthesizing the information of each unit to be evaluated in the evaluation. The use of entropy weights to empower each factor can simplify the evaluation process.

Step 1: Data collection and processing according to the relevant data obtained by the survey, the data is collected, summarized and sorted out, special test data, etc., and the original data a_{ij} is first normalized, and the proportion p_{ij} is calculated:

$$p_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a}, i = 1,2,\ldots,n, j = 1,2,\ldots,m \tag{3}$$

Step 2: Entropy calculation: For the *jth* influencing factor, the data column under the influencing factor is used to calculate the entropy value e_{ij} of the influencing factor, that is

$$e_j = -\frac{1}{\ln n}\sum_{i=1}^{n} p_{ij} \ln p_{ij}, j = 1,2,\ldots,m \tag{4}$$

Tips: *k>o, k=1/lnm, o≤Eij≤1*

Step 3: Calculate the degree of bias: calculate the deviation degree g_j of the *jth* influencing factor, for the *jth* influencing factor determined, if the degree of influence of this factor on the comprehensive evaluation of the entire data sample index is smaller, the closer the data column under the influencing factor is to the completely disordered state, the larger the e_j, the smaller the deviation degree of the influencing factor should be, hence the definition

$$g_j = 1 - e_j, j = 1,2,\ldots,m \quad (5)$$

Step 4: After calculating the weights to normalize the deviation degree calculated above, the weights of each influencing factor are obtained, which reflects the degree of influence of the influencing factors on the comprehensive evaluation of the entire data sample index. Among them, the weight calculation formula of the *jth* influencing factor is

$$w_j = \frac{g_j}{\sum_{i=1}^{m} g_j}, j = 1,2,\ldots,m \quad (6)$$

Combination of the Both:
Finally, we combine the two methods by means of the averaging method.

$$w_i = \frac{w_{1i} + w_{2i}}{2} \quad (7)$$

Table 3 lists the weight diagram of each indicator.

Table 3: The weight of each indicator

Cohesion Indicators	C1	0.0452	Political Indicators	P1	0.0805
	C2	0.0452		P2	0.0403
	C3	0.0452		P3	0.0805
	total	0.1357		total	0.2013
Economic Indicators	E1	0.1148	Climate Change	Y1	0.0087
	E2	0.1148		Y2	0.0288
	E3	0.1148		Y3	0.0159
	total	0.3443		total	0.0534
Social Indicators	S1	0.0671	Cross-Cutting Indicators	X1	0.0640
	S2	0.1342			
	total	0.2013		total	0.0640

Establishment and Explanation of Comprehensive Evaluation System:
We weighted the indicators based on the above weights to obtain the vulnerability of each country.

$$CF = \sum w_i * x_i \quad (8)$$

Among them,

- *CF* : Representation of countries' fragility results;
- w_i : weight of each secondary indicators,*i*=1,2…15;
- x_i : secondary indicators,*i*=1,2…15.

According to Task1, our model should meet some requirements and standards:

When a State is Fragile, Vulnerable, or Stable:

In our model, the higher the value of CF is, the higher the vulnerability is. A country's CF changes according to the year and the value of each indicator, so we can determine the status of a country by determining the threshold value.

How Climate Change Increases Fragility:
On one hand, climate change directly affects vulnerability as an indicator. Our model can give a diagram which shows the direct relationship between climate change and vulnerability based on data for each indicator.

On the other, it also affects ultimately vulnerability by indirectly or directly affecting other indicators. Our model can explain the functional relationship between other indicators and climate change indicators through a regression model, and use the significance of the relationship between model indicators.

Specific instructions are explained in the following questions.

Calculation of a Specific Country and Result Analysis
In order to meet Task2's requirements, we select Afghanistan (ranked 8th in 2022) to determine how climate change may have increased fragility of that country. We should search for concerned data and make necessary calculation based the evaluation system model.

Data Collection and Quantification of Indicators:
Based on the secondary indicators, the data of those influencing factors expect *Climate Change* come from the global vulnerability index of the website (fragilestatesindex.org/). On this website, each indicator is scored out of 10, and the higher the score, the worse the indicator scores, increasing the country's vulnerability.

About the indicators of *Climate Change,* we quantify Temperature, Precipitation and CO_2 Emission.

- **Temperature**: Considering the influence of hypothetical extreme weather, we select the average temperature in summer from June ~ August and winter in December ~ February, and take the average of these six months after assigning a ten-point value with 15~18 degrees Celsius as the best range.
- **Precipitation:** We take the annual precipitation of the country and also take 1000~1800mm per year as the best interval for assignment.
- **CO_2 Emission:** The higher the annual per capita carbon emissions were, the higher the country's vulnerability was.

The temperature each year comes from the weather spark website. The average annual precipitation and carbon emissions per capita of each country come from the World Bank Organization.

Data Normalization [8]:
We found that most of the indicators were minimal data, with temperature and precipitation being ranged, so we needed to standardize the data.

Transform interval data into extremely small:

$$x' = \begin{cases} 1 - \frac{a - x}{c}, & x < a \\ 1, & a \le x \le b \\ 1 - \frac{x - b}{c}, & x > b \end{cases} \quad (9)$$

Among them,

- $[a,b]$: the best stable interval for x.
- c=max{a-m,M-b}
- M: the maximum values of x's possible values.
- m: the minimum values of x's possible values.

Presentation of the Results:

The vulnerability of the final country is derived from the weighted formula in the model. Table 4 shows the vulnerability of Afghanistan.

Table 4: Vulnerability of Afghanistan

Time	**Temperature**	**Precipitation**	**CO_2**	**Fragility**
2022	6.94	9.74	4.35	8.69
2021	7.64	9.48	3.78	8.36
2020	6.92	9.87	3.31	8.41
2019	6.67	9.61	4.08	8.59
2018	6.33	9.22	3.97	8.71
2017	6.78	10.00	2.73	8.74
2016	6.48	9.48	2.76	8.77
2015	5.78	9.09	2.89	8.70

Sensitive Analysis-How Climate Change Increases Fragility

Task 2 requires us to determine how climate change may have increased fragility of a country. Therefore, we use sensitive analysis based on model Ⅰ by adjusting data of climate change indicators in order to find some connections between climate change and fragility.

Following are the specific measures. We select the data of Afghanistan's fragility in 2022 as sample and then the three indicators of climate change will be increased by 0.1, 0.2 and 0.3 in turn, and decreased by 0.1, 0.2 and 0.3, respectively, to compare the changes of the results before and after. We use Excel to analyze the sensitivity of each indicator and the results are as follows. Table 5 shows the results of the sensitive analysis.

Table 5: Results of sensitive analysis

Adjustment	Temperature	Precipitation	CO_2 Emission
+0.3	8.6889	8.6950	8.6911
+0.2	8.6881	8.6921	8.6895
+0.1	8.6872	8.6892	8.6879
previous	8.6863		
–0.1	8.6854	8.6834	8.6847
–0.2	8.6846	8.6805	8.6831
–0.3	8.6837	8.6777	8.6816

From the results of sensitive analysis, we can clear see:

1. **Precipitation impacts fragility the most** since with its value larger, the more value of vulnerability changes. *Practically speaking*, the greater the distance between the precipitation and the ideal value in the current year, that is, the possibility of experiencing a long period of drought and flood, will increase the country's vulnerability.
2. Apart from precipitation, **temperature and CO_2 emission also have some effects.** With their value larger, the greater the vulnerability of the country. *Practically speaking*, on the one hand, some extreme weather like severe cold and hot or unpredictable weather will make it difficult for the country to cope with, on the other hand, the increase in CO_2 emissions will affect the role of the greenhouse effect, so that Eldono effect caused by global warming affects the country's development. But none of their effects are as pronounced as precipitation.

To conclude, if the state of a country like Afghanistan would not be so fragile as before, without the impacts of those three indicators.

MODEL II: PREDICTIONS BY YEAR ABOUT A COUNTRY'S FRAGILITY

Modeling Ideas

We have obtained some countries' fragility by year. In order to predict fragility by year for a country and we have considered that there are 15 secondary indicators of which data is hard to define or predict in the next few years. These indicators also have little connection with time. So, we would like to use the **Grey Prediction GM (1,1) model** [9] to make predictions about a country's fragility by year.

The grey prediction model GM (1,1) uses the original discrete data column to generate a new regular discrete data column that weakens the randomness by one accumulation, and then obtains the approximate estimate of the original data generated by the accumulation of the solution at the discrete point by establishing a differential equation model, so as to predict the continuous development of the original data.

Following is the process of GM (1,1).

Step 1: Generate Discrete Sequences

Suppose $x^{(0)} = \left\{x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(n)\right\}$ is the original data column is the original one, and we can accumulate it once to get the new generated data column as

$$\begin{cases} x^{(1)} = \left\{x^{(1)}(1), x^{(1)}(2), \cdots, x^{(1)}(n)\right\} \\ x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i) \end{cases} \tag{10}$$

Step 2: Least Squares Estimation

We introduce the matrix form :

$$B=\begin{bmatrix} -\frac{1}{2}(x^{(1)}(1)+x^{(1)}(2)) & 1 \\ -\frac{1}{2}(x^{(1)}(2)+x^{(1)}(3)) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(x^{(1)}(5)+x^{(1)}(6)) & 1 \end{bmatrix}, Y=\begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(5) \end{bmatrix} \tag{11}$$

Therefore, we can use the least square method to obtain the estimated values of parameters a and b

$$\hat{u}=\begin{bmatrix} \hat{a} \\ \hat{b} \end{bmatrix}=(B^T B)^{-1}B^T Y \tag{12}$$

Step 3: Solving the Results

Solve the corresponding solution of the following equation

$$\frac{\mathrm{d}x^{(1)}(t)}{dt}+\hat{a}\,x^{(1)}(t)=\hat{b} \tag{13}$$

The answer is:

$$\hat{x}^{(1)}(k+1)=(x^{(0)}(1)-\frac{\hat{b}}{\hat{a}})e^{-\hat{a}k}+\frac{\hat{b}}{\hat{a}} \tag{14}$$

From the above formula, the analog value of the original data column x (0) is

$$\hat{x}^{(0)}(k+1)=\hat{x}^{(1)}(k+1)-\hat{x}^{(1)}(k)=(1-\mathrm{e}^{a})[x^{(0)}(1)-\frac{b}{a}]e^{-am}, m=1,2,\ldots,n-1 \tag{15}$$

We want to predict the original data, so we only need to take m ≥ n in the above formula

Model Calculation of Kenya

Task3 requires us to predict a country's fragility and we select Kenya as the sample country which is not in the top 10 list.

Preparation of the Model:

We calculate Kenya's vulnerability and some data about climate change by year by collecting data based on Model I (Table 6).

Table 6: Kenya's vulnerability

Time	**Temperature**	**Precipitation**	**CO_2**	**Fragility**
2022	5.00	7.45	3.12	7.11
2021	4.52	7.36	3.38	7.19
2020	3.70	7.23	3.29	7.27
2019	4.17	7.36	2.97	7.51

2018	4.17	7.53	3.71	7.81
2017	4.58	7.32	3.72	7.79
2016	5.00	7.36	3.89	7.93
2015	4.91	7.62	4.07	7.91

Calculation and Presentation of Prediction Results:

Through screening and analyzing the data, we calculate the annual vulnerability of Kenya, and then use MATLAB to carry out grey prediction on the indicator data. The calculation results are shown in the table below (Table 7).

Table 7: Vulnerability of Kenya in 2023 • 2026

Country	2015	2016	2017	2018	2019	2020
Kenya	7.91	7.93	7.79	7.81	7.51	7.27
Country	2021	2022	**2023**	**2024**	**2025**	**2026**
			Estimate	Estimate	Estimate	Estimate
Kenya	7.19	7.11	**6.93**	**6.78**	**6.62**	**6.52**

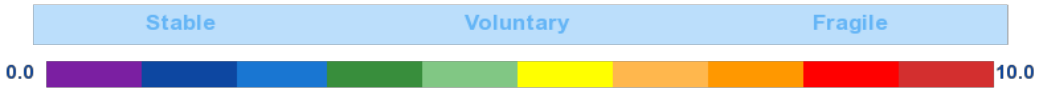
Result Analysis About When a State is Fragile, Vulnerable, or Stable

Define a Tipping Point:

Considering the characteristics of the data of the indicators, we divide 10 into 3 parts to define tipping points based on the assumption that the data follows a normal distribution as following (Table 8).

Table 8: Status score classification

score	state
0–3	stable
3–7	vulnerable
7–10	fragile



Result Analysis:

The result analysis of GM (1,1) is shown in Fig. 4.

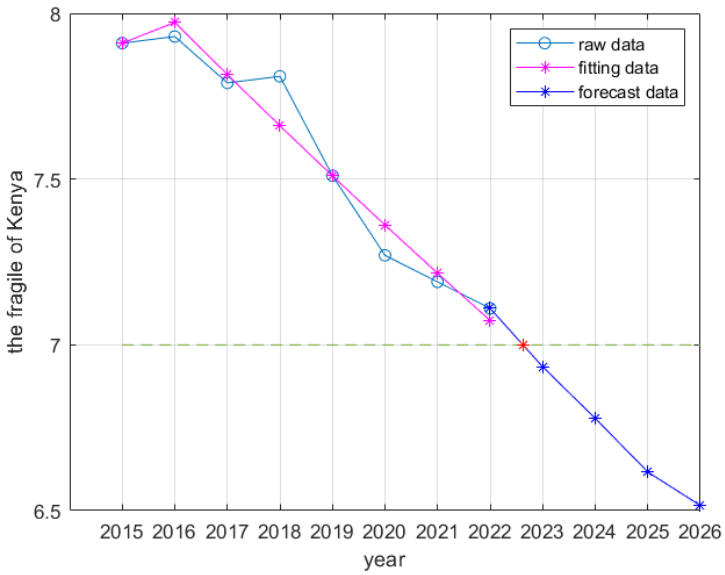


Fig. 4: Result analysis of GM (1,1)

The Residual Test:
We have done the Residual Test for this prediction results of the model and it shows that the result meets the requirements.

The average relative residual is 0.0070074

The result of residual test shows that the model fits the original data very well.

The average grade ratio deviation is 0.013741

The result of grade ratio deviation test shows that the model fits the original data very well.

Result Analysis
The fragility of Kenya is always above 7.0 and it is fragile according to the tipping point we have made before. The trend of Kenya's vulnerability decreasing over time is clear, so we can determine when Kenya reaches a state of vulnerability.

From the picture above, we can clearly see that in the second half of 2022 Kenya will reach a state of vulnerability.

MODEL III: REGRESSION MODEL ABOUT CLIMATE CHANGE'S IMPACTS

Nonlinear Regression-How Climate Change Impacts Fragility Directly

Modeling Ideas:

It is a common way to the scatter plot to see the trend of the model (Fig. 5), through the trend of the model we can fit the model by comparing its functional form:
From the scatter chart ：

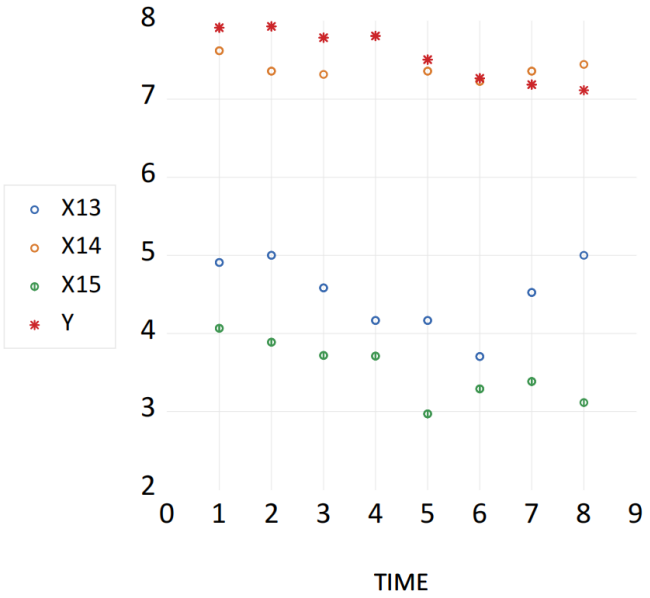


Fig. 5: (1) We could find the date of X15(Precipitation) in 2019 is out of track, we get off it for further study. (2) The trend of Y is similar to Index as well as X14; the trend of X15 is a liner model which is in a decrease; the trend of X13 has a peak in 2020, so we can define it as a quadratic function.

As a result, we would like to build a nonlinear regression [10] in order to find the relationships.

Model Calculation and Result Analysis:

$$e^{\hat{y}} = c + \beta_1 \hat{x}_{13}{}^2 + \beta_2 e^{\hat{x}_{14}} + \beta_3 \hat{x}_{15} + \beta_4 Time$$
$$c = 1066.6, \beta_1 = 3.99817, \beta_2 = 0.09212, \beta_3 = 446.3415, \beta_4 = \text{-}192.9375 \quad (16)$$
$$R^2 = 0.93$$

Among them,

- c: Constant
- θ_i: Constant coefficient, i=1,2,3,4.
- R^2: Goodness of fit
- $\hat{x}_{13}$ change a percentage, $\hat{y}$ would relative change 3.99817 percentage;
- $\hat{x}_{14}$ change a percentage, $\hat{y}$ would relative change 0.09212 percentage;
- $\hat{x}_{15}$ change a unit, $\hat{y}$ would increase 446.34 units;

Given 'Time' is a variable based on time, it can be said that if other things being equal, vulnerability decreases 192.9375 each year over time.

Sensitive Analysis-How Climate Change Impacts Fragility:

Choose four parameters of the original data as the basic parameters of the control variables (see Table 9).

Table 9: Sensitivity analysis samples

Model	X13	X14	X15	Time	Fragility
A1	4.9090	7.6190	4.0664	2015	7.9972
A2	5	7.3593	3.8876	2016	7.8863
A3	4.5833	7.3160	3.7167	2017	7.7703
A4	4.1666	7.5324	3.7083	2018	7.6923

The problem requires a sensitivity analysis of the results, we adjust the variables of the numerical value up and down, increase the perturbation rate, compare the results before and after the change. Table 10 gives the Results of the sensitivity analysis.

Table 10: Results of sensitivity analysis

Fragility	Number	Pre-adjustment vulnerability of each variable	X13 increase by 10%	X14 increase by 10%	X15 increase by 10%
	A1	7.9972	8.0040	8.0668	8.0565
	A2	7.8863	7.8942	7.9438	7.9495
	A3	7.7703	7.7777	7.8315	7.8380
	A4	7.6923	7.6990	7.7769	7.7651
	Number	Pre-adjustment vulnerability of each variable	X13 decrease by 10%	X14 decrease by 10%	X15 decrease by 10%
	A1	7.9972	7.9910	7.9630	7.9342
	A2	7.8863	7.8791	7.8576	7.8189
	A3	7.7703	7.7636	7.7395	7.6977
	A4	7.6923	7.6863	7.6499	7.6138

Based on the above results, we can see that vulnerability has decreased over time, such a situation has something to do with Kenyan policies and international support. On the basement of the fixing values of the other parameters, changing the values of X13, X14 one by one to observe the changes in vulnerability can be seen a slight increase in X13, X14's 10% decreased vulnerability and a relative decrease in X13, X14's 10% decreased in vulnerability, however, the magnitude of the changes is very small, indicating that the impact of temperature on vulnerability is very small. The contribution of CO_2 to the vulnerability change in Kenya can be seen from the observation of vulnerability changes by changing the values of X15 alone while fixing the values of other parameters, this relates with Kenya's status as a developing country and a populous nation [11].

Linear Regression--How Climate Change Impacts Other Indicators

Modeling Ideas:

Step 1: Build multiple linear regression models [12]

A *multi*ple linear regression model involving p independent variables can be expressed as

$$\begin{cases} y = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p + \varepsilon \\ \varepsilon \sim N(0, \sigma^2) \end{cases} \tag{17}$$

Among them, ε: error

For the convenience, we introduce matrix notation by actual observing data through n groups:

$$Y=\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}, X=\begin{bmatrix} x_{11}\, x_{12}\cdots x_{1p} \\ x_{21} x_{22}\cdots x_{2p} \\ \vdots\ \ \vdots \qquad \vdots \\ x_{n1}\, x_{n2}\cdots x_{np} \end{bmatrix}, \beta=\begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{bmatrix}, \varepsilon=\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix} \tag{18}$$

Inside that, X is the model design matrix, which is a constant matrix, Y and ε are random vectors

$$Y \sim N_n(X\beta, \sigma^2 I), \varepsilon \sim N_n(0, \sigma^2 I) \tag{19}$$

is an unobservable random error vector, β is a vector composed of regression coefficients, which also is a constant vector that is unknown and undetermined.

Step 2: Least squares estimate of the regression coefficient β

Take an estimate of the β and denote it as β and make the sum of squares of the random error ε is the minimum

$$\begin{aligned} \min_{\beta} \varepsilon^T \cdot \varepsilon &= \min_{\beta} (Y - X\beta)^T (Y - X\beta) \\ &= (Y - X\hat{\beta})^T (Y - X\hat{\beta}) \overset{def}{==} Q(\hat{\beta}) \end{aligned} \tag{20}$$

Due to the requirements of the least square's method, and the must conditions for obtaining extreme values from multivariate functions, the standard equation for solving the regression parameters is as follows:

$$\begin{cases} \left.\dfrac{\partial Q}{\partial \beta_0}\right|_{\beta_0 = \hat{\beta}_0} = 0 \\ \left.\dfrac{\partial Q}{\partial \beta_1}\right|_{\beta_1 = \hat{\beta}_1} = 0 \end{cases} \tag{21}$$

Step 3: the verify of *Multi*collinearity

Due to the numerous number of variables in the system, it is necessary to have the view that the climate changes do indirect affect economy, policy and human behaviors and everything, which would cause a *Multi*collinearity case in the established regression model to influence its accuracy and fitness[13].

Model Calculation and Result Analysis:

Define A Model That Included All Kinds of Variables:

$$\begin{aligned} &\mathrm{y} = c + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \beta_{11} x_{11} + \beta_{12} x_{12} + \beta_{13} x_{13} + \beta_{14} x_{14} + \beta_{15} x_{15} \\ &R^2 = 0.998,\ \ P > 0.05, F_{test} < F_{\alpha/2} \end{aligned} \tag{22}$$

Tips:

- β_i: Constant corresponding to each indicator, *i*=1,2…15.
- x_i : secondary indicators, *i*=1,2…15.

From E views, it is not difficult to find that the coefficient of determination R2 of the model is close to 1, However, there are individual explanatory variables whose coefficients are not significant, suggesting that there may be *Multi*collinearity in our mode [13].

Choose Variables Whose Coefficients Are Not Significant and Separate Them to Compare and Combinate with Variables of Climate Change:

From the table, it is easy to point that climate changes can change fragility via other factors albeit to varying degrees.X3: Group Grievance, X5: Economic Inequality, X6: Human Flight and Brain Drain, X7: State Legitimacy, and X12: External Intervention are all highly correlated with one of variables in climate change (X13: Temperature, X15: level of $CO_{2)}$. Table 11 shows the linear regression results.

Table 11: From the table, it is easy to point that climate changes can change fragility via other factors albeit to varying degrees. X3: Group Grievance, X5: Economic Inequality

Dependent variable	Independent variable	Equation	R-squared
X2	X13	$x_2 = c + \beta x_{13}$ $c = 13.9355, \beta = -0.873647$	0.685
X5	X13 X15	$x_5 = c + \beta_1 x_{13} + \beta_2 x_{15}$ $c = 4.3956, \beta_1 = 0.35748, \beta_2 = 0.258069$	0.783
X6	X13	$x_6 = c + \beta x_{13}$ $c = 12.0309, \beta = -0.619$	0.549
X7	X13	$x_7 = c + \beta x_{13}$ $c = 12.15958, \beta = -0.455$	0.762
X12	X15	$x_{12} = c + \beta x_{15}$ $c = 11.96814, \beta = -0.823$	0.540

Use a Variable-Elimination Method, Implementing High Fit of The Model

$$\alpha_1 x_{13} + \alpha_2 x_{15} = x_2 + x_5 + x_6 + x_7 + x_{12}$$
$$y = c + (\beta_1 + \alpha_1) x_{13} + \beta_2 x_{14} + (\beta_3 + \alpha_2) x_{15} \quad (23)$$

By imposing the datum, we could get the specific number of coefficients:

$$y = 5.148539\text{-}0.025675 x_{13} + 0.170954 x_{14} + 1.059128 x_{15}$$
$$R^2 = 0.76 \quad (24)$$

Based on the above conclusions we could define that some factors related with economy and policy are somewhat reliance on the climate change which tells us the importance to protect the environment and the fragility is highly related to climate changes:

1. **Factionalized Elites's negative effect will be ease off due to the climate change** [14] Factionalized Elites means the policy [15] changes of upper-class to the society, and as the degree of vulnerability to climate impacts increases, there will be a political tendency to mitigate this, then neutralize the increase in vulnerability.
2. **Temperature and precipitation increase the influence of economic inequality**

When vulnerability indicators of temperature and precipitation rise, natural diseases can accelerate to the point where they become a drag on Economic development, thus contributing to Economic Inequality.

3. **Brain drain becomes the vice influence** [16]
   As the impact of climate change increases, the focus of the state is on keeping the country running, so the impact of the brain drains on national vulnerability declines.
4. **State Legitimacy is a regional problem in comparison of the climate diseases** [17]
   Climate impacts are national, so the political nature of State Legitimacy is of less importance for a country when natural diseases are sweeping the globe.
5. **External interventions maintain country's stability**
   Extreme weather and CO_2 emissions both cause external interventions to maintain social stability, so external intervention under the influence of climate will decrease the overall vulnerability to maintain this value.

Considering Human Interventions and Its Cost [18,19]:

Due to the specific situation of Afghanistan which is the most developing country in the world [20], namely the constant wars, geography location as well as the survivals that reliance on financial assistances. All variables seem make a big difference on the fragility; we choose to **take Afghanistan as an example** for further study.

Our team believes that ***the state power should establish a comprehensive civil defense system.***

From our view as outsiders, intervening in the factor 'national legitimacy' is a good choice. Given the situation of Afghanistan, countless parades and armed rebellions sway such a country which could highlight the influence of state legitimacy (X7) among all variables.

It is widely acknowledged that building a comprehensive civil defense system is a good way to prompt the legitimacy of the country. If a comprehensive civil defense system is built, it would help to reduce the natural disasters impacts on people's survival as well as strengthen the status of government.

In 2022, Afghanistan has lost more than 2 billion dollars in its economy due to climate changes, but if human interventions on national legitimacy take effect, it is highly expected that the cost will retain in 2.5-3 billion dollars.

MODEL EVALUATION AND FURTHER DISCUSSION

Task 5 needs us to discuss whether the model we have built can be used in small or large areas. We will analyze the advantages and disadvantages of the model to see whether our model can adapt well when the scope of the region changes. The vulnerability results will be analyzed, and give the corresponding modification plan.

Strengths

We adopt a combination of subjective and objective methods to calculate the weight. When assessing the fragile, this scheme considers a variety of human and natural factors. meanwhile, the analysis and decision-making of complex systems are more in line with the decision-making process and the psychology of decision makers. This scheme is not only practical but also scientific.

Grey prediction with high fitting accuracy was adopted. In the case of a small number of samples, the fitting value with high accuracy can be obtained directly according to the change trend.

The influence of *multi*collinearity was firstly eliminated. After eliminating this influence; it will be easy to consider the influence of climate as an independent variable on various factors, so that the regression equation can be obtained with high goodness of fit.

Weaknesses

The amount of data referred to when establishing the model is small, and the adaptability of the model will decline when the scope of the problem becomes larger.

It is difficult to find suitable and public data, so we can only select Afghanistan, a fragile country, and Kenya, a country that has gradually improved its vulnerability. We can only use climate impact assessment and prediction models in small areas.

Analysis

The model we have built is highly scientific and highly predictive. When it is necessary to study the vulnerability of a smaller area, the reference value can be obtained by using the local distinct climatic conditions. The numerical values are brought into the assessment model we built earlier, and then we can use our prediction model to accurately and completely see the vulnerability of the next few years, and at the same time, we can see the impact of climate on various indicators in the regression model, it is convenient for regional managers to take corresponding measures.

However, for a large area (such as the mainland), its climate conditions will be greatly affected by the dimension, so it is difficult to uniformly select a suitable value to bring into our model.

Further Discussion

In order to make our model more suitable for large regions, the assumptions and the definition of the data being used should be changed. For example, we need to expand the scope of the assumptions and define a new continental vulnerability. For example, the mainland GDP, population density, and currency devaluation, etc. might be used. After carefully defining the new indicators to evaluate the continental vulnerability, we can substitute it into the equation according to our method to make it applicable to larger regions.

CONCLUSIONS

A framework to measure national fragile based on data processing analysis was constructed in this paper and Cohesion, Economic, Political, Social, Cross-cutting and climate change into account were considered. In our method, comprehensive measurement and weight assessment of the main indicators have been carried out, and the rationality and sensitivity of the data results were tested. Also, the changes in Kenya's vulnerability in the next few years using the GM (1,1) model were successfully predicted. The *multi*ple regression model to solve the impact of climate change on other indicators was also used. The results still followed the latest ranking of the fragile country index.

1. A comprehensive assessment model for national fragility based on AHP was established. First, other indicators and secondary indicators of temperature, precipitation and CO_2 emissions in the climate change through information online were identified, and the indicators were totally quantified. Then, the weight of each indicator was determined by the entropy weight method combining subjectivity and objectivity, and then the

vulnerability of the country was determined by weighting.

2. Afghanistan as a sample for specific analysis was selected. Afghanistan's vulnerability from 2020 to 2022 is: 8.41, 8.36, and 8.69, respectively. Sensitivity analysis based on the model of Task 1 was conducted, and the size of temperature, precipitation, and CO_2 emissions up and down, respectively, were adjusted in order to conclude that droughts and floods, extreme weather, and the increase of greenhouse gases made countries more vulnerable. If the climate and environment were good, the country would not be so fragile.
3. Kenya as a sample for specific analysis was selected. First, a nonlinear regression model is constructed considering the time factor, and then a sensitivity analysis is carried out, and the size of each indicator is adjusted up and down. It was found that the effect of CO_2 emissions over time was more significant, which means that the impact of the greenhouse effect is increasing year by year, making the country more vulnerable. Later, we determined the tipping points: 0~3 is stable; 3~7 is vulnerable; 7~10 is fragile. Finally, GM (1,1) to make predictions by year was built, and the result is that Kenya will move from a fragile state to a fragile state in the second half of 2022.
4. The relationship between temperature change and other factors based on linear regression model was explored, and conclude that temperature and politics-related national legitimacy are the most significant. Through the analysis of the Afghan state, an intervention was proposed: a comprehensive civil defense system was established, its impact process was analyzed, and finally the approximate cost of 2.5~3 billion dollars was predicted.
5. The advantages and disadvantages of the model to conclude that the model was suitable for smaller countries were analyzed and we hope to adjust the type of indicators in the comprehensive evaluation: considering GDP, population density and other factors, so that the model can be applied to larger countries.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 85-92

Mitigation of IoT Device Based DDoS Attacks (Using Blockchain)

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Abstract:
Internet of Things (IoT) refers to the connection or interconnection of smart objects or devices sharing data and/or information. In the world of today, devices are being made smart which makes internet of things to emerge as an area of incredible impact, potential and growth. Therefore, the rapid development of internet of things also brings about threat of insecurity. There is difficulty in the securing of private data and information as the internet of things (IoT) is being vulnerable to various attacks. In this review article, we focus on the Distributed Denial of Service (DDoS). This is an attack initiated by the attacker to disrupt the authentic user from using the required services and also make network resources unavailable thereby consuming bandwidth. This paper aims at reviewing different methods and articles used to mitigate these attacks with great focus on blockchain variant used with smart contracts. This blockchain variant known as Ethereum is integrated with the Internet of Things devices and prevents the rogue devices and DDoS attacks from gaining access to the server. The research methodology is based on qualitative analysis where various literatures is being reviewed based on IoT devices and DDoS attack mitigation. This paper will be of benefit to individual in the cyber security field.

Keywords: Internet of Things (IoT), Distributed Denial of Service (DDoS), Blockchain, Ethereum, Smart Contracts.

INTRODUCTION

Technology is fast becoming an integral part of the human race where every device is moving towards the "always connected" model. The trending revolution of technology has made all devices to be interconnected with each other thereby introducing a new concept known as Internet of Things (IoT) [4]. Internet of Things (IoT) can be defined as the integration of physical devices which are capable of communicating, sharing, operating and disseminating, thereby enabling new services in a wide range of areas [9]. Figure 1 below shows a high-level overview of the Internet of Things (IoT) based systems and their interaction where a centralized server communicates with the IoT devices like sensors through a communication network.

A lot of security platforms that are required for IoT; Confidentiality is one of them where message that is sent from one source to the other can be easily intercepted by an attacker and the content can easily be compromised. It is necessary to secure the message by hiding it from the relay nodes. The solution to this is a method known as encryption/decryption mechanism [1]. Integrity is also a security service which means message that is sent should not be altered, it should get to the receiver the same way it was sent. Altering the message breaks the security measures [2]. For the internet of Things to continue working, the services must always be available for use and accessibility must be granted so that it will be easy to detect when the service is being intruded then intrusion can be prevented to ensure availability always [7]. Users of the services from end to

end should be able to identify those they are interacting with so that an attacker will not be introduced into the system [3].

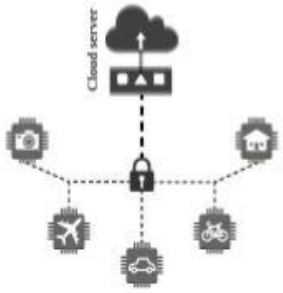

Figure. 1: IoT Architecture [9].

Security has been a major concern for to these IoT applications and devices. This is due to the high volume of data and large size of network being used and produced. Distributed Denial of Service (DDOS) attack should be focused on and tackled as it is a security threat to Internet of Things systems [3]. DDoS attack is when an attacker that is malicious attempts to consume bandwidth of legitimate users and make network resources unavailable. In terms of IoT devices, DDoS attack overloads the network resources or targeted computing device using any IoT application [9]. A DDoS attack flow diagram is shown below in figure 2 where the attacker uses various units as handlers to fill the host with packets which ends up taking up resources and bandwidth [23]. Some of the most common DoS attacks are SYN flood, DNS flood, Ping flood, UDP flood, ICMP broadcast etc.

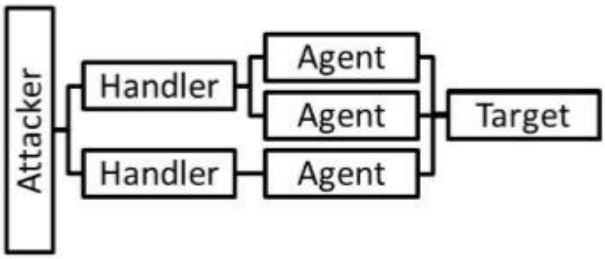

Figure. 2: DDoS Attack Flow [23].

This paper uses blockchain technology for providing security solution to the DDoS attacks on IoT devices. Blockchain is being described as an online distributed ledger which consists of a list of blocks, each block is an ordered record of a timestamp and hash of the previous record [11]. Blockchains are mostly used in cryptocurrencies such as bitcoin and smart contracts such as ethereum [9]. This paper will review other methods of mitigating DDoS attacks on IoT devices but more attention will be given to blockchain being used as a defense mechanism against DDoS attacks using the ethereum blockchain. This paper is organized as follows: Section 2 describes the various models and methods being reviewed based on DDoS attacks on IoT devices and also highlights the number of journals and their sources being used for this paper. Section 3 introduces and highlights the proposed Ethereum blockchain model being used to prevent DDoS attack on IoT devices while section 4 presents the conclusion of the paper.

RELATED WORKS

Various methods and models have been developed by scholars in other to mitigate DDoS attacks on IoT devices. This section of the paper highlights some of the models and methods adopted and reviewed accordingly.

Learning Automata (LA) concept is being deployed as a strategy in mitigating DDoS attacks as Service Oriented Architecture (SOA) is presented as a system model for IoT [14]. Here the Service Oriented Architecture gives room to various developers to develop applications for IoT thereby acting as a middleware. With this, the prevention of DDoS attacks on IoT devices has proven effective.

Software Defined Networking (SDN) provides a better solution to the mitigation of DDoS attacks compared to sampling-based approaches. Traffic flow statistics are being checked and also normalized at each SDN-enabled switch [3].

The application of correlation and regression analysis is also being deployed to detect security incidents which could also include DDoS attacks on Internet of Things devices [13]. These correlation and regression analysis is also capable of detecting other various security threats that are eminent on the IoT devices.

A framework known as Multi Level DDoS Mitigation Framework (MLDMF) is proposed to defend against DDoS attacks on Internet of Things devices [19]. This framework includes edge computing level, fog computing level and cloud computing level. SDN is also being deployed to manage and mitigate DDoS attacks on IoT devices.

Kuusijarvi J., Savola R., Savolainien P., & Evesti A. in 2016 proposed as a solution a system known as trusted Network Edge Device (NED). Here, the trusted network elements download the security counter-measures of individual devices. The advantage of this system is the protection of the IoT devices with defined policies which are also initiated on other devices. Managing the countermeasures of the multiple Internet of Things devices all at once is also an added advantage of the model.

A DNS query-based distributed denial of service attack mitigation system using Software Defined Networking (SDN) is proposed to block and prevent the network traffic for DDoS attacks [3]. The network traffic traces obtained is distinguished from malicious traffic using a prototype system with Dirichlet process mixture model. Feng & Xu in 2018 designed and analysed a distributed and demand-based backscatter MAC protocol for Internet of Things. With this system and model, distributed denial of service attacks will be prevented and mitigated from IoT devices.

METHOD OF INVESTIGATION

This article took up a review of two hundred and fifteen journal papers that is published in reputable academic journals ranging from 2006 to 2018. To carry out the research properly, the keywords that were considered are "Internet of Things", Distributed Denial of Service" and "Blockchain". The search was carried out in databases which include IEEE, Elsevier, ProQuest, and Emerald publishing. Table 1 below shows a table detailing the distribution of the search, number of journals and its percentage distribution.

Table 1: Distribution of reviewed papers

S/no.	Database	Number of papers	Percentage
1	Google Scholar	80	37%
2	IEEE	31	15%
3	ProQuest	31	15%
4	Elsevier	40	18%
5	Emerald	16	15%

SYSTEM MODEL AND DESIGN

In this section, we will discuss the system model that comprises the devices and its peripherals and also discuss the proposed IoT-Blockchain model or design that will mitigate DDoS attacks on various IoT Devices.

NETWORK &THREAT MODEL

The figure below shows the network model and its entities which consists of Device, Gateway, Smart Contract and Server/Miner.

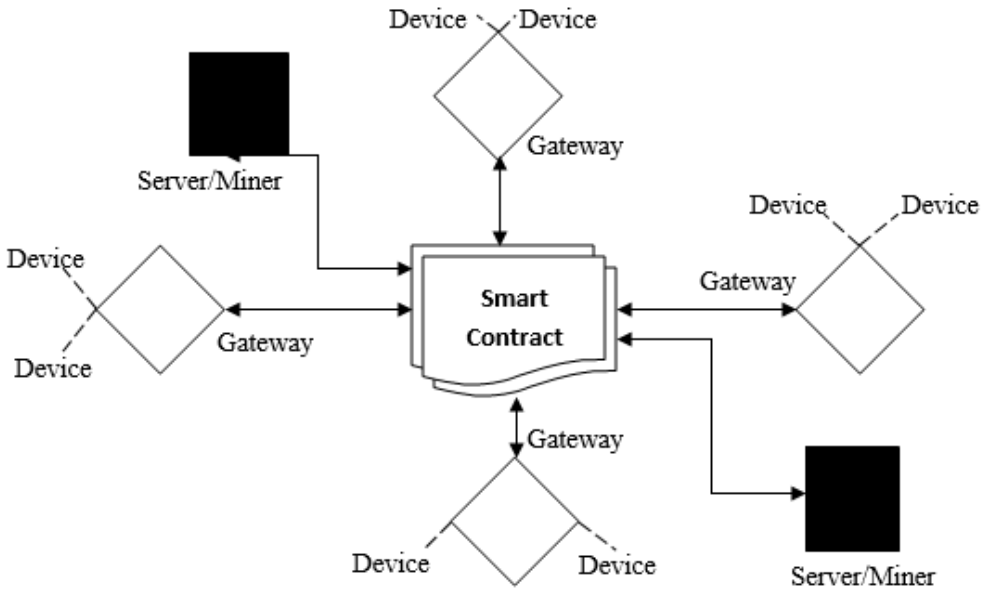

Figure 3: IoT-Blockchain System Model (Jayaid, Siang, Aman & Sikdar, 2018).

Device

This represents the Internet of Things (IoT) which are interconnected with each other, for transferring communicable data to the server through the gateway [9]. A gateway can be used to bring together multiple devices.

Gateway

This provides network connection to all the devices around itself. It also offers data aggregation and security features. In this case, it represents a gateway that group of devices can use for communication purposes.

Smart Contract

This is a system that serves as an authority and responsible for ensuring that the devices do not go further than what is required of the gas limit [9]. It is also considered as a regulatory body.

Server/Miner

This system is known for validating the transaction and data exchange through smart contracts using high computational processing capabilities.

The major objective of the distributed denial of service (DDoS) attack is to cause data traffic to the server which will cause outages [9]. With this flooding and overloading, it is assumed that the IoT devices are made to send a certain amount of data to the target of the DDoS attack. The IoT devices is used by the attacker to launch DDoS attacks on the servers.

IoT-BLOCKCHAIN MODEL

An online established software platform known as Ethereum which allows smart contracts and systems that are decentralized to be built on blockchains along with their states which are comprised of objects known as accounts that have fields like 20-byte address, a nonce, a balance of Ether, a contract code and storage [9] e. A state in Ethereum is known as data that is present in blockchain, therefore, when there is a transaction, a state transition occurs. There exists a gas limit when it comes to processing in Ethereum. Gas is known as resource. The model that is proposed is charged with allocating addresses for each node and also applying our coded smart contract with dependency on Ethereum. The contract determines which devices are trusted and those that are not trusted. Devices must be registered to the platform and given a specific gas limit. The enlistment will produce an account with special address for each device and a gas limit for a device to be related to their details. It depends on the transmission capacity and asset necessities of the device. Interactions between devices and servers are empowered by utilizing the smart contract represented by the server hub.

The smart contract in this system is charged with the task of checking invulnerable communication amongst the IoT units and the disbursed systems. It is developed with the usage of solidity, which is contract-oriented, high-level language for the ethereum digital computing device environment. Smart contract has two stages of operation which are

- **Initialization**: This phase of the smart contract describes how the system sends the smart contract which is regarded as server variable by using the contract to apprehend the trusted host. This paper takes into consideration that systems are the hosts that are trusted. The smart contract address will at that point be sent to all the Internet of Things device for them to lock in with the contract instance. The gas limit for each exchange within the contract is set in this stage to protect from the attacks.
- **Deployment:** In this stage, IoT devices will connect, communicate and log into the server hub which conveyed the smart contract thereby getting enrolled. It is only the server that can authorize devices to induce enlisted or erased. Upon accepting affirmation from the server, an IoT node address will be enlisted and kept in the smart contract list of trusted devices. Whenever the server suspects a node to be malicious or it is required to be removed, it can call the erase function which will remove that specific node.

All Internet of Things devices within the IoT-Ethereum framework are able to be communicated with the smart contract to deploy a message. This message will be deployed and put away within the blockchain for recovery only if the Internet of Things device is granted access. The Internet of Things node is checked with the list of authorized addresses by the smart contract and is passed as a trusted device as expressed so within the contract [9]. If the node does not gain access, the

messages will be dropped and rendered void. The figure below shows the flow diagram of the IoT-Blockchain model.

The DDoS issue here is that a device is sending amazingly huge amount of data to over-burden a server and consume its assets. In the system framework, any of the devices may begin persistently sending data to the system and impact a DDoS attack.

Such attacks can be avoided with the gas limit trait of Ethereum because it guarantees no advanced assets can be devoured once the limit is surpassed [9]. Within the smart contract, there is a gas limit which acts as a component to anticipate the framework from over-burdening.

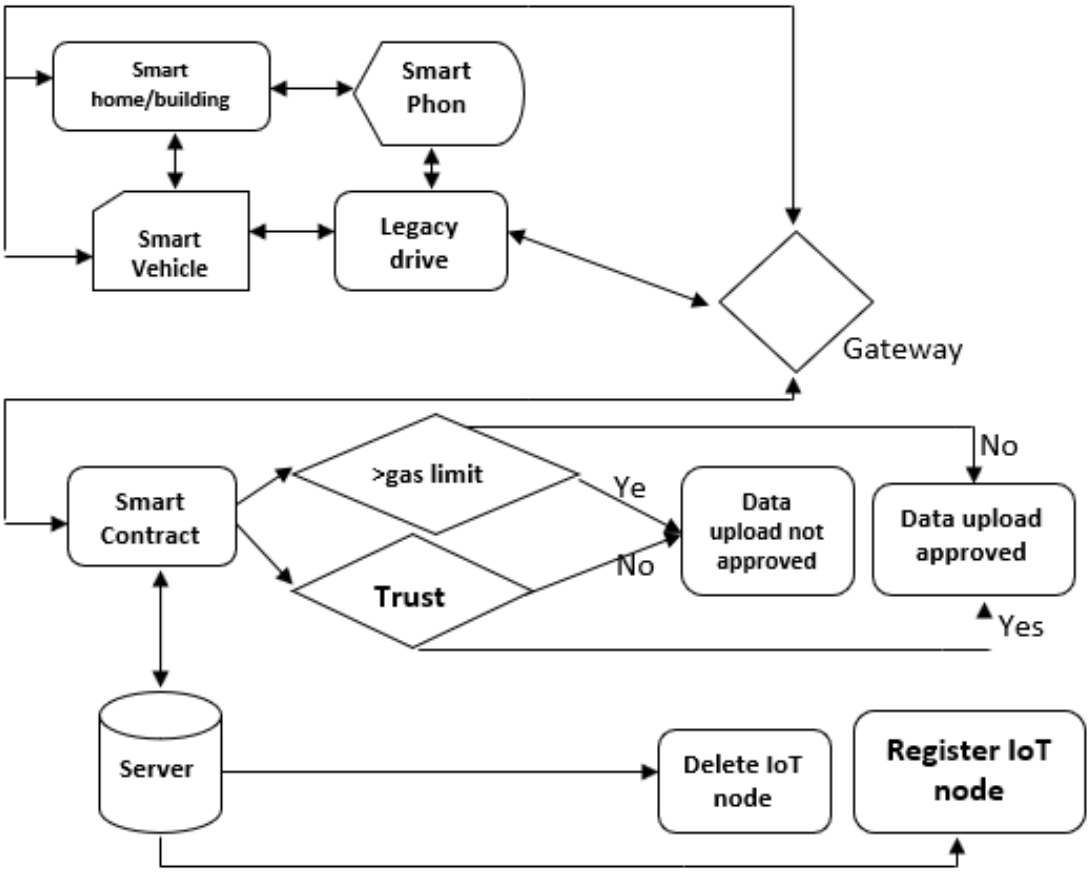

Figure 4: Flow Diagram of IoT-Blockchain Network [9].

CONCLUSION

This review presented Internet of Things (IoT) devices and how its security challenges which is mostly Distributed denial of service (DDoS) attacks to flood and overload the system and deny legitimate users access to their resources. The paper reviews literatures of other models and methods being applied to mitigate the security challenges of Internet of things (IoT) devices.

It takes a comprehensive review on blockchain being used as a mitigating tool where a platform known as Ethereum introduces smart contracts into the system and sets a gas limit for each IoT device so that whenever the attacker seeks to overload the server, the IoT device being used will reach its limit and then it drops.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 93-105

Development of Artificial Intelligence of Ensembles of Software and Hardware Agents by Natural Intelligence on the Basis of Self-Organization

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Abstract:
Natural intelligence is the totality of acquired knowledge and intellectual skills of a person. Intellectual skills are the ability to think creatively and gracefully, communicate and learn universally. From the point of view of the Orthodox tradition, there are three types of thinking, learning and communication: carnal, creative and grace-filled (spiritual). Creative thinking, learning and communication develop and improve rational intelligence. Gracious thinking, learning and communication develops and improves spiritual intelligence. Strong natural intelligence generates superior knowledge relative to the knowledge of society. It expands and deepens the knowledge of society. Knowledge is a social product. The dynamic process of discovering knowledge and broadcasting about the works of the Creator is described in (18:3-5) parables: “Day imparts speech to day, night reveals knowledge to night. There is no language and no dialect where their voice is not heard. Their voice goes throughout the whole earth, and their words to the ends of the world. As part of the dynamic process of knowledge discovery, the natural intelligence of each person develops. Natural intelligence began to develop artificial intelligence. Artificial intelligence can be possessed by a software-hardware operating process capable of creating poetry and essays, painting pictures, developing recommendations and solutions for goals set by humans, managing production and systems in various fields of activity based on the existing knowledge of the natural intelligence of mankind. Artificial intelligence cannot develop without human participation. A very promising use of artificial intelligence is carried out by ensembles of software and hardware agents using proven methods based on self-organization in various spheres of life. Ensembles of software and hardware agents can be trained using the knowledge and skills of natural intelligence.

Keywords: natural intelligence, creative thinking, universal learning, artificial intelligence, ensembles of software and hardware agents.

INTRODUCTION

Developing efficient multi-agent systems is critical for many applications that require collaboration and coordination with humans. In the classical theory of artificial intelligence, solving a problem comes down to creating a single intelligent system, for example, an ensemble of agents, which, having at its disposal all the necessary knowledge, abilities and computing resources, is able to solve some global problem.

Learning coordination in cooperative multi-agent systems is a central problem that has received much attention. attention in interdisciplinary research in the fields of robotics, economics, technology platforms, as well as in various artificial intelligence communities. Coordination in this context refers to the ability of two or more agents to jointly reach agreement on the actions to be performed in the environment. For example, a team of robots working together to find victims in

a search rescue situation, or a group of robots that need to coordinate to lift, carry and deliver cargo in object-based transportation tasks, or in the context of autonomous vehicles where coordination between autonomous vehicles and drivers is critical. This highlights the need to develop ensembles that can learn to coordinate and collaborate with individuals and among themselves.

Solving a problem by an ensemble of agents based on knowledge engineering represents the point of view of classical artificial intelligence, according to which an intelligent system, having a global vision of the problem, has all the necessary abilities, knowledge and resources to solve it. In contrast, in distributed artificial intelligence it is assumed that an individual agent can have only a partial understanding of the overall problem and can only solve some of its subtasks. Therefore, to solve any complex problem, as a rule, interaction of agents is required, which is inseparable from the organization of a multi-agent system. This social (collective) aspect of problem solving is one of the fundamental characteristics of the conceptual novelty of advanced computer technologies of artificial (virtual) ensembles of agents.

Artificial intelligence methods are used by ensembles of software and hardware agents for such areas and industries as healthcare, education, clean energy, sustainable living, etc. These methods are used so that various ensembles can make automated forecasts, make recommendations or propose solutions for a wide range of problems. Some Sufficient training of agents and their self-organization bring certainty to the behavior of ensembles. This results in manageable ensembles and predictable outcomes for end users.

To harness the benefits of artificial intelligence in a sustainable and responsible manner, the characteristics and governance principles of ensembles are defined. The controllability of the ensemble in the domain strengthens the understanding of the correctness of the result. Manageability is an important fundamental characteristic to ensure security for end users. To implement controllability, key observation points are identified for the state of the ensemble and its transition from one state to another. Implementing an intervention requires a "transfer of control" from the ensemble to a specialist or other external agent. Specific points at which control transfer is possible are determined during the development and implementation of the ensemble. Transfer of control for the purpose of external intervention in the operation of the ensemble can be easily accomplished within reasonable limits of time, space and complexity, while minimizing the delay for both parties, taking into account the specific costs of transfer of control or control. The effectiveness of implementing ensemble controllability depends on this. Moreover, since certainty must exist on both sides of the transfer of control, it is important to carefully design transfer of control processes to minimize or mitigate uncertainty and other undesirable consequences.

The effectiveness of management and control is tested and depends on the design features of the ensemble and the method of implementing management or control. For control, functions must be developed that implement the control logic. To do this, it is necessary to determine principles and approaches for verifying the controllability of the ensemble and its self-organization. Self-organization is a process that unites, combines and integrates the agents of an ensemble into a coherent format. The approval is handled by the managing agent. When agents exhibit the declared behavior, control is disabled. The user can appropriately intervene in the ensemble in a timely manner. When a certain condition is satisfied, the ensemble transitions to another state.

The interrelated actions of interacting agents constitute the process of producing a result by the agent. Agents are trained in actions. Communicating agents can exchange data and facilitate each other's functioning. Researchers from scientific, commercial and government organizations are constantly improving approaches and methods for training agents, increasing the intelligence of ensembles and their intellectual capabilities [1-10].

TECHNOLOGICAL SELF-ORGANIZING ENSEMBLES OF INTELLIGENT AGENTS

The basic law of the organization of an ensemble is the law of synergy: the sum of the properties of the organized whole exceeds the sum of the properties of each of the elements included in the whole separately. The most important feature of an ensemble is the presence of qualities that are not reducible to the sum of the qualities of its constituent intelligent agents. An important indicator of the stability of the ensemble organization as an integral system is the nature of interaction with the environment. The ensemble has a number of regulators subordinate to each other. Regulation as a process is a change in the relationship of intelligent agents. aimed at preservation through the transfer of information through communication channels, in which the functional nature of the properties of intelligent agents is maintained and enhanced. To do this, a selection of features or grounds is carried out first to connect intelligent agents into an integral system according to the law of proportionality. The law of proportionality determines the relationship between the organization of the ensemble and what is between each of the types of intelligent agents included in it. There are certain quantitative and qualitative relationships between the characteristics of intelligent agents. The law of proportionality determines the proportionality of the parts combined as a whole, which achieves a synergy effect.

The synergetic approach makes it possible to implement the self-organization of intelligent agents of a technological ensemble. Technological self-organizing ensembles are capable of interacting with production teams, replacing them for some time and even completely releasing them in various areas of professional activity. Technological ensembles of intelligent agents can manage industries, make decisions in complex changing circumstances and ensure safety in extreme conditions.

Synergetic mechanisms of self-organization of technological ensembles of intelligent agents are applied in accordance with the standard case of using ensembles in various fields. The standard case "Application of an ensemble of intelligent interacting agents" defines the parameters, characteristics, methods, models of human counterparts, knowledge, skills, behavior, images, categorical methods of utility and preferences and other essences of interaction of intelligent diversified agents.

COMMUNICATIVE AND ASSOCIATIVE DEVELOPMENT OF SMART ARTIFICIAL INTELLIGENCE

Smart artificial intelligence is being developed based on communicative-associative logic, hierarchical preferences, and evolving utility of ensembles of diversified intelligent agents. The development of smart artificial intelligence reveals new systemic qualities and technological singularity in the process of joint action and mutual adaptation of diversified intelligent agents according to the standard case of their application. Technological smart artificial intelligence compares information according to the criteria of usefulness, selects it according to the criterion of preference, identifies novelty according to the principle of opposition (optimal - not optimal; effective - not effective; dangerous - safe, etc.) by contradiction based on objective conditions based on communicative associative logic.

Development of Artificial Intelligence by Ensembles of Diversified Agents

Cognitive ensembles of mobile diversifying agents have a well-developed and replenished information model of the external world due to the presence of knowledge base, reasoning mechanisms and action analysis. Agent mobility is the ability to migrate across technological platforms in search of the necessary information with access to analytical systems for its analysis. Cognitive ensembles contain many mobile diversified agents distributed in the network, which migrate through it in search of relevant data, knowledge, procedures on technological platforms and analytical systems and cooperate to achieve the goals set for them. The agent's cognitive behavior is ensured by the ability to make decisions. The architecture of a cognitive ensemble allows the use of self-learning agents, the knowledge of which is formed in the process of solving practical problems.

Agent interactions establish two-way and multi-way dynamic relationships between the ensemble, technology platforms, and analytical systems. It is a necessary condition for the formation of virtual communities. Interaction is accompanied by mutual transformations of the agents themselves and the relationships between them. The main characteristics of interaction are directionality, selectivity, intensity and dynamism:

- Direction: positive or negative; cooperation or competition; cooperation or confrontation; coordination or subordination, etc.;
- selectivity - interaction occurs between agents that in some way correspond to each other and the task at hand. In this case, agents can be connected in one respect and independent in another;
- intensity - interaction between agents is not reduced to presence or absence, but is characterized by a certain strength;
- dynamism - the direction of interactions can change over time.
- Analysis of interaction between agents includes the following tasks:
- identification of the situation of interaction between agents;
- identifying the main roles and their distribution between agents;
- determination of the number and types of interacting agents;
- building a formal interaction model;
- determination of a set of possible strategies for the behavior of agents;
- formation of a variety of communicative actions.

Each agent has a limited set of knowledge necessary for it to realize its own and common goals. Obligations are one of the tools that allows you to streamline the singular interactions of agents. They allow you to predict the behavior of other agents, predict the future and plan your own actions. The following groups of obligations can be distinguished: a) obligations to other agents; b) the agent's obligations to the group; c) obligations of the group to the agent; d) the agent's obligations to himself. A formalized representation of goals, obligations, desires and intentions, as well as all other characteristics, forms the basis of the mental model of an intelligent mobile diversifying agent, which ensures its reasonable behavior.

Different forms of interaction between agents arise:

- simple cooperation, which involves the integration of the experience of individual agents (distribution of tasks, exchange of knowledge, etc.) without special measures to coordinate their actions;

- coordinated cooperation, when agents are forced to coordinate their actions (sometimes involving a special coordinating agent) in order to effectively use resources and their own experience;
- productive cooperation, when agents share resources or solve a common problem, exchanging experiences and not interfering with each other.
- A model based on competition is used as a reasonable model for coordinating the behavior of agents. In the process of collective work of mobile diversifying agents, many problems are solved:
- recognition of the need for cooperation;
- selection of suitable partners;
- the ability to take into account the interests of partners;
- organization of negotiations on joint actions;
- formation of joint action plans;
- synchronization of joint actions;
- decomposition of tasks and division of responsibilities;
- identification of conflicting goals;
- competition for shared resources;
- formation of rules of behavior in a team;
- training in team behavior, etc.

A feature of the collective behavior of mobile diversifying agents is that their interaction in the process of solving particular problems (or one general one) gives rise to a new quality of solving these problems. To do this, mobile agents can leave the client server and move to a remote server to perform their actions, after which they can return back. The use of mobile agents provides:

- reducing the time and cost of data transfer;
- expansion of limited local resources;
- facilitating coordination;
- performing asynchronous calculations.
- The life cycle model of mobile diversifying agents includes the following stages:
- processing new messages;
- determination of rules of behavior;
- performing actions;
- updating the mental model in accordance with specified rules;
- planning actions based on preferences and utility.

A mental model includes a description of goals, preferences, utilities, obligations and opportunities, as well as rules for the behavior of agents. Based on this model, the choice of certain actions of intelligent mobile diversified agents is carried out. When using mobile agents, you have to solve a number of serious problems, including: the legality of ways for agents to move across the network; agent verification (for example, virus protection); respect for private property rights; maintaining confidentiality of information; overpopulation of the agent network; compatibility of the agent code and the software and hardware of the network machine.

The main efforts to improve the intelligence of intelligent mobile diversified search agents on the Internet are aimed at developing knowledge representation models, mechanisms for inferring new knowledge, reasoning models and methods for training agents to ensure full interaction of ensembles of mobile smart agents with technological platforms and analytical systems.

Intelligent agents with synergistic interaction form ensembles. Fast, efficient collection and analysis of large volumes of data, flexible operational mobility of data updating and synergistic open collaboration of intelligent agents with information platforms and analytical systems help accelerate the digital transformation of the high-tech industry and the social sphere by teaching new skills. The interaction of intelligent ensemble agents with information platforms and analytical systems is facilitated by a standard case of synergetic interaction.

New skills are taught in a virtual space and then developed in a specific environment. The accumulation of professional experience in the virtual space contributes to the development of artificial intelligence in the industrial environment.

Preferences of Smart Artificial Intelligence

Artificial intelligence achieves preference-based goals. To identify preference on a plurality of objects A is to specify a plurality of all those pairs of objects (a, b) for which object a is preferable than b. When a preference is identified, the following approaches are possible 1, 2.

Unconditional Table-Based Approach:

We will fill in the table according to the principle:

- Aij = 1 if the ith object is better than the j object;
- Aij = 0 if the ith object is worse than the j object.

Logical Approach:

The approach comprises three stages:

- private criteria for preference selection are identified;
- table of "alternatives-private criteria" is drawn up, which specifies for each alternative the values of quantitative private criteria or the rank of qualitative criteria;
- critical rule is chosen to determine the best alternative.

Since the private criteria under consideration are qualitative, they are given ranking (by preference) rather than quantitative. Rank scores can be considered as scores. On the basis of them, it is necessary to determine the preference. For this purpose, a decisive rule is created. For example, points 1, 2, 3.

1. Absolute preference. Alternative ai is preferred to alternative aj if, for all particular criteria, ai is preferred or equivalent to aj. Absolute preference has the property of transitivity (if A is preferred to B and B is preferred to C, then A is preferred to C).
2. Majority rule preference. Alternative ai is better than aj if the number of private criteria by which ai is better aj is greater than the number of criteria by which ai is worse aj.
3. The criterion of the highest sum of points. Instead of quantifying private criteria, it is possible to set their rank values. The rank value is treated as a score, with the lowest score being 1 for the worst value and the highest score for the best value. The preference criterion is then formulated as: alternative ai is better than alternative aj if the sum of the score estimates for ai is greater than for aj

When using the rule preference criteria or the sum of scores, an additional requirement is often imposed on the alternative - the absence of a private criterion with the worst value. Such alternatives are immediately excluded from consideration.

With a large number of alternatives and particular criteria, it becomes difficult to directly determine the best alternative by the majority criterion because of the difficulty of calculating the number of best and worst criteria for each alternative. In this case, a preference table should be drawn up to identify the best alternative.

According to the rule of majority and absence of the worst value, a preference table for alternatives is drawn up: if alternative b is preferable to a, then at the intersection of row b and column a, 1, otherwise 0 is set.

Useful Choice of Cognitive Virtual Mind

The concept of "utility" was introduced into economic science by the English philosopher Jeremiah Bentham (1748-1832). Today, all the science of a market economy is essentially based on two theories: utility and cost. The utility category explains the operation of the law of demand. For example, digital human twin with artificial intelligence analyzes unrealized demand for high-tech products on the market. Unrealized demand for high-tech products in the market in practice is related to the use of key indicators of economic efficiency NPV, IRR, PB, PL, ROI and others. According to the main indicators of economic efficiency, the digital twin determines the preferences and usefulness of participants in unrealized demand for high-tech products. It identifies new competencies and skills of technological software functional realization of goods or services to quickly meet demand with minimum production costs.

A useful choice of cognitive virtual mind is a functionality that determines preferences on some set of possibilities by the utility criterion. The cognitive virtual mind develops the ability to highlight the properties and functions of entities regardless of the different conditions in which they are observed, relying on useful choices. The better the cognitive virtual mind begins to distinguish similarities with other adjacent entities, the sooner it gains the skill of generalizations. The logical method as a practical acceptance of the use of logical laws and rules in a particular kind of mental activity of the cognitive virtual mind turns them into an algorithm of logical rational thinking. When logical techniques are used, it turns general logic into application logic. For this purpose, forms a set of reasonable possibilities: situations that may arise in a virtual application environment. Also forms a set of originations - execution of rules and operations in the virtual application environment. And forms set of cognitive functions capable of solving the problem of promotion from the starting situation to the target situation. The path of promotion to the target state is built according to the rules and operations of generation in the applied virtual environment by cognitive functions, using methods of analogy, similarity, combination of available solutions and increase of sensitivity of artificial intelligence. In this way of intellectual activity, the cognitive virtual mind establishes reasonable targeted sequences, forming a new knowledge in the mental model by analysis, synthesis, analogy, comparison, induction, derivation and creative ensembles from well-trained artificial neural networks to achieve the desired goal in dialogue with a professional expert [11-14].

FUNCTIONAL AND HARMONIOUS SELF-ORGANIZATION OF ENSEMBLES WITH HYBRID COMPETENCIES

Functional harmonious self-organization of the interaction of intelligent agents in various environments is carried out on the basis of data from a specific environment obtained by analytical competent intelligent agents. For each set of functions and hybrid competencies of an intelligent ensemble, there is a critical value for the number of its intelligent agents capable of synergistic self-organization of interaction. Artificial intelligence of large ensembles of intelligent

agents with functional hybrid competencies can be configured for functional harmonious self-organization of collective interaction of the necessary intelligent agents to implement a set of functions and competencies, if their number exceeds the critical value that determines their ability to self-organize interaction based on multiple attempts and sufficient positive feedback connections.

The complex dynamic organization of a purposeful functioning ensemble requires continuous management, without which the ensemble cannot exist. The peculiarity of this control is that it causes a number of processes in the ensemble itself and, above all, processes of internal self-regulation according to the laws of self-tuning, self-development and self-learning.

A self-tuning ensemble is an adapting system in which the accumulation of experience (memorization of information) is expressed in changes in certain of its parameters that are essential for the purpose of the system.

A self-developing ensemble is an adapting system that independently develops its development goals and criteria for achieving them, changes its parameters, structure and other characteristics in a given direction.

A self-learning ensemble is an adaptable system that, in the process of development, undergoes a learning process, accumulating experience, and has the ability to independently search for criteria for the quality of its functioning.

All organizational management activities should be aimed at creating intelligent management agents capable of independently, during the management process, constructing their own algorithm as a result of adaptation and training. Such control, in contrast to control according to a predetermined rigid algorithm, is called adaptive control. The task of adaptive control is to find the best strategy in relation to the control goal.

The self-organizing ensemble, according to the laws of synergetic, is rebuilt in such a way as to create minimal resistance to the flow that generates it. Flow gives rise to structure; structure tends to maintain flow.

All this happens within the range of existence of the structure. When the flow increases above the critical value, a restructuring of the structure occurs. The old structure, unable to handle the increased flow, collapses. In its place, a new structure corresponding to a higher flow range is abruptly organized. A system that has found itself within the range of its existence tends to stabilize the flow. Resists its reduction below the occurrence range and its increase above this range.

The activities of the organizational structure are considered as a dynamic interaction of information flows. An algorithm for determining quantitative and qualitative characteristics of a hierarchical management structure works on these flows. The mathematical apparatus of cognitive analysis and control are sign networks that take into account hundreds of functional parameters of the system and give not a quantitative, but a qualitative answer to the questions posed.

Self-organization is the formation of a spatial, temporal, informational or functional organization, structure (more precisely, the desire for organization, for the formation of a new structure) due to the internal resources of the system as a result of goal-setting interactions with the environment of the system. We are talking about information interaction with the external environment. In recent decades, algorithms have appeared that make it possible to work with large information flows.

The process of self-organization of ensembles of intelligent agents is carried out according to the law of structural harmony of the system: "Generalized golden sections are invariants, on the basis and through which, in the process of self-organization, systems acquire a harmonious structure, a stationary mode of existence, and structural and functional stability." The organization of a system presupposes a certain coordination of the states and activities of its subsystems and constituent elements. The ability to self-organize is based both on the multiplicity of elements of the system and the ramification of connections between them, contributing to the emergence of integrity, and on the presence of flexible interaction between elements according to the type of feedback. Negative feedbacks ensure stability of system functions, constancy of its parameters, and resistance to external influences. Positive feedback plays the role of process amplifiers and is of particular importance for the development and accumulation of changes. The presence of negative and positive feedback leads to the possibility of development according to the law of the golden ratio using external and internal relationships.

At the moment of self-organization of the ensemble, a qualitative transition occurs, intelligent agents begin to function as a single whole, and organizational stability begins.

A fundamental step in the description of such systems was made by a Danish scientist who worked in America for many years, Per Bak, in the theory of self-organized criticality. The name emphasizes that the system self-organizes into a critical state, in which its dynamics acquire large-scale invariance in collective interaction in the network that develops as a result of self-organization. This approach is called "connectionism" (from English to connect).

The stable distribution of positive and negative responses of interacting connections according to the law of the golden ratio determines the critical importance of the intelligent agents of the ensemble. An ensemble that has the number of necessary intelligent agents equal to or more than the critical value is capable of self-realization and obtaining the required result.

Determining the critical values of ensembles of intelligent agents for the implementation of various sets of functions and competencies will help create a universal large ensemble with smart artificial intelligence [15-18].

ARCHITECTURE OF THE ELBRUS BEG SUPERCOMPUTER WITH ARTIFICIAL INTELLIGENCE

The development of science, technology, intellectual technologies and industry leads to an increase in the volume of information processed using computers. The efficiency of processing large volumes of information on a computer depends on the organization of the computing process. Methods for parallelizing program execution and proactive pumping of data and program modules in a cloud environment at the hardware level are a very effective way to solve large volumes of information. The architecture of the Elbrus BEG supercomputer with artificial

intelligence allows for rapid processing of programs and data and ensures the development of artificial intelligence by ensembles of agents.

The architecture of the Elbrus BEG supercomputer with artificial intelligence, which provides proactive pumping of data and program modules for their continuous processing, is briefly discussed. The Elbrus BEG supercomputer provides continuous processing of large programs with deterministic connected modules [19].

Programs with deterministic connected modules are formed at the compilation stage by constructing their operator linear-cross circuits. The supercomputer command system is focused on implementing programs with linear-cross module communication schemes. For subprograms with operator subcircuits with returns and with hammock-shaped subcircuits, polysemantic operators with machine software implementation in the instruction system are formed at the compilation stage.

Elbrus BEG contains new devices: an intelligent processor for analyzing connections between program modules, counters for the use of RAM segments by modules, an intelligent processor for moving modules through virtual memory, an intelligent processor for moving general data of modules [20].

The analysis processor performs a proactive analysis of the connections between program modules and deterministically related modules. The analysis processor implements the process of calculating the numbers of current RAM modules using the SPP_t communication program of the PI_t module, and also implements the process of adjusting the values of counters that take into account the use of RAM segments by program modules.

The shared data movement processor implements the movement of shared data between modules. Shared variables have sequences of move addresses from the current values. According to the sequence of movement addresses, flows of general data values are organized and delivered to the place of use in modules on operational segments. Modules are referred to by their numbers. For external memory modules, the values of general variables are transferred to the resident general data module when replacing the module containing general data.

A control processor with artificial intelligence organizes processing, movement of general data, analysis of connections and determination of current modules within the program. It combines the work of devices on one module during different cycles of calls to the operational segment.

The number of operational segments for continuous processing of a program with deterministically linked modules is determined during its translation or compilation.

RAM segments are switched with processors sequentially, according to the processing sequence of the modules located on them. This allows you to minimize the switching of processors with RAM, sequentially proactively dynamically switching processors from RAM segments.

Ready for subsequent processing, general data values are moved through program modules located in RAM. For each value of a common given d, the sequence of modules using it, the places where they are used in these modules, and the relative moments of using the values of d in the

modules are determined. Based on the set of modules of use d, an additional set of modules is compiled through which the values of a given d move.

General data values are moved dynamically across modules located on RAM segments, forming a data stream.

General data of modules not located in RAM is moved to resident ROD modules. In the resident general data module, values are stored together with movement pointers. Values moved into one module are arranged in a row. At the beginning of the sequence their number is indicated. After writing new values to the common data module, its free space (write) pointer is moved if the counter of the common data module does not exceed the allowed number of values.

The values are provided with signs of recalculation. If the attribute takes on the immutable state, then the value is moved to all used modules.

Values are placed in the general data module in the order in which they are moved to modules coming from external memory to RAM. In the general data module, values can be supplied with several pointers.

After all values have been moved to a program module, the "moved" flag is set in it, which indicates that the module is ready for processing. Let there be k execution sequence modules and n RAM segments.

Let the first module have variables. For each variable, the numbers of subsequent modules in which it is used are determined. For the second module, all variables that are not in the first module are defined. For each variable, the numbers of subsequent modules in which it is used are determined. For subsequent modules, the sequences of using variables that are not specified in previous modules are similarly determined.

For each variable we define modules. Let us determine the sequence of module numbers. Variables will be stored in the resident module of general data according to the sequential numbering of external modules that use variables. Proactive data movement using a resident shared data module ensures continuous processing.

Programs with deterministic coupled modules are formed by ensembles of intelligent decision-making agents for each class of algorithms [21]. Ensembles of intelligent decision-making agents provide universal application of Elbrus BEG.

Continuous processing of large programs with deterministic coupled modules was demonstrated on the modernized Elbrus BEG interpreter. Programs with deterministic connected modules exponentially reduce the waiting time for the result of their continuous processing on the virtual memory of the universal Elbrus BEG with proactive memory management in comparison with a supercomputer with random memory management and processing programs with non-deterministic connected modules.

The implementation of the Elbrus BEG processor with proactive memory management using the 3 nm process technology can be carried out together with a branch of Taiwan Semiconductor Co.

Ltd. (H.K.) and MCST. Elbrus BEG will help scientists and researchers quickly process ultra-large programs.

CONCLUSION

One of the main goals of natural intelligence is to create ensembles of intelligent agents that can collaborate with people and empower people. That is, they will learn to be more adaptive to human behavior. Advances in cognitive science suggest that ensembles of intelligent agents that accurately represent human behavior will be able to collaborate more successfully with humans when they have the ability to quickly learn expert knowledge and skills across a wide range of tasks.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 106-113

The Three-Fold Cords in Rescue Operations

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Abstract:
In the fundamentals of the basis rescue operations, is embedded the major three aspects involving the disaster management entities. These include the transportation, water as well as the fire disasters. The safety of any environments or communities' rests solely and majorly on the level or the degree of managing the entire situations. Fire entails a very complex chemical process. The fire science is a branch of physical science which includes fire behavior, dynamics, and combustion. The physics of combustion determines when and where we have a fire. The diffusion flame process(fire)consists of three basic elements: fuel, oxygen, and heat. these basic components have been recognized in the comprehensive study of the science of fire. A fire itself is the result of a chemical reaction known as combustion, where fuel and oxygen react with one another and atoms rearrange themselves irreversibly. For this to occur, fuel must reach its ignition temperature, and combustion will continue if there is enough fuel, heat and oxygen. It's a state, process, or instance of combustion in which fuel or other material is ignited and combined with oxygen, giving off light, heat, flame. And various reaction products. Transportation systems are designed to move people, goods and services efficiently, economically and safely from one point on the earth's surface to another. Despite this broad goal, there are many environmental hazards that commonly disrupt or damage these systems at a variety of spatial and temporal scales. Whereas road curve geometry and other engineered hazards can be addressed through design hazards such as extreme weather, landslides and earthquakes are much more difficult to predict, manage and mitigate. Droughts leading to over-extraction of water, permafrost melt, increased karsts dissolution from precipitation, clay soil shrinkage, and other factors can result in ground subsidence or collapse. Impacts include potential loss of human life or injuries, building and infrastructure damage, flooding, saline intrusion to groundwater, poor drainage, and loss of agricultural land. There are three primary hazards—floods, droughts, and extreme storms. Floods affect the greatest number of people annually in terms of economic damage, floods result in the highest annual damage. In this paper, a clear survey and analysis of the three-fold means which are involved in any rescue operational processes supports and services

Keywords: Fire services, flood, hazards, protection, natural disaster.

INTRODUCTION

The economic livelihood of many individuals, firms, and nations depends on efficient transportation, and this is embodied in twentieth-century innovations like just-in-time manufacturing and overnight shipping. Transportation systems are designed to move people, goods and services efficiently, economically and safely from one point on the earth's surface to another. Despite this broad goal, there are many environmental hazards that commonly disrupt or damage these systems at a variety of spatial and temporal scales. Whereas road curve geometry and other engineered hazards can be addressed through design hazards such as extreme weather. Flooding can be classified into urban flooding, pluvial flooding (also called flash flooding), fluvial flooding (exceeding river channel capacity resulting in floodplain Inundation), water logging, and coastal flooding Droughts are "characterized by a deficiency in a region's

water supply as a result of constantly below average precipitation" over a period of time. In the past, droughts have resulted in the death of millions. Fire entails a very complex chemical process. The fire science is a branch of physical science which includes fire behavior, dynamics, and combustion. The physics of combustion determines when and where we have a fire. The diffusion flame process(fire)consists of three basic elements: fuel, oxygen, and heat. These basic components have been recognized in the comprehensive study of the science of fire. A fire itself is the result of a chemical reaction known as combustion, where fuel and oxygen react with one another and atoms rearrange themselves irreversibly. For this to occur, fuel must reach its ignition temperature, and combustion will continue if there is enough fuel, heat and oxygen. It's a state, process, or instance of combustion in which fuel or other material is ignited and combined with oxygen, giving off light, heat, flame. And various reaction products. This work is purposely set out in order to study majorly the basic dynamics and processes leading generally to disaster outbreaks, prescribe preventive measures and creating necessary awareness on how to curtail the occurrence as much as possible.

DISASTERS IN TRANSPORTATION SYSTEMS

Landslides and earthquakes are much more difficult to predict, manage and mitigate. These adverse events can dramatically reduce network serviceability, increase costs, and decrease safety. As the movement of people, goods, and services increases at all scales due to population growth, technological innovation, and globalization, the systematic study of these events becomes increasingly important. Transportation systems also create hazards. Accelerated movement comes with risks, and the corresponding accidents that occur disrupt lives and transportation systems daily. (See [47]) An accident is something which happens without planning. However, most people think of accidents in terms of physical injury, death, or at least property damage. Behind the data lies untold human suffering. This is the too costly way to learn. An "accident" is an unplanned, undesired event which may or may not result in injury or property damage, that interferes with the completion of an assigned task. A "near miss" is a form of an accident that does not result in injury or property damage. While much effort and time is expended on accident investigation, this information tells us that we should be focusing on accident prevention. The majority of accidents are near-miss and may never be reported. The causes of accidents can be broken down into two basic components, unsafe conditions and unsafe acts. Unsafe conditions are hazardous conditions or circumstances that could lead directly to an accident. An unsafe act occurs when a worker ignores or is not aware of a standard operating procedure or safe work practice designed to protect the worker and prevent accidents. Accident prevention involves the identification and elimination of causes before an accident occurs. Accident reaction is what most supervisors practice, that is, investigating the accident to determine the causes and then implementing corrective actions to avoid reoccurrence. This helps eliminate future accidents from a specific cause, but does nothing to address avoiding the accident that just occurred. One tool commonly used in accident investigations is to reenact the accident. This can provide insight as to the conditions faced by personnel during the accidents and what options were available for response. The reenactment must be done under strict controls to ensure that no one is injured during the reenactment. (Please, see [46]). Accidents as an unplanned and unexpected occurrence, which upsets a planned sequence of work; are resulting in loss of production, injury to personnel, damage to plant and equipment and eventually interrupting production flow. Control measures as an act of limiting or making something happen in a particular way, stop something from spreading, going out of hand, or getting worse. An accident is something which happens without planning. However, most people think of accidents in terms of physical injury, death, or at least property damage. Every year, accidents claim the

lives of thousands of children and many thousands more are injured. These are facts and figures. Many people believe that "accidents happen". They believe that the occurrence of an accident is inevitable and cannot be avoided. Some say "it was just bad luck" or "they were in the wrong place at the wrong time". All of these excuses fail to identify the true causes of accidents. One researcher found that for every serious or disabling injury, there are: ten minor injuries thirty property damage incidents six hundred near-miss accidents

WATER

There are three primary hazards-floods, droughts, and extreme storms. Floods affect the greatest number of people annually in terms of economic damage, floods result in the highest annual damage. Improvements in transportation, communications, and response time now mostly limit damage from droughts to economic losses, although the loss of urban water supply presents problems which are increasingly difficult to manage through transport mechanisms with increasing scale. Extreme storms include cyclones, hurricanes, hailstorms, snowstorms, dust storms, or coastal storm surges. Dust storms are the result of sustained high winds at low levels and a thermally unstable atmospheric stratification lifting dry soil or sand to heights over a kilometer. These are ecologically sensitive areas with low precipitation and little vegetation cover. Dust storms are observed with a frequency between one and twenty days per year in dry regions. Landslides and avalanches can be initiated by storms, precipitation, melting permafrost, or glacial melt. Desertification in steep areas, often due to overgrazing or previous agricultural conversion, and increases in rainfall intensity are also linked with increased number of landslides. Higher population density and development of mountainous terrain is increasing the risk from landslide hazards. Geographically, landslide events are mainly distributed where the main landslide-inducing factors include rainfall, earthquake, and flood. Droughts leading to over-extraction of water, permafrost melt, increased karts dissolution from precipitation, clay soil shrinkage, and other factors can result in ground subsidence or collapse. Impacts include potential loss of human life or injuries, building and infrastructure damage, flooding, saline intrusion to groundwater, poor drainage, and loss of agricultural land. The river basin flood control plans have several limitations, including a heavy reliance on structural flood control measures, lack of watershed management provisions, exclusion of the management of tributaries and areas subject to water logging, and insufficient stakeholder involvement. The plans generally do not sufficiently incorporate other land use or sector plans and are often based on an analysis of limited management options. Risk management is a proactive approach and is focused on the design of measures in advance of a drought that are intended to be put in place to prevent or mitigate the level of risk exposure and hence vulnerability to impacts. This approach seeks to build resilience in the systems to cope better in the future through structural and nonstructural measures on an ongoing basis. Disaster management is a reactive approach based on the implementation of measures and actions after a drought disaster is recognized. This approach applies to emergency situations and is likely to produce inefficient technical and economic solutions since actions are taken under stress without the time to adequately evaluate options. This tends support dependence on emergency relief measures rather than resilience. The figure below outlines the difference between a reactive and proactive approach for drought management. The proactive approach is more complicated but supports a longer-term outcome compared to the reactive approach. It leads to improved (Please, see [39 - 41]). From 2001 to 2018, there were nearly 300 droughts, where over 21,000 people died, and over 1.3 billion people were directly affected. Overall, Asia and Africa are the regions most affected by both floods and droughts. From 2001 to 2018, droughts occurred most often in Africa (about 120 times), followed by Asia (more than 60 times). However, more than a billion people were affected by droughts in Asia, compared to 200 million in Africa. Similar to flood occurrence,

this contrast may be due to a higher population density in affected areas in Asia. The top countries with the highest number of recorded droughts were China and the United States, (see [44,45]).

FIRE SERVICES

Fire is a complex chemical process, and fire investigators must understand the basic chemistry and physics involved to enable them to formulate opinions based on these scientific principles rather than on "old fire investigators' tales." Not being able to explain the technical aspects of fire behavior may prevent an investigator being able to accurately analyze the cause, origin, and progress of a fire. The diffusion flame process (fire) consists of three basic elements: fuel, oxygen, and heat. These basic components have been recognized in the science of fire protection for over 100 years. The diffusion flame process is defined by Richard Tuve in the *Principles of Fire Protection Chemistry* as "a rapid self-sustaining oxidation process accompanied by the evolution of heat and light of varying intensities."(see [11])

Combustion is any process in which a substance reacts with oxygen to produce a significant rise in temperature and the emission of light. For a fire to start it needs a source of ignition, a source of fuel and a source of oxygen. For example, if a smoker falls asleep with a cigarette still lit, and sets fire to the sofa, the cigarette is the source of ignition, the material on the sofa is the source of fuel and the air is the source of oxygen. Unchecked, this fire will spread quickly. (See [36]) To prevent fire, sources of ignition, fuel and oxygen need to be kept apart as much as possible. Obviously, this is difficult for oxygen, as it is in the air all around us, but it's important to always think carefully about what possible sources of ignition are in your building, as well as thinking about what will allow a fire to spread once it has been ignited. A muster point is a designated place or an area where all employees, guests or visitors to the work site, or a large crowd can assemble in case of an emergency. The muster point ensures that everyone knows where to gather even in the panic of an emergency. A meeting point, meeting place, or assembly point is a geographically defined place where people meet. Such a meeting point is often a landmark that has become popular and is a convenient place for both tourists and citizens to meet. A muster point is a safe, geographically defined place where people (i.e., the workforce and visitors) converge in the event of an emergency to receive information, instruction, and also for head count before rescue operations is initiated if necessary. A muster point is a safe, geographically defined place where people (i.e., the workforce and visitors) converge in the event of an emergency to receive information, instruction, and also for head count before rescue operations is initiated if necessary. It can also be called EMERGENCY ASSEMBLY POINT (EAP) or simply ASSEMBLY POINT. The assembly or muster point is often a landmark and all personnel at offices and work sites are aware of and instructed, trained and informed to go straight to, in an emergency situation. It is considered as the safest place of the job premises. It is an essential safety measure for any work site and must be well marked and easily found at both night and day time. Specific safety signs should point the way and mark the location as MUSTER POINT OR ASSEMBLY POINT. Emergency drill is always carried out to determine the workability of the company's emergency and evacuation plan. Muster point must be close enough that everyone can access and gather there quickly during an emergency but it should be still far enough from the work site so that those who gather are safe from the risks posed by the emergency. It should be placed in opposite direction to the wind movement so that in the event of fire, the point is still safe since fire grows with the wind. Muster point enables supervisors and other designated personnel to identify any missing employee or visitor who may still be at the work site after the evacuation. The information is thus passed to the rescuers or emergency respondents. Kindly note that muster point Should Not be attached to the building of the workplace. The U.S. Fire Administration (USFA) sponsors

research and conducts studies to support emergency responder health and safety and help fire departments prepare for and respond to fire, natural disasters, non-fire emergencies, and other threats and vulnerabilities.

Natural Disasters and Non-Fire Emergencies

The public relies on first responders during emergencies, and the more substantial the incident or the disaster, the greater the need for assistance delivered by the fire department and others with public safety missions.

Vehicle and Roadway Safety

Approximately 25 percent of on-duty firefighter fatalities occur each year while responding to or returning from incidents, with the majority of fatalities resulting from vehicle crashes. Vehicle collision is the second leading cause of firefighter fatalities.

Assembly Points:

The assembly points can be defined as a location for gathering. Such is known to be identified across the workplace. Mostly, they are being designated by the department or area of a facility. The purpose of the assembly point is simply to serve as a location through which information updates are given from emergency responders. It is natural to provide access to washroom facilities and other protection measures from the elements. The six elements of the life cycle of fire are described by Dawson Powell in The Mechanics of Fire. These elements are input heat, fuel, oxygen, proportioning, mixing, and ignition continuity. All of these elements are essential for both the initiation and continuation of the diffusion flame combustion process. The first three elements--input heat, fuel, and oxygen—are represented by the fire triangle. The combustion reaction can be depicted more accurately by a four-sided solid geometric form called a tetrahedron. The four sides represent heat, fuel, oxygen, and uninhibited chain reactions.

Table 1: Fatal Fires by the Number of Deaths Per Fire, Lagos 2009 - 2014.

Number killed in fire	2009	2010	2011	2012	2013	2014	Total number of fires	Proportion of fatal fire
1	95	95	102	116	103	193	704	93.7%
2	1	2	10	8	13	4	38	5.11%
3	--	2	1	2	1	-	6	0.8%
4	-	-	1	-	-	-	1	0.13%
5	1	-	-	-	-	-	1	0.13%
6	1	-	-	-	-	-	1	0.13%
Total number of fires	98	99	114	126	117	197	751	100%

Source: Lagos State Fire Safety Services. (See [14])

SUMMARY

Generally, the disasters which are being influenced by many factors that affect growth, spread, and developments. The physical shape and state of the fuel, the available oxygen, and the transmission of heat all play vital roles in fire development. While each fire is different, all fires follow certain predictable patterns which, when understood by the investigator, provide a scientific basis for determination of origin and cause. Floods affect the greatest number of people annually in terms of economic damage, floods result in the highest annual damage. Accidents happen without planning. However, most people think of accidents in terms of physical injury,

death, or at least property damage. Behind the data lies untold human suffering. This is the too costly way to learn.

CONCLUSION

Indeed, it's very clear without any iota of doubt that disasters have greatly a significant economic importance which cannot be underestimated.

RECOMMENDATION

From the information so far, it can be deduced that the disasters (such as fire) seem as being uncontrollable with time. This could be generally believed to be caused due to lack of proper information and necessary awareness. Hence, there supposed to be a proper as well as regular creation of awareness.

ACKNOWLEDGMENTS

Indeed, the author will really want to sincerely appreciate and be very grateful to the anonymous reviewers for their helpful comments which has improved the quality as well as the general presentation and the entire format of the work. The impacts of the department of fire and rescue operational services, ministry of public affairs and transports, Oyo state secretariat, Agodi, Ibadan, Nigeria, is highly recognized, for showing kindness in making relevant information available towards the success of this work and the general supports given in making the work publishable and relevant.

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Journal of Research in Engineering and Computer Sciences
October 2023, Vol. 1, No. 4, pp. 101-109

Image Splicing and Copy-Move Image Forgery Identification Methods Based on Deep Learning: A Survey

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Abstract:
With the advancements of technology in current era, everyone faces a challenge to identify digitally manipulated images. It is not easy to discriminate the original and forged images. For digital image tampering, image splicing and copy-move forgeries are very much well-known and common techniques. Image forgery is detected and spotted based on feature descriptor of an image. It is a concise and important local descriptor which is to be applied to grasp hierarchical representations from the input images. The significant correlation among nearby pixels has been identified by deep learning-based methods. It prefers locally grouped networks rather than one-to-one networks among all pixels. A convolution operation can be implemented by sharing weights to produce the output feature map. Many well-known deep learning-based backbone architectures, such as CNN, R-CNN, LSTM, U-Net, encoder-decoder have been implemented in the past for detection and localization of these types of image forgeries. To detect copy-move and splicing forgeries can be proposed based on these existing frameworks. The various performance parameters like accuracy, F1-score, AUC will be computed and compared. Many available standard forged image datasets comprising of images of these forgery types, viz. CASIA_v2, CoMoFoD, Columbia, IMD, NIST16 will be used for training purpose. Different training-testing datasets will be used for model working to check effectiveness of model.

Keywords: Copy-move, Image Splicing, Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), Region-based Convolutional Neural Network (R-CNN).

INTRODUCTION

It is very easy to create fake and manipulated images because there are many easy image manipulation software and tools. With the advancements of technology in current era, the misuse of data in the form of images is in boom everywhere. All of us face this thought-provoking task of identifying such manipulated images and separating the real, called as pristine images, from the forged images.

The most common technique used for digital image manipulation is splicing. In this a selected area is taken from an image and it is put on same or another one. It is reliant on proofs and evidences that are caused due to manipulation of images. Some general evidences are object inconsistency, lighting conditions and edge discontinuity. If same area of an image is used then it is a copy-move forgery. It may be done to create illusion of multiple objects of same type which already exist in the image. If a correlation value of entire image is computed, then it found that

this value of these two regions of this manipulated image will be comparatively greater considering other areas of that image. Correct recognition of the copies in the images is the main aim of copy-move forgery. Various distance measures can be used for comparison of attributes extracted from image features. It is very difficult to detect and perceive tampering visually. An effective solution is required for tampering detection problem. There are many application Areas like: Surveillance systems, Intelligence services, medical imaging, Journalism, Forensic study, and Criminal search.

A sample splicing forgery is shown in fig.1a, 1b below, where the animal zebra is copied to new background. A sample copy-move forgery is shown in fig.2a, 1b below, where the girl on stairs is duplicated on the same image. Most research work was proposed on image splicing, as it's easy to detect image inconsistency in illumination direction, contrast and noise which causes to detect tampering traces using deep learning-based models.

Fig. 1a) Original image of animal Zebra from [24]

Fig.1 b) Image splicing forgery of 1a image from [24]

Fig. 2a) Original image from [24]

Fig. 2b) Copy-move forgery of 2a from [24]

Many types of methods and techniques are proposed for detection of the image forgeries. Generally, the image forgery identification techniques detect it by finding the dissimilarity of various attributes in image. There are some properties of images like contrast, illumination, shadow, compression, sensor noise which are important for this task. For various computer vision tasks Deep learning-based models are very much popular recently. Many images related tasks can be done using DL based models like object recognition, segmentation, and classification of images. There are two major reasons for Deep learning-based models' success in computer vision. Firstly, significant correlation between adjacent pixels is typically taken advantage. So, the grouping of networks locally than over one-to-one networks among all pixels is more preferred. Second, through a convolution operation each output feature map is formed by weights sharing. The typical methods are dependent on engineered attributes for detection of exact forgery. While the DL based models are based on training of existing images and identification of newly and different types of manipulations. These advantages of deep learning models help to find the existence of manipulation and forgery in an image. The artifacts found in the image are used to train the model.

LITERATURE SURVEY OF EXISTING METHODS

In [1], ResNet50v2 based architecture was implemented by using transfer learning using YOLO CNN model. Image batches will be given as input to the model which exploits the weights Convolutional Neural Network (CNN) based on YOLO. ResNet50v2 framework is used here. The model was an efficient model with accuracy 99.30% for CASIA_v2 dataset [24].

In [2], a Correlation Network called as PSCC-Net based on Progressive Spatio-Channel was developed for forgery detection. It detects and localizes image manipulations. Two-path procedure is used here. Local and global features are extracted in the top-down path and image manipulation is detected and their manipulation mask is also detected at four scales in bottom to upward path. In this path, Spatio-Channel Correlation Module (SCCM) is used which collects two types of correlations i.e., correlations based on spatial and channel. This enables the model to manage with a wide range of image forgery and manipulation. Experimentation was conducted on synthetic dataset generated using MS-COCO image dataset.

In [3], detection of spliced image and its localization methodology was developed. It was based on feature descriptor captured locally and it was using CNN. Ordered depictions are collected from the input testing images which are either RGB or grayscale. For suppression of the image contents' effects and extraction of varied and features which are expressive-residual the first layer of model was used. For the extraction of features for each block of the input images CNN was

used. Then block pooling was added along with SVM classifier. Experimentation was conducted on CASIA_v2, Columbia grey DVMM [27] and DSO-1 image datasets.

In [4], the parallel deep leaning based neural network scheme called Buster Net was developed for localization of image copy-move forgery. It also allows separating source and target regions. It was having two sub-networks one for copy-move detection and another for source/target region separation. Three main aspects of model are namely, serial scheme instead of parallel, double-level self-correlation, atrous convolution usage, attention mechanism for improvement of the similarity detection and using network for images to discriminate the alike regions. Experimentation was conducted on artificial dataset created, CASIA_v2, CoMoFoD [25], and COVERAGE [28] image datasets.

In [5], a robust system was developed for double image compression context. The difference is calculated for an original image and its recompressed version which is used for training purposes. This CNN-based model was lightweight and trivial. The performance of this model exhibits its great efficiency than more recent approaches. The experimental results give validation accuracy of 92.23% on CASIA_v2 dataset.

In [6], CAT-Net, a fully CNN was developed. RGB and DCT streams were included in this network. On RGB and DCT domains together the forensic features of compression artifacts were learned by this model. For handling various shapes and sizes of spliced object multiple resolutions of each stream are considered. Experimentation was conducted on CASIA_v2, Spliced COCO, Fantastic Reality, IMD2020 [26] image datasets.

In [7], for image tampering identification and localization method was developed. It involves residual network and UNET Architecture along with dilated convolution. An encoder anddecoder as residual units are implemented with UNET architecture as a backbone. The residual units are helpful for gaining speed of training process. The information spread happens between lower and higher layers which get facilitated by these units. In this model, global image tampering artifacts are captured and computational burden is also reduced. The method has achieved excellent performance. The experimentation was carried out on four benchmark image forensics datasets Nist Nimble 2016 [29], CASIA_v2, Columbia Uncompressed, MICC F2000 datasets.

In [8], feature learning through multi-view and supervision using multi-scale address the aspects like sensitivity and specificity. The model learns semantic-agnostic generalizable features by using noise scattering and edges' nature surrounding tampered regions. This semantic segmentation network-based method was called as MVSS-Net. Five standard datasets viz. CASIA_v1, CASIA_v2, Columbia, COVERAGE, NIST16, were tested to identify manipulation at pixel level and image level too.

In [9], the technique was based on Mask R-CNN with a main support of MobileNet. Numerous images splicing manipulations in an image were detected and located. The amount of percentage of forged region for a numerous and more than one splicing of images was also calculated. The model was trained and tested using self-created Multiple Image Splicing dataset. For Multiple Image Splicing Dataset, average precision was 82%, 86% on Columbia Gray, 81% on WildWeb and 74% on CASIA_v1. The F1-Score was 67% on MISD, 68% on WildWeb, 64% on CASIA_v1, and 61% on Columbia Gray, which was showing great performance on ResNet variants.

In [10], for complete and correct image forensics, a top-down architecture called as Constrained R-CNN was developed. A unified feature representation was learned by manipulation feature extractor directly from data. The network meritoriously categorizes forged areas for next level for classification of manipulation and rough localization. To increase the global manipulation features the combination of low- and high-level information is done. At last, the detailed local features learning and tampered region distinguishment was facilitated using this rough localization information. The F1-score on the Columbia, NIST16 and COVERAGE is 13.3%, 28.4%, 73.2% respectively.

In [11], copy-move image forgery identification methods' review was done for years for duration of 2017-2020. Several approaches related with fraud images detection were discussed. It also highlights latest tools used for this fraud detection. During last few years focus was on use of SIFT algorithm. Illumination, transformation of objects in an image is some aspects which need to be worked on. Best accuracy can be achieved by very complex models for forgery detection.

In [12], image splicing finding and localization was framed for detection of forged images. It carries out compact matching between two input images. Then it identifies does an image has forged area inserted from some other image. An encoder-decoder deep learning based network which was attention-aware was developed. The features matching based on hierarchy and masks generation for fine-grained, encoder-decoder along with atrous convolution was modelled. On normalization operations and informative features recalibration a correlation computation module which is attention-aware is built. VGG and ResNets are framed as feature extractors. The performance was evaluated on CASIA, MFC2018, PS-BATTLES image datasets.

In [13], ManTra-Net model was developed for detection as well as localization. There was no extra pre-processing as well as post-processing used in this work. Many types of manipulations like copy-move, splicing, enhancement, removal and other unfamiliar types can be detected. ManTra-Net is a fully convolutional network which can handle random sizes of images. The investigational results demonstrate the robustness and superiority of ManTra-Net for multiple types of forgery. The performance was evaluated on NIST, COLUMBIA, COVERAGE, CASIA_v2 image datasets.

In [14], scheme was based on deep learning using CNN for copy-move forgery identification. Specific pre-processing layers were integrated in CNN to generate adequate outcomes. The experimentation was on done on synthetic dataset. It shows general validation accuracy of 90%. Synthetics datasets from available datasets were used for experimentation.

In [15], Image splicing detection was done VGG-16 based CNN. The image blocks were given as input to the network. During training stage, blocks were selected from input images, specifically on boundaries of objects where splicing was done. For fine-tuned model accuracy of 97.8% was obtained. For images with false distortions, accuracy of 96.4% was obtained for CASIA dataset.

In [16], for copy-move forgery detection, a network called as BusterNet, which is having two branches architecture along with a module for fusion was developed. It was the algorithm with distinguishability to localize source and target regions in an image. The non-domain datasets and phase wise strategies were developed for synthesizing large-scale copy-move forgery detection samples. BusterNet showed great performance for copy-move detection algorithms on two popular datasets viz. CASIA and CoMoFoD.

In [17], a wide-ranging literature review of image forgery techniques based on deep learning was presented. A wide variety of image forensics problems were discussed here. Many pioneers work either make use of pre-processing step or a special initialization in first layer of network. This was done to obtain a certain feature at initial phase itself.

In [18], multiple types of image manipulations were detected using Spatial Pyramid Attention Network (SPAN) framework. A local self-attention blocks' pyramid was constructed. The image patches' relationship at multiple dimensions is shown by this pyramid. A generic, synthetic dataset is used by SPAN for training. But it can be tuned finely for exact datasets like Synthetic, NIST16, Columbia, COVERAGE, CASIA_v1, CASIA_v2.

In [19], traditional non-DL-based ones cannot produce the results as good as DL-based approaches were confirmed. The techniques surveyed were based on many effective DL based methods; it includes CNN and its aligned frameworks to adjust to detecting tampered traces. The categorization was based on the well-known DL backbone architectures like CNN, R-CNN, LSTM, U-Net, and Encoder-Decoder.

In [20], high-confidence manipulation localization architecture was modelled. This architecture utilizes multiple frameworks like resampling features, LSTM and an encoder-decoder network. Image tampering localization was carried out by the mapping from low-resolution features to pixel-wise estimates. The last layer provides the predicted mask. Image manipulations are localized at pixel level with great precision. The learning of mapping from encoded feature maps to binary mask is done using a decoder network. A new synthesized dataset of images was introduced. The detailed experiments showed an efficient segmentation of various manipulations like splicing, copy-move and object removal. The performance was tested on IEEE Forensics, NIST16 and COVERAGE image datasets.

In [21], for detecting the compression ratio is computed for original image and fake image using Error Level Analysis. VGG-16 architecture was modelled for identification of image manipulation through Error Level Analysis. The experimentation was carried out on CASIA_v2 dataset with accuracy of 92.2% for training and 88.46% for validation in 100 epochs.

In [22], for recognition and localization of image manipulations a combination of features resampling and deep learning-based methods were developed. In one method, on overlapping image patches Radon transform was computed. Next, heatmap is created through Gaussian Conditional Random Field along with Deep learning model. Segmentation using Random Walker method was used for Tampered image areas localization. In the second method, processing was done using network based on LSTM for resampling features having overlapping image patches. Nist Nimble 2016 image dataset was use for performance evaluation.

In [23], for image splicing and copy-move finding CNN was designed. Initialization of weights in network at first layer was done using 30 high-pass filters. The residual maps were calculated in spatial rich model (SRM) by use of these weights. This SRM was helpful as a regularizer to identify the changes due to manipulations. The dense features are extracted from the test images by CNN. For SVM classifier gets the final discriminative features from feature fusion technique. The performance evaluation was carried out for CASIA_v1, CASIA_v2 and DVMM image datasets.

In [30], for training image forgery detection model, a different approach was presented. The prior knowledge transfer is done to the new model. Transfer learning is accomplished through this process of knowledge transfer. Other datasets training can be easily done using such modelling. Various transformations like shearing, rotating, and scaling of images were tested for model evaluation. The validation accuracy of 94.89% was achieved for image manipulation detection.

In [31], Mask R-CNN which is an enhanced mask regional CNN was developed to detect both types of manipulations, copy-move and splicing. To boost predicted masks Sobel filter acts as a supplementary task. It allows having alike image gradients like ground truth mask. F1-score obtained 78.25%, this performance was evaluated on COVERAGE and Columbia image datasets. In [32], C2RNet was developed is a combination of Coarse and Refined CNN called as C-CNN and R-CNN. For authentic and manipulated regions of images, the modifications in the image features were extracted. An image-based CNN was introduced rather than patch-based. The difference computation guarantees a steady performance for detection. Time complexity gets reduced extremely due to image-level CNN. The experiment was carried out on CASIA_v2, Columbia, FORENSICS which gives F1-score of 67.58%.

In [33], for feature extraction block discrete cosine transform (BDCT) and improved threshold method was used. For classifying the image into splicing or copy-move forgery CNN is implemented. Furthermore, Zernike Moment (ZM) polar is employed for locating the replica portions in the image. The performance evaluation was carried out on CASIA_v1 and CASIA_v2 datasets with accuracy of 99.03%.

In [34], the main backbone was deep convolutional residual network architecture. A classifier network which is fully connected is used to classify images following to this residual network. The performance was evaluated on CASIA_v2 dataset with accuracy more than 96% on an average.

In [35], Faster RCNN network based on a multi-stream was developed. It takes input of the element-wise sum of the Error Level Analysis (ELA) and Block Artifact Grid (BAG) error maps to provide higher accuracy than a single stream alone. Performance was evaluated on CASIA_v2, CoMoFoD, COVERAGE datasets with maximum accuracy of 82%.

CONCLUSION

Image Splicing and Copy-move are the very popular and common techniques used for digital image manipulations. There are many images forgery detection and localization schemes based on deep CNN.

A CNN is used for building an expressive local descriptor. The hierarchical representations of input images can be obtained from CNN, if it is applied in progressive manner. Many well-known deep learning-based support architectures, such as CNN, R-CNN, LSTM, U-Net, and encoder-decoder have been implemented for detection and localization manipulations in the forged images. An effective model for the detection of copy-move and splicing forgeries, based on these existing frameworks can be proposed. The performance parameters assessed are Accuracy, F1-score, AUC. The standard forged image datasets are CASIA_v1, CASIA_v2, CoMoFoD, Columbia, COVERAGE, IMD, NIST16 which have been used for training and testing purposes.

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