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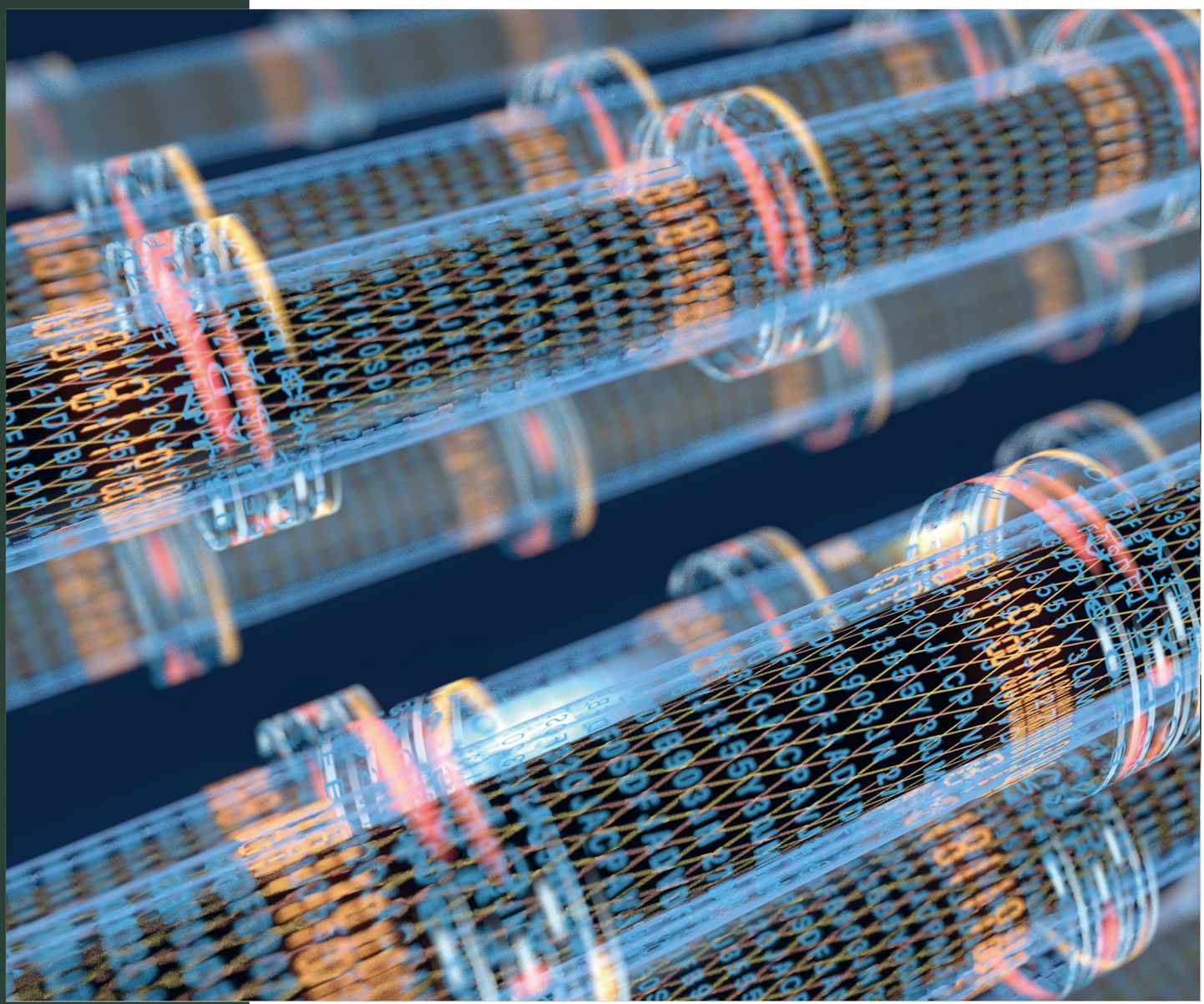

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ARTICLE

Nonlinear Vibration Analysis of an Electrostatically Actuated Microbeam using Differential Transformation Method

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ABSTRACT

In this paper, nonlinear vibration of electrostatically actuated microbeam is analyzed using differential transformation method. The high level of accuracy of the analytical solutions of the method was established through comparison of the results of the solutions of exact analytical method, variational approach, homotopy analysis method and energy balance methods. Also, with the aid of the present analytical solution, the time response, velocity variation and the phase plots of the system are presented graphically. It is hope that the method will be widely applied to more nonlinear problems of systems in various fields of study.

1. Introduction

The applications of micro-electro-mechanical systems (MEMS) (batch-fabricated devices and structures at a microscale level [1]) in microswitches, transistors, accelerometers, biomechanics, consumer electronics sensors in aerospace, optical and biomedical engineering [2-4] show its tremendous importance in many areas. In these microelectromechanical systems, electrostatic actuation is the most popular actuation mechanism used. Such actuation can be modeled by an electrostatically driven microbeam and a pair of fixed electrodes. Understanding the mechanical behavior of microbeams [5-8] and microplates [9-11] is of great importance due to their various applications [12-14]. However, dynamic response of the beam is greatly influenced by the inherent nonlinearities in the system. These nonlinearities reveal that a collapse of the movable structure occurs at a critical voltage (pull-in instability), and the phenomenon can be used as change of ON or OFF state [15-19]. In order to investigate this chaotic behaviour, nonlinear analysis of dynamic and stability responses of the system have been presented [20-25] using different analytical and numerical methods. However, a combined advantage of simplicity and high accuracy were not able to be achieved through these methods. The high accuracy of the methods trade-off simplicity in approaches and principles. A further investigation revealed that the required combined advantage of simplicity and high accuracy of a solution method can be achieved using differential transformation method. Therefore, in this work, nonlinear vibration of electrostatically actuated microbeam is analyzed using differential transformation method. With the aid of the method, analytical solution is derived to analyze the behaviour of the system.

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2. Model for the Electrically Actuated Microbeam

Consider a fully clamped microbeam with uniform thickness h, length l, width b(b≥5*h*) as shown in Figure 1. By applying the Galerkin Method and employing the classical beam theory and taking into account of the mid-plane stretching effect as well as the distributed electrostatic force, the dimensionless equation of motion for the microbeam is derived as

$$\ddot{u}\left(a_1u^4+a_2u^2+a_3\right)+a_4u+a_5u^3+a_6u^5+a_7u^7=0 \qquad (1)$$

the initial conditions are

$$u(0)=A,\quad \dot{u}(0)=0 \qquad (2)$$

where u is the dimensionless deflection of the microbeam, a dot denotes the derivative with respect to the dimensionless time variable $t=\tau\sqrt{\frac{\bar{E}I}{\rho bhl^4}}$ with I and t being the second moment of area of the beam cross-section and time, respectively.

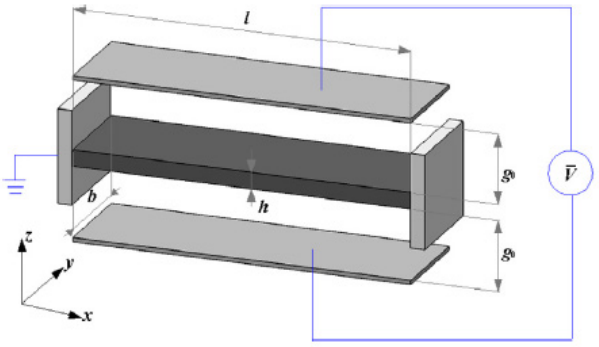

Figure 1. Schematics of a double-sided driven clamped-clamped microbeam-based electromechanical resonator

$$\begin{aligned}
&a_1=\int_0^1\phi^6d\xi,\qquad a_2=-2\int_0^1\phi^4d\xi,\qquad a_3=\int_0^1\phi^2d\xi,\\
&a_4=\int_0^1\left(\phi''''\phi-N\phi''\phi-V^2\phi\right)d\xi\\
&a_5=-\int_0^1\left(2\phi''''\phi^3-2N\phi''\phi^3+\alpha\phi''\phi\int_0^1\left(\phi'\right)^2d\xi\right)d\xi,\\
&a_6=\int_0^1\left(\phi''''\phi^5-N\phi''\phi^5+2\alpha\phi''\phi^3\int_0^1\left(\phi'\right)^2d\xi\right)d\xi\\
&a_7=-\int_0^1\left(\alpha\phi''\phi^5\int_0^1\left(\phi'\right)^2d\xi\right)d\xi
\end{aligned} \qquad (3)$$

where effective modulus $\bar{E}=\frac{E}{1-\nu^2}$, Young's modulus E, Poisson's ratio υ and density ρ .A is the initial angular displacement or the amplitude of the oscillations. The prime (') indicates the partial differentiation with respect to the coordinate variable x . The parameter N denotes the tensile or compressive axial load, g_0 is initial gap between the microbeam and the electrode, V the electrostatic load and ε_0 vacuum permittivity. The trial function is $\varphi(\xi)=\frac{16\xi^3}{(1-\xi)^2}$

3. Differential Transformation Method to the Nonlinear Problem

The application of differential transform method to the nonlinear problem is demonstrated in this section.

The DTM recursive relations for the governing equation of motion (Eq. (1)) of the system is

$$\begin{aligned}
&a_1\sum_{l=0}^{k}\sum_{p=0}^{k-l}\sum_{q=0}^{k-l-p}\sum_{r=0}^{k-l-p-q}(k-l-p-q-r+2)(\mathrm{k}-l-l-p-q-r+1)\\
&U[l]U[p]U[q]U[r]U[k-l-p-q-r+2]\\
&+a_2\sum_{l=0}^{k}\sum_{p=0}^{k}(k-l-p+2)(k-l-p+1)U[l]\,\mathrm{U}[p]U[k-l-p+2]\\
&+a_3(k+1)(k+2)U[k+2]\\
&+a_4U[k]+a_5\sum_{l=0}^{k}\sum_{p=0}^{k-l}U[l]U[p]U[k-l-p]\\
&+a_6\sum_{l=0}^{k}\sum_{p=0}^{k-l}\sum_{q=0}^{k-l-q}\sum_{r=0}^{k-l-q-r}U[l]U[p]U[q]U[r]U[k-l-p-q-r]\\
&+a_7\sum_{l=0}^{k}\sum_{p=0}^{k-l}\sum_{q=0}^{k-l-q}\sum_{r=0}^{k-l-q-r}\sum_{s=0}^{k-l-p-q-r-s}\sum_{v=0}^{k-l-p-q-r-s-v}\\
&U[l]U[p]U[q]U[r]U[s]U[x]U[k-l-p-q-r-s-v]=0
\end{aligned} \qquad (4)$$

Alternatively, we can write the recursive equation for governing equation as

$$\begin{aligned}
&a_1\sum_{k_4=0}^{k}\sum_{k_3=0}^{k_4}\sum_{k_2=0}^{k_3}\sum_{k_1=0}^{k_2}U[k_1]U[k_2-k_1]U[k_3-k_2]\\
&U[k_4-k_3](k-k_4+1)(k-k_4+2)U[k-k_4+2]\\
&+a_2\sum_{k_2=0}^{k}\sum_{k_1=0}^{k_2}U[k_1]U[k_2-k_1](k-k_2+1)(k-k_2+2)U[k-k_2+2]\\
&+a_3(k+1)(k+2)U[k+2]+a_4U[k]\\
&+a_5\sum_{k_2=0}^{k}\sum_{k_1=0}^{k_2}U[k_1]U[k_2-k_1]U[k-k_2]\\
&+a_6\sum_{k_4=0}^{k}\sum_{k_3=0}^{k_2}\sum_{k_2=0}^{k_3}\sum_{k_1=0}^{k_4}U[k_1]U[k_2-k_1]U[k_3-k_2]U[k_4-k_3]U[k-k_4]\\
&+a_7\sum_{k_6=0}^{k}\sum_{k_5=0}^{k}\sum_{k_4=0}^{k}\sum_{k_3=0}^{k_4}\sum_{k_2=0}^{k_3}\sum_{k_1=0}^{k_2}U[k_1]U[k_2-k_1]U[k_3-k_2]U[k_4-k_3]\\
&U[k_5-k_4]U[k_6-k_5]U[k-k_6]=0
\end{aligned} \qquad (5)$$

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subject to

$$U[0] = A,\ U[1] = 0, \tag{6}$$

From the recursive relation, the term by term solutions were obtained. For example,

$$U[2] = -\frac{\left(a_4 A + a_5 A^3 + a_6 A^5 + a_7 A^7\right)}{2\left(a_1 A^4 + a_2 A^2 + a_3\right)},\ U[3] = 0$$

The other term by term analytical expressions for the solutions are too long and huge to be included in this paper. Using the definition of DTM, the desired analytical solution was established.

4. Results and Discussion

The accuracy of the differential transformation method is shown in Table 1. The Table depicted the high level of accuracy and agreements of the symbolic solutions of the DTM when compared to the exact analytical method, homotopy analysis method (HAM), variational approach (VA), and energy balance method (EBM). From the results in the Table, it could be stated that the differential transformation method gives highly accurate results as homotopy analysis method and agrees very well with the exact analytical solution. The DTM is comparably very simple and avoids any numerical complexity. Also, the higher accuracy of the differential transformation method over variational approach and energy balance method is shown. It is shown that the results obtained by EBM and VA are not reliable.

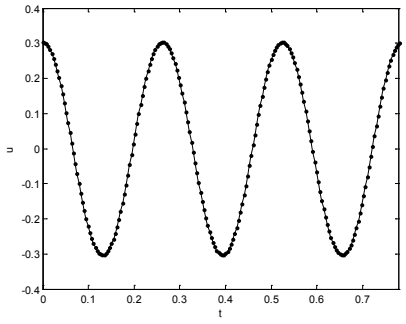

Figure 2. Time response of the system when $A = 0.3$

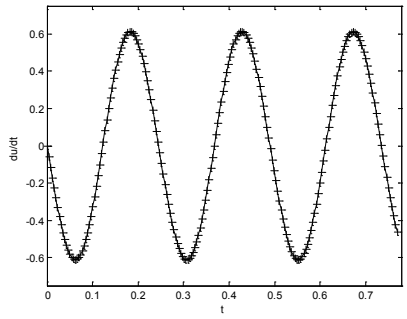

Figure 3. Velocity variation with time when $A = 0.3$

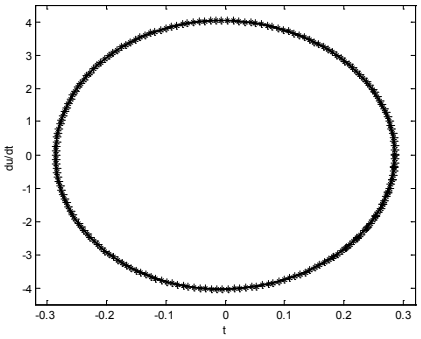

Figure 4. Phase plots of the system

Figure 2 shows the time response of the system while Fig, 3 displays the velocity variation of the system with time. It could be seen that for the relatively large initial displacement value, it can be seen that the time-displacement graphs have a consistent harmonic pattern.

Figure 4 shows the phase plots of the system. The circular curve around (0,0) in figure shows that the system goes into a stable limit cycle. The plot agrees very well with the past works. It is therefore established that, DTM provides a good analytical solution to non-linear equation of motion of the system.

5. Conclusion

In this work, the effectiveness and convenience of differential transformation method to the nonlinear vibration of electrostatically actuated microbeam has been displayed. The analytical solution was verified through comparison with the solutions with the exact analytical method, variational approach, homotopy analysis method and energy

Table 1. Comparison of results of frequency corresponding to various parameters of the system

A	N	a	V	Exact [24]	HAM [24]	VA [25]	EBM [21]	DTM
0.30	10	24	0	26.8372	26.8372	26.3644	26.3867	26.8372
0.30	10	24	10	16.6486	16.6486	16.3556	16.3829	16.6486
0.30	10	24	10	28.5382	28.5368	26.1671	26.5324	28.5382
0.30	10	24	20	18.5902	18.5902	17.0940	17.5017	18.5902

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balance methods. The differential transformation method was shown to be very efficient, simple, suitable and useful as a mathematical tool for solving the nonlinear problems.

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REVIEW

Machine Learning: A Review

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ABSTRACT

Due to the complexity of data, interpretation of pattern or extraction of information becomes difficult; therefore application of machine learning is used to teach machines how to handle data more efficiently. With the increase of datasets, various organizations now apply machine learning applications and algorithms. Many industries apply machine learning to extract relevant information for analysis purposes. Many scholars, mathematicians and programmers have carried out research and applied several machine learning approaches in order to find solution to problems. In this paper, we focus on general review of machine learning including various machine learning techniques. These techniques can be applied to different fields like image processing, data mining, predictive analysis and so on. The paper aims at reviewing machine learning techniques and algorithms. The research methodology is based on qualitative analysis where various literatures is being reviewed based on machine learning.

1. Introduction

Questions have been asked with regards to computers if they are capable of learning on their own. Human beings have over the years created different tools to enable them solve various tasks which led to the invention and production of different machines [57]. With the rapid developments, the difference between humans and machines has remained intelligence. A human brain analyses information and makes decision accordingly but machines are not able to analyse and take decisions [1]. Automating tasks has generated high interest in the information technology field where some designs and operations can be handed over to machines [13]. Recently, with the introduction of artificial intelligence, machines have been created to have the same level of intelligence as the human brains. Artificial intelligence started in 1943 when the first Neural Network Model was introduced [12].

A machine is expected to learn whenever there is changes in the structure, program or data, this is based on the input or response to the external environment which improves its expected results [51], therefore, machine learning can be defined as a part of artificial intelligence that explains that fact that machines can learn on their own when given the right data thereby solving a specific problem [80]. With the help of mathematics and statistics, machine learning can

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perform intellectual tasks independently that are always generally performed by human beings [82].

Machine learning is a part of computer science that emanated from the study of pattern recognition and computational learning theory all in artificial intelligence. Algorithms are used to make predictions on data [52]. Before now the field of machine learning was mainly algorithms and theory of optimization but recently machine learning covers several other disciplines which includes statistics, information theory, theory of algorithms, probability and functional analysis [24]. Machine learning and computational statistics are always closely related because of their specialty in prediction making and mathematical optimization which brings about methods, theories and application to the field [1]. In machine learning, strictly static program instructions are not followed, rather, algorithms are used to build a model from input which are used to make data-driven prediction or decisions [80].

Currently, research on machine learning focuses on areas like pattern recognition, natural language processing, cognitive computing, image processing, knowledge representation, traffic classification, cognitive radio and intrusion detection, optical networks and so on [13]. Machine learning problems and tasks are mostly classified into three broad categories because of the signal and feedback that is being fed into the learning system [53]. These categories are explained below:

(1) Supervised Learning where the computer is being supplied with example input and their desired output which learns a rule that is able to map inputs to outputs [9]

(2) Unsupervised Learning where no label is given to the learning algorithm and its allowed to determine the structure of its input [70].

(3) Semi-Supervised Learning lies between supervised and unsupervised learning where the teacher gives an incomplete input or signal where some of the target outputs are missing, it can also be regarded as Transduction [46].

(4) Reinforcement Learning where an environment interacts with the computer to be able to perform a certain goal without any input or interference of a teacher telling it what to do [28].

There are various reasons why machine learning is important:

(1) Machine learning is important in adjusting its structure to produce desired outputs due to the heavy amount of data input into the system [57].

(2) Machine learning is also suitable for data mining because of the little amount of important data hidden in the heavy chunk of data that can be important for processing of output [10].

(3) Machine learning is important for jobs that are on the go thereby improving the existing machine designs because some designers produce non-workable machines that are not desired in the environment [50].

Knowledge computation is being carried out by machines easily which will be a bit difficult for humans due to the large amount of knowledge available for certain tasks [26]. Redesigning of systems due to change in environment is reduced with the introduction of machine learning because environments change overtime [51]. New knowledge, new task, new data is being gotten and discovered by humans on every day, with machine learning, tracking of new knowledge is made easy [26].

In this paper, a general overview of the application of machine learning is carried out. An introductory highlight on the use of machine learning, its methods, techniques and applications in various fields is considered. We also carry out a survey on the existing work with machine learning so far. This paper is organized as follows: Section 2 describes machine learning, its applications and current work being carried out. It also highlights the number of journals and their sources being used for this paper. Section 3 introduces and highlights the techniques and methods used in machine learning while section 4 presents the conclusion of the paper.

2. Review of Literature

Machine learning is a fast growing field and one of the latest technologies being used recently in the information technology field. Machine learning has been deployed to solve different problems in different aspects of life like medical, engineering, agricultural etc. This section discusses various applications of machine learning in different aspects of life.

Machine learning is recently deployed in National Innovation Performance data analysis where the impact of government decisions and policies are still not clear. A machine learning approach is proposed which includes clustering, correlation analysis, Bayesian Neural network and breakdown for decomposing innovation output prediction. This approach has shown improvement for benchmarking national innovation profiles [29].

Machine learning is combined with satellite imaging to predict poverty. A study carried out from five African countries which are Nigeria, Tanzania, Uganda, Malawi and Rwanda. Here a neural network is used and trained to capture and identify image features that explains local economic outcomes [41].

Scientist are now called upon and required to use advanced machine learning and many other artificial intelligence technologies to help find new scientific discoveries in the analysis of their data. This is important for applica-

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tions like object recognition, natural language processing, deep learning and automatic translation [39].

Machine learning is applied in databases that are compiled using symmetry-based calculations which contains thousands of topological insulators and semimetals. Using the gradient boosted trees approach of machine learning. The model predicts the topology of a given existent material. Although the model has errors which can be overcome [21].

In the field of chemistry, a machine learning approach known as graph neural networks is proposed for solving problem of quantitative structure-odor relationship which relationship between molecules structure and its odor remains difficult [78].

Based on widely analysed classification model, patient data is being analysed for the predictability of the patient to have liver disease. There are five phases highlighted. The first is the min-max algorithm application followed by the use of PSO feature selection for demarcation of attributes, then classification algorithm is used for comparative analysis and categorization. The fourth phase is the accuracy calculation and finally evaluation phase [26].

Decision Tree based algorithm is used to evaluate individual and ensemble model performance for predicting secondary progressive multiple sclerosis disability progression [+].

Machine learning is a branch of artificial intelligence that is deployed and most suited for medical applications especially in the detection and prediction of cancer and prognosis. A number of publications have shown that machine learning methods can be used to improve the accuracy of predicting cancer susceptibility, reoccurrence and mortality [23].

The use of Bayesian deep learning method as machine learning technique to address the analysis challenges of future surveys. This technique will enable multibendpass, multi-instrument processing of individual images, targeting science objectives [4].

In order to manage and control the operational environment while also predicting future actions, IoT application developers tend to buy data from IoT owners in order to train machine learning models by combining edge computing resources with data sources [76].

Machine learning is used in the multimedia world for conversion assignment. The audio/video data is recorded from a location and converted to text data. The text data is then analysed and tagged to each individual based on attributes. Self learning software designed using machine learning algorithm is generated based on the tagging [24].

Machine learning approach has also be deployed in the discovery of drugs. The use of virtual screening evolving from traditional similarity searching to an advanced application domain for data mining and machine learning approaches. The advanced approach requires large training set compounds to learn robust decision rules [50].

Wireless sensor networks work dynamically due to the external factors or initiated by the system designers. Therefore, machine learning is used to adapt to these conditions and eliminate the need for unnecessary and also prolong the lifespan of the network [1].

Quantum systems are said to be faster and produce patterns that classical systems cannot which means quantum computers may outperform classical computers in terms of machine learning. Although hardware and software challenges still exist, quantum algorithms could act as a building block for machine learning programs [6].

In project management, project delay is one of the pressing challenges faced by the construction sector due to complexity and delay risk sources. Machine learning algorithms identified and developed in order to facilitate accurate delay risk analysis and prediction using objective data sources. Two machine learning algorithms which are decision tree and naive Bayesian classification were trained using the data set for predicting project delay events [32].

In order to minimize investment risks while evaluating the potential business impact, machine learning systems is used to leverage business transformation [64].

Retrieval of patients data rightly and at the right time is vital, therefore, a learning electronic medical record (LEMR) is developed that learns statistical models of clinician information seeking behaviour and applies it to the direct display of data for future patients [45].

3. Machine Learning Techniques

Machine learning is simply about designing algorithm that will allow a computer to be able to learn [52]. This is based on the input and desired outcome of the algorithm. Some of the machine learning techniques will define how humans can approach a task [64]. Several mathematicians and programmers have come up with solutions on the approaches and techniques for machine learning which is narrowed down as shown in the diagram below.

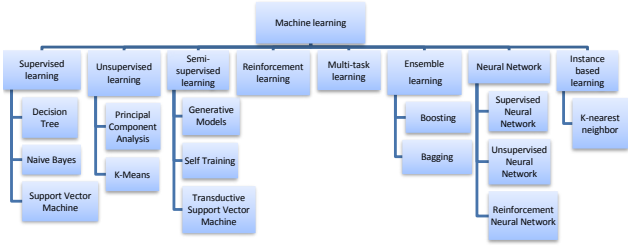

Figure 1. Machine Learning Techniques [25]

The various techniques of machine learning is discussed below and the different applications that follow the techniques are also highlighted:

(1) SUPERVISED LEARNING: In supervised learning, a correct classification is already assigned to train a data sample from the data source [22]. It can also be seen as a formalization of a certain idea of learning from examples where there is an input and desired output [25]. Here, the learner which could be a computer program is provided with a training set and test set of data. The trainer is required to learn from the training set with examples of labelled set which will be used to identify the unlabelled examples in the test set with highest possible accuracy [15]. The supervised learning technique requires external assistance. The work flow of the supervised learning technique is shown below.

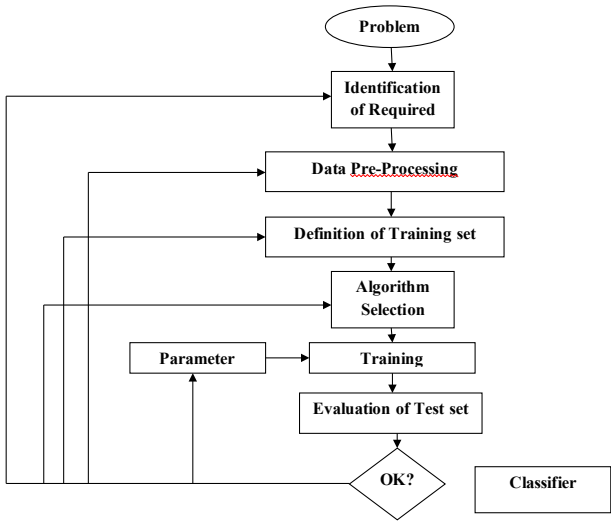

Figure 2. Workflow of supervised machine learning technique [25]

There are three major types or algorithm of supervised learning technique as discussed below:

(a) Decision Tree: Decision trees group attributes thereby sorting them based on their different values [62]. Each of this decision trees consist of nodes and branches and are mainly used for classification. A node represents attributes in a group while the branch represents a value that the node can take. An example of a decision tree is shown below.

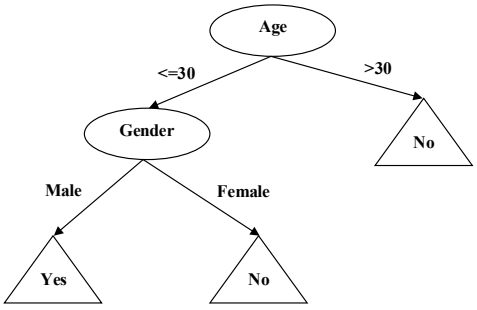

Figure 3. Decision Tree [25]

(b) Naive Bayes: This algorithm is mostly used and is a target of the text classification industry [83]. It is also used for clustering and classification purposes. Conditional probability is the backbone of Naive bayes algorithm where it creates trees based on the probability of occurring. These trees can also be regarded as Bayesian Network. An example is shown below.

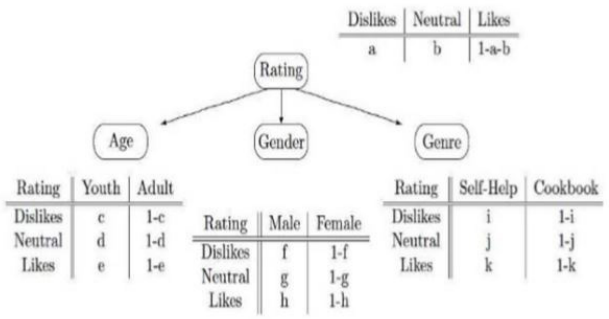

Figure 4. Bayesian Network [25]

(c) Support Vector Machine: This algorithm is a commonly and widely used machine learning technique and mostly used for classification [90]. Support Vector Machine uses margin calculations where it draws margins between the classes. The distance between margins and classes is always big so as to reduce the error in classification [3]. The diagram below shows a working support vector machine.

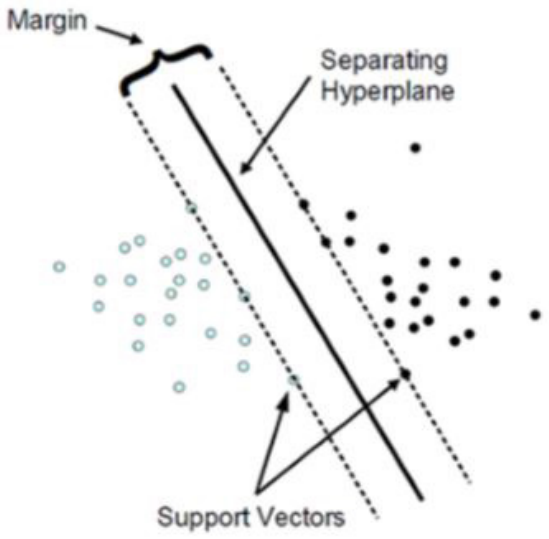

Figure 5. A working Support Vector Machine [25]

An application of the supervised learning technique is where a supervised data of the Stanford Natural Language Inference datasets is used to train and show how universal sentence representations can consistently outperform unsupervised methods [22].

(2) UNSUPERVISED LEARNING: This technique is a

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bit harder than the supervised learning. This is so because we tell the computer to learn to do something that we don't tell it how to do [82]. This learning technique does not produce classification but make decisions that maximize rewards. Some self-organized neural networks learn using the unsupervised learning technique to uncover hidden patterns in unlabelled data input [89]. The advantage of this lack of direction is that it lets the algorithm to look back for patterns that were not previously considered. The unsupervised learning technique learns few features from a set of data and then when a new data is being introduced, then it uses the learned features to recognize the class of the data [70]. Unsupervised learning technique is mainly used for clustering and feature reduction. And example is shown below.

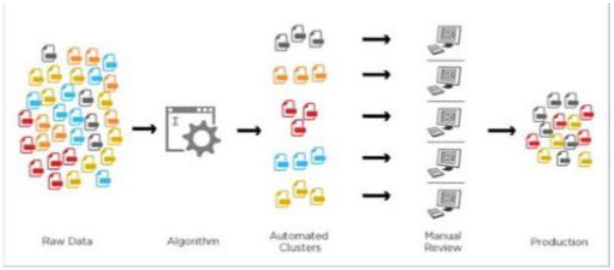

Figure 6. Example of Unsupervised Learning [25]

There are two main algorithms for supervised learning technique which are discussed below:

(a) K-Means Clustering: Clustering is also known as grouping which is a type of unsupervised learning technique that creates group which initiated automatically [87]. It is known as K-means because it creates k-distance clusters where items with similar characteristics are put in the same cluster. The centre of the cluster is gotten from the mean of the values in the cluster.

(b) Principal Component Analysis: Here, to make the computation faster and a bit easier, the dimension of the data is reduced. For example, when principal component analysis is being applied on a 2D data, the data will then be reduced to 1D [87].

Unsupervised learning techniques can be applied to sentences to improve embeddings [72]. Unsupervised learning technique can be used to identify phases and its transitions in systems, principal component analysis is used to extract the original data while clustering is used to identify the phases [87].

(3) SEMI SUPERVISED LEARNING: This technique is a technique that combines both supervised and unsupervised learning techniques [46]. The unlabelled data is already present while discovering the labelled data is very tasking and tedious. This technique is common in data mining field [71]. Some of the algorithms for semi-supervised learning technique are discussed below.

(a) Generative Models: This is one of the oldest semi-supervised learning technique where models like guassian mixture models is used as a mixed distribution to assume a structure [48]. The mixed component can be identified within the unlabelled data.

(b) Self-Training: Here, the classified is trained to learn by itself by providing it with portion of labelled data where the labelled points and the predicted labels are added together in the training set, and then the process is repeated [65].

(c) Transductive Support Vector Machine: This algorithm is an extension of the Support Vector Machine algorithm where both the labelled and unlabelled data is considered [86]. This algorithm is used to label the unlabelled data such that the margin is large between the labelled and unlabelled data.

Odena Augustus in 2015 extended Generative adversarial networks to the semi-supervised learning technique of machine learning to show it can be used to create a more data-efficient classifier and higher quality samples can be generated. Semi-supervised learning is applied on graph-structured data which learns hidden layer representation that encode the graph structure and feature of nodes [46].

(4) REINFORCEMENT LEARNING: In this type of technique, the positive outcome of the decisions is determinant or dependent on the actions to take [95]. The learner has no idea of the action to take until it is given a particular situation. Depending on the actions taken by the learner, the future is affected in terms of the situations. Below shows a model for reinforcement learning.

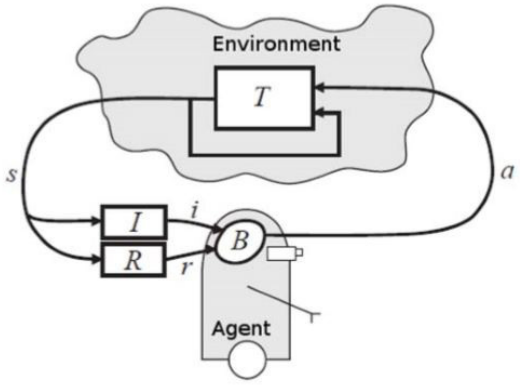

Figure 7. Reinforcement Learning Model [25]

In the above model, the input i, is being received by the agent. The agent also receives current state, s, state transition r, and input function I from the environment. With these inputs, the agent generates a behaviour B and takes an action a which generates an outcome [25]. Rein-

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forcement learning technique is being applied to natural language processing for dialogue creation where a model simulates dialogues between vitual agents using policy gradients for reward to conversational properties [54].

(5) MULTITASK LEARNING: The algorithm remembers the process and procedure how a particular problem was solved and how it arrived at a certain conclusion [54]. The process and procedure is being used to proffer solution to other tasks or problem. It can also be known as transfer mechanism [73]. Sharing experience between learners helps them to learn concurrently rather than individually which is much faster. Four clinical predictions benchmark is proposed using data derived from publicly available medical information database where multitask learning, deep supervision and data specific modifications is applied on the performance of neural models [36].

(6) ENSEMBLE LEARNING: This technique refers to the combination of individual learners to form one learner [49]. For example, a decision tree, naive baye and neural network can be combined to form an ensemble learning. Combination of learners performs better work than individual learner. There are two algorithms under ensemble learning:

(a) Boosting: This technique collects weak learners and converts them to one strong learner [92]. It decreases bias and variance.

(b) Bagging: This technique is also known as boostrap aggregating, whenever the machine learning algorithm needs to increase accuracy and stability, bagging technique is required [92].

Machine learning models are built and proposed using ensemble learning technique where large repository of malware samples and applications are gotten from an anti-virus vendor. This is in vie to reduce that malware attack on the android platform [92]

(7) NEURAL NETWORK LEARNING: This technique is gotten from the concept of neurons which has four parts, dendrites, nucleus, Soma and Axon[58]. Interconnection of the neurons is known as neural network. The artificial neural network behaves in the same pattern. A diagram of artificial neural network is shown below.

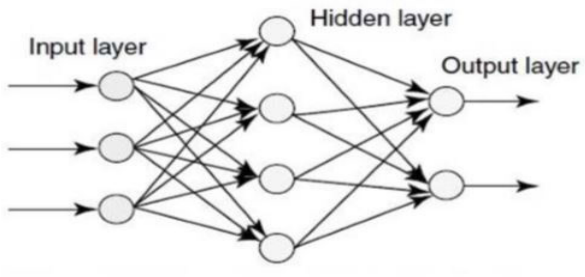

Figure 8. Artificial Neural Network [25]

The input layer takes input while the hidden layer processes the input and then the output layer sends the calculated output. Artificial Neural Network can be divided into three types which are supervised, unsupervised and reinforcement neural network. Neural networks are powerful and works well for difficult learning task like in image, speech and natural language processing [95].

(8) INSTANCE-BASED LEARNING: In this technique, the learner is familiar with only one particular type of pattern where it tries to apply to newly fed data [16]. The technique is termed lazy because it waits for the test data to arrive and then act on it with training data. It gets complex as the data increases. An example of the instance-based learning technique is the k-nearest neighbour algorithm. In the agricultural field, the instance based learning approach is used to segment crop images whereby green texture crops are automatically discriminated from the rest of the crops [2].

4. Conclusion

This review presented a general research on machine learning, its algorithm and techniques. The paper reviews literatures on the applications of machine learning algorithm and techniques on various fields of life which include medical, agriculture, science and so on. Machine learning is one of the high rising technologies used recently for solutions to various problems. It has various algorithms which include supervised, semi-supervised, unsupervised, reinforcement algorithms and so on.

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ARTICLE

A Study on Thermal Performance of Palladium as Material for Passive Heat Transfer Enhancement Devices in Thermal and Electronics Systems

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ABSTRACT

In this work, the thermal behavior of fin made of palladium material under the influences of thermal radiation and internal heat generation is investigated. The thermal model for the extended surface made of palladium as the fin material is first developed and solved numerically using finite difference method. The influences of the thermal model parameters on the heat transfer behaviour of the extended surface are investigated. The results show that the rate of heat transfer through the fin and the thermal efficiency of the fin increase as the thermal conductivity of the fin material increases. This shows that fin is more efficient and effective for a larger value of thermal conductivity. However, the thermal conductivity of the fin with palladium material is low and constant at the value of approximately 75 W/mK in a wider temperature range of -100℃ and 227℃. Also, it is shown that the thermal efficiencies of potential materials (except for stainless steel and brass) for fins decrease as the fin temperatures increase. This is because the thermal conductivities of most of the materials used for fins decreases as temperature increases. However, keeping other fin properties and the external conditions constant, the thermal efficiency of the palladium is constant as the temperature of the fin increases within the temperature range of -100℃ and 227℃. And outside the given range of temperature, the thermal conductivity of the material increases which increases the efficiency of the fin. The study will assist in the selection of proper material for the fin and in the design of passive heat enhancement devices under different applications and conditions.

1. Introduction

Palladium is a lustrous silvery-white metal that belong to platinum group metals (PGMs). Palladium is used in electronics, multilayer ceramic capacitors, watch making, aircraft spark plugs, metallizing ceramics, solar energy, catalytic converter, fuel cells, electrical contacts, surgical instruments, production of ethanol fuel, oil refining, hydrogen purification, production of purified terephthalic acid, platinotype process, groundwater treatment, medicine, blood sugar test strips, industrial products, chemical applications, dentistry (dental alloys), medicine, and jewelry and it is a key component in pollution-control devices for cars and trucks.

Over the years, the demands for fins applications for passive cooling in thermal systems have grown exponentially. Fins, as passive devices for cooling and thermal control of thermal and electronics equipment. Further augmentation of the heat transfer has been achieved through the use of porous fins. The importance of such fins in various thermal

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and electronic equipment aroused various studies [1-23]. Various key parameters in the porous fin thermal models have been used for the improved heat transfer enhancement [2-6]. Some of the past works have focused on the utilizations of the fin geometry as well as the thermo-electro-magnetic properties of fin to achieve the optimized heat transfer augmentation of the porous fin [7-14]. In some of the studies, the properties of the surrounding fluid around the passive device have been used to increase the heat dissipating capacity of the fin [15-17]. Additionally, some authors displayed the efficacy of some new analytical and numerical methods in the thermal analysis of the porous fin [18-23]. Further studies on porous fin are presented in [24-47].

In the applications of fin for the heat transfer enhancement, it is established that the thermal conductivities of the materials for fins are temperature-dependent as shown in Figure 1. Therefore, the effects of the temperature-dependent thermal properties on the fin performance have been taken into consideration in previous studies. However, as depicted in Tables 1, 2 and 3, the thermal conductivities of the palladium at different temperatures. Even though the Tables present different values of thermal conductivity for palladium at different temperature, the stability of thermal conductivity palladium with temperature can be well established. Also, Figure 2 shows that the thermal conductivity of palladium is constant at a relatively low temperature. The relatively low temperature is the temperature region where the fin operates. Therefore, it is very important to analyze the thermal performance of this metal with temperature-invariant thermal conductivity. In this work, the thermal analysis of porous fin using palladium is analyzed. Parametric studies are carried out and the results are discussed.

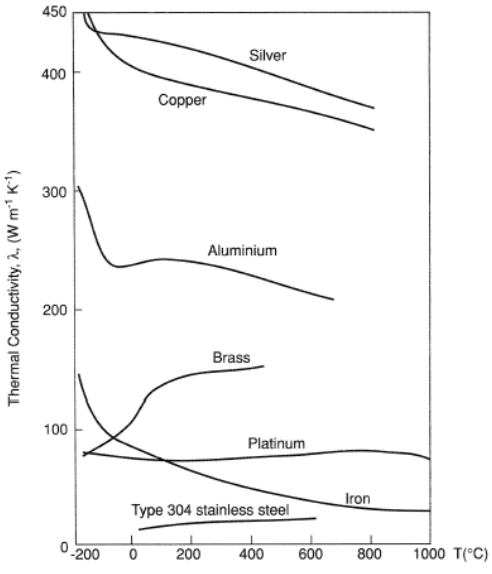

Figure 1. Variation of Thermal conductivity with temperature for difference materials

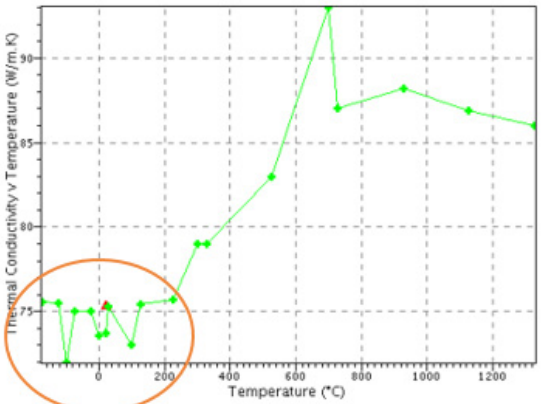

Figure 2. Variation of palladium thermal conductivity with temperature

Table 3.1 Thermal conductivity of Palladium with temperature [48]

S/N	Temperature (K)	Thermal conductivity (W/mK)
1	100.15	76.0
2	150.15	75.5
3	200.15	75.0
4	250.15	75.0
5	300.15	75.4
6	400.15	75.5
7	500.15	75.7

Table 3.2 Thermal conductivity of Palladium with temperature [50]

S/N	Temperature (K)	Thermal conductivity (W/mK)
1	100.15	75.1
2	300.15	75.4
3	400.15	75.4
4	500.15	75.7

Table 3.3 Thermal conductivity of Palladium with temperature [49]

S/N	Temperature (K)	Thermal conductivity (W/mK)
1	173.15	72.0
2	273.15	72.0
3	373.15	73.0

2. Problem Formulation

Consider a longitudinal rectangular fin with pores having convective and radiative heat transfer as shown in Figure 3. In order to derive the thermal model of the porous fin, it is assumed that the porous medium is isotropic, homogeneous and it is saturated with single-phase fluid. The physical and thermal properties of the fin and the surrounding fluid surface are constant. The temperature varies in the fin is only along the length of the fin as shown in the Figure 3. and there is a perfect contact between the fin base

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and the prime surface.

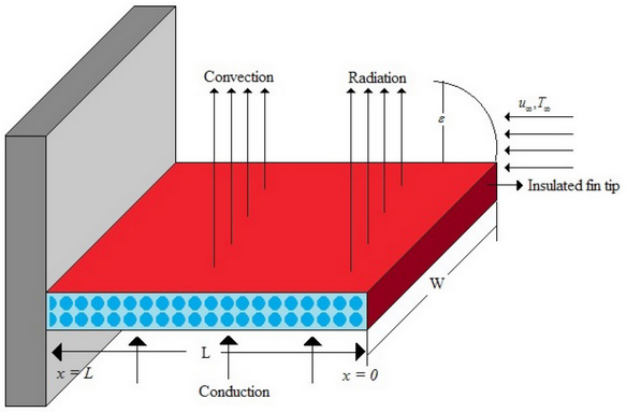

Figure 3. Schematic of the convective-radiative longitudinal porous fin with internal heat generation

From the assumptions and with the aid of Darcy's model, the energy balance is

$$q_x - \left(q_x + \frac{\delta q}{\delta x}dx\right) + q(T)dx = \dot{m}c_p(T - T_a) + hP(T - T_a)dx + \sigma\varepsilon P(T^4 - T_a^4)dx + q_{\text{int.}}(T)A_{cr}dx \quad (1)$$

The fluid flows through the pores at the rate of mass flow given as

$$\dot{m} = \rho u(x)Wdx \quad (2)$$

Also, the fluid velocity is given as

$$u(x) = \frac{gK\beta}{v}(T - T_a) \quad (3)$$

Then, Equ. (1) becomes

$$q_x - \left(q_x + \frac{\delta q}{\delta x}dx\right) = \frac{\rho c_p gK\beta}{v}(T - T_a)^2 dx + hP(T - T_a)dx + \sigma\varepsilon P(T^4 - T_a^4)dx + q_{\text{int.}}(T)A_{cr}dx \quad (4)$$

As dx→0, Eq. (3.5) reduces

$$-\frac{dq}{dx} = \frac{\rho c_p gK\beta}{v}(T - T_a)^2 + hP(T - T_a) + \sigma\varepsilon P(T^4 - T_a^4) + q_{\text{int.}}(T)A_{cr} \quad (5)$$

Applying Fourier's law for the heat conduction in the solid, one has

$$q = -k_{eff}A_{cr}\frac{dT}{dx} \quad (6)$$

where the effective thermal conductivity of the fin is given as

$$k_{eff} = \phi k_f + (1 - \phi)k_s \quad (7)$$

According to Roseland diffusion approximation, the rate of radiation heat transfer is

$$q = -\frac{4\sigma A_{cr}}{3\beta_R}\frac{dT^4}{dx} \quad (8)$$

From Eqs. (6) and (8), the total rate of heat transfer is given by

$$q = -k_{eff}A_{cr}\frac{dT}{dx} - \frac{4\sigma A_{cr}}{3\beta_R}\frac{dT^4}{dx} \quad (9)$$

Substitution of Eq. (9) into Eq. (6) leads to

$$\frac{d}{dx}\left(k_{eff}A_{cr}\frac{dT}{dx} + \frac{4\sigma A_{cr}}{3\beta_R}\frac{dT^4}{dx}\right) = \frac{\rho c_p gK\beta}{v}(T - T_a)^2 + hP(T - T_a) + \sigma\varepsilon P(T^4 - T_a^4) + q_{\text{int.}}(T)A_{cr} \quad (10)$$

Expansion of the first term in Eq. (10), provides the governing equation for the required heat transfer

$$\frac{d^2T}{dx^2} + \frac{4\sigma}{3\beta_R k_{eff}}\frac{d}{dx}\left(\frac{dT^4}{dx}\right) - \frac{\rho c_p gK\beta}{k_{eff}tv}(T - T_a)^2 - \frac{h}{k_{eff}t}(T - T_a) - \frac{\sigma\varepsilon}{k_{eff}t}(T^4 - T_a^4)dx - q_{\text{int.}}(T) = 0 \quad (11)$$

The boundary conditions are

$$x = 0, \quad \frac{dT}{dx} = 0, \quad x = L, \quad T = T_b \quad (12b)$$

The internal heat general varies linearly with temperature as

$$q_{\text{int.}}(T) = q_a\left(1 + \lambda\left(T - T_a\right)\right) \quad (13)$$

When Eq. (13) is substituted into Eq. (11), one e arrives at

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$$\frac{d^2T}{dx^2}+\frac{4\sigma}{3\beta_R k_{eff}}\frac{d}{dx}\left(\frac{dT^4}{dx}\right)-\frac{\rho c_p gK\beta}{k_{eff}tv}(T-T_a)^2-\frac{h}{k_{eff}t}(T-T_a)$$
$$-\sigma\varepsilon P(T^4-T_a^4)dx-q_{\text{int.}}(T)+\frac{q_o}{k_{eff}}\left(1+\lambda\left(T-T_a\right)\right)=0 \tag{14}$$

The term T^4 can be expressed as a linear function of temperature as

$$T^4=T_\infty^4+4T_\infty^3\left(T-T_\infty\right)+6T_\infty^2\left(T-T_\infty\right)^2+\ldots\cong 4T_\infty^3T-3T_\infty^4 \tag{15}$$

Substitution of Eq. (15) into Eq. (14), results in

$$\frac{d^2T}{dx^2}+\frac{16\sigma}{3\beta_R k_{eff}}\frac{d^2T}{dx^2}-\frac{\rho c_p gK\beta}{k_{eff}tv}(T-T_a)^2-\frac{h}{k_{eff}t}(T-T_a)$$
$$-4\sigma\varepsilon PT_a^3(T-T_a)dx+\frac{q_o}{k_{eff}}\left(1+\lambda\left(T-T_a\right)\right)=0 \tag{16}$$

Applying the following adimensional parameters in Eq. (17) to Eq. (16),

$$X=\frac{x}{L},\ \theta=\frac{T-T_a}{T_b-T_a}\ S_h=\frac{gk\beta\left(T_b-T_\infty\right)b}{\alpha\nu k_r}\ \ M^2=\frac{pbh}{A_b k_{eff}}$$
$$Rd=\frac{4\sigma_{st}T_\infty^3}{3\beta_R k_{eff}}\ \ Nr=\frac{4\sigma_{st}bT_\infty^3}{k_{eff}}. \tag{17}$$

$$Q=\frac{qb}{k_{eff}(T_b-T_\infty)}\quad \gamma=\lambda(T_b-T_a)$$

One arrives at the adimensional form of the governing Eq. (16) as presented in Eq. (18),

$$\left(1+4Rd\right)\frac{d^2\theta}{dX^2}-S_h\theta^2-M^2\theta-Nr\theta+Q\left(1+\gamma\theta\right)=0 \tag{18}$$

and the adimensional boundary conditions

$$X=0,\quad \frac{d\theta}{dX}=0 \tag{19a}$$

$$X=1,\quad \theta=1 \tag{19b}$$

3. Numerical Solution of the Thermal Model using Finite Difference Method

The numerical analysis of the nonlinear thermal model using finite difference method is presented in this section. The governing Eq. (18) and also, the boundary conditions in Eq. (19) are discretized as shown in Figure 4, Eqs. (20) and (22).

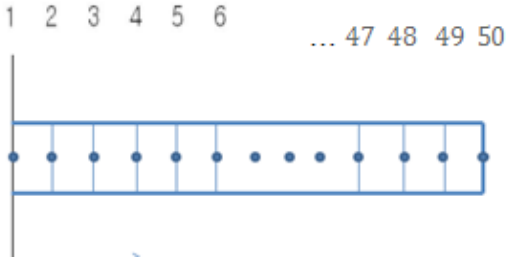

Figure 4. Nodal representation for finite difference method

$$\left(1+4Rd\right)\left(\frac{\theta_{i+1}-2\theta_i+\theta_{i-1}}{\Delta^2X}\right)-S_h\theta_i^2-M^2\theta_i-Nr\theta_i+Q(1+\gamma\theta_i)=0 \tag{20}$$

From Eq. (20), the final algebraic form of the finite difference equation becomes

$$\theta_{i+1}-2\theta_i+\theta_{i-1}-\frac{S_h(\Delta^2X)}{\left(1+4Rd\right)}\theta_i^2-\frac{M^2(\Delta^2X)}{\left(1+4Rd\right)}\theta_i$$
$$-\frac{Nr(\Delta^2X)}{\left(1+4Rd\right)}\theta_i+\frac{\mathrm{Q}(\Delta^2X)}{\left(1+4Rd\right)}+\frac{\gamma\,\mathrm{Q}(\Delta^2X)}{\left(1+4Rd\right)}\theta_i=0 \tag{21}$$

The finite difference discretization of the boundary conditions is

$$i=1,\quad \frac{\theta_2-\theta_0}{2\Delta X}=0\ \Rightarrow\theta_2=\theta_0 \tag{22a}$$

$$i=N,\quad \theta_N=1 \tag{22b}$$

From the above finite difference scheme in Eqs. (21) and (22), a set of 50 non-linear algebraic equations are developed. These systems of the non-linear equations are solved simultaneously with the aid of MATLAB using fsolve.

In order to investigate the impact of the constant thermal conductivity (temperature-invariant thermal conductivity), a variable thermal conductivity is introduced as

$$k=k_a\left(1+\psi\left(T-T_a\right)\right) \tag{23}$$

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The dimensionless thermal model becomes

$$\left(1+4Rd\right)\left(\frac{d^2\theta}{dX^2}+\beta\theta\frac{d^2\theta}{dX^2}+\beta\left(\frac{d\theta}{dX}\right)^2\right)-S_h\theta^2 -M^2\theta-Nr\theta+Q\left(1+\gamma\theta\right)=0=0 \tag{24}$$

where

$$\beta=\psi(T_b-T_a) \tag{25}$$

The finite difference discretization of Eq. (24) is

$$(1+4Rd)\left(\frac{\theta_{i+1}-2\theta_i+\theta_{i-1}}{\Delta^2X}+\beta\theta_i\left(\frac{\theta_{i+1}-2\theta_i+\theta_{i-1}}{\Delta^2X}\right)+\beta\left(\frac{\theta_{i+1}-\theta_{i-1}}{2\Delta X}\right)^2\right) -S_h\theta_i^2-M^2\theta_i-Nr\theta_i+Q(1+\gamma\theta_i)=0 \tag{26}$$

After simplification, we have

$$\theta_{i+1}-2\theta_i+\theta_{i-1}+\beta\theta_i\left(\theta_{i+1}-2\theta_i+\theta_{i-1}\right)+\beta\left(\frac{\theta_{i+1}-\theta_{i-1}}{2}\right)^2-\frac{S_h(\Delta^2X)}{(1+4Rd)}\theta_i^2 -\frac{M^2(\Delta^2X)}{(1+4Rd)}\theta_i-\frac{Nr(\Delta^2X)}{(1+4Rd)}\theta_i+\frac{\mathrm{Q}(\Delta^2X)}{(1+4Rd)}+\frac{\gamma\,\mathrm{Q}(\Delta^2X)}{(1+4Rd)}\theta_i=0 \tag{27}$$

The finite difference discretization of the boundary conditions is

$$i=1,\quad \frac{\theta_2-\theta_0}{2\Delta X}=0\ \Rightarrow\theta_2=\theta_0 \tag{28a}$$

$$i=N,\quad \theta_N=1 \tag{28b}$$

Also, a set of 50 non-linear algebraic equations are developed from Eq. (27) and (28). As before, these systems of the non-linear equations are solved simultaneously with the aid of MATLAB using fsolve.

It should be noted that when $\beta=0$ in Eq. (27), Eq. (21) is recovered as well the results of the temperature-invariant thermal conductivity,

4. Heat Flux and Efficiency Models of the Fin

The fin base heat flux is given by

$$q_{bn}=A_ck(T)\frac{dT}{dx} \tag{29}$$

Using the dimensionless parameters in Eq. (17), at the base of the fin, the dimensionless heat transfer rate is developed as

$$q_b=\frac{q_{bn}L}{k_aA_c(T_b-T_\infty)}=\frac{d\theta}{dX} \tag{30}$$

The finite difference discretization is given by

$$q_b=\left(\frac{\theta_{i+1}-\theta_i}{\Delta X}\right) \tag{31}$$

The total heat flux of the fin is given by

$$q_T=\frac{q_b}{A_ch(T-T_b)} \tag{32}$$

After substitution of Eq. (29) and using the dimensionless parameters in Eq. (17), one arrives at

$$q_T=\frac{1}{Bi}\frac{k}{h}\frac{d\theta}{dX}=\frac{1}{Bi}\frac{d\theta}{dX} \tag{33}$$

The finite difference discretization is given by

$$q_T=\frac{1}{Bi}\left(\frac{\theta_{i+1}-\theta_i}{\Delta X}\right) \tag{34}$$

The fin efficiency is the ratio of the rate of heat transfer rate by the fin to the rate of heat transfer that would be if the entire fin were at the base temperature and is given by

$$\eta=\frac{Q_f}{Q_{\max}}=\frac{\int_0^L Ph(T-T_\infty)dx}{Ph_bL(T_b-T_\infty)} \tag{35}$$

Applying the dimensionless parameters in Eq. (17) to Eq. (35), the fin efficiency in dimensionless variables is given by

$$\eta=\int_0^1\theta\,dX \tag{36}$$

After finite difference discretization, we have is

$$\eta=\sum_{i=1}^{N}\theta_i \tag{37}$$

5. Results and Discussion

The numerical solutions are coded in MATLAB and the parametric and sensitivity analyses are carried out using the codes.

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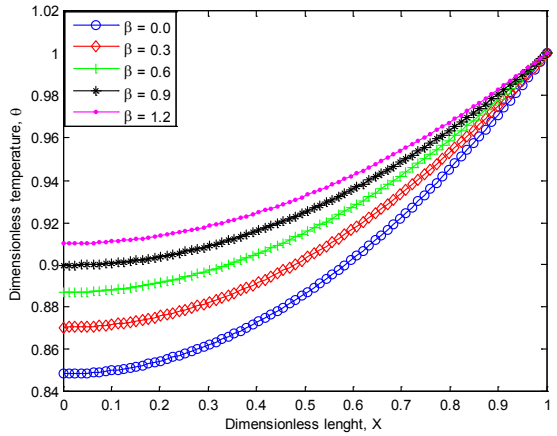

Figure 5. Dimensionless temperature distribution in the fin parameters for varying thermo-geometric parameter when S_h,= 0.2,M=0.4

Because of the temperature-invariant of thermal conductivity of the material (palladium) under consideration, effect of thermal conductivity parameters on the dimensionless temperature distribution are first study as presented in Figures 5 and 6. It is established that as the thermal conductivity parameter (β) increases, the adimensionas temperature distribution in the fin increases which results in increase in the local temperature. A situation where $\beta = 0$ implies constant or temperature-invariant thermal conductivity as in the material (palladium) under consideration. This situation provides the lowest temperature distribution in the fin.It is shown that the temperature profile has steepest temperature gradient at the lower value of thermal conductivity especially when the thermal conductivity parameter $\beta = 0$. The higher the values of the thermal conductivity, the lower temperature difference between the base and the tip of the fin.

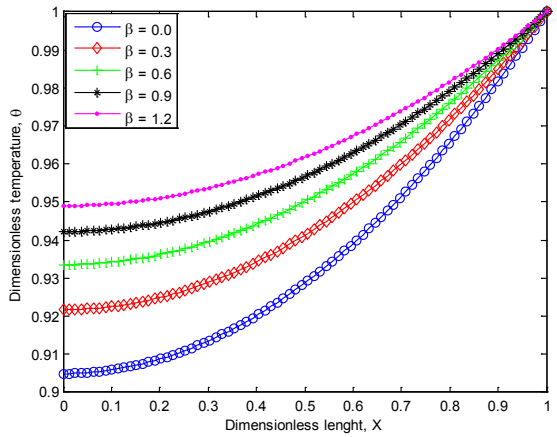

Figure 6. Dimensionless temperature distribution in the fin parameters for varying thermo-geometric parameter when S_h,= 0.1,M=0.4

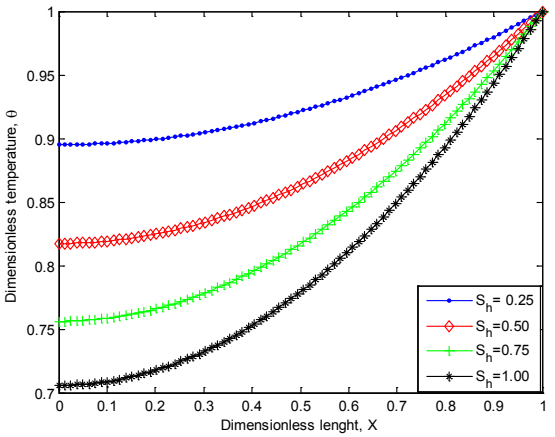

Figure 7. Dimensionless temperature distribution in the fin parameters for varying thermo-geometric parameter for constant thermal conductivity

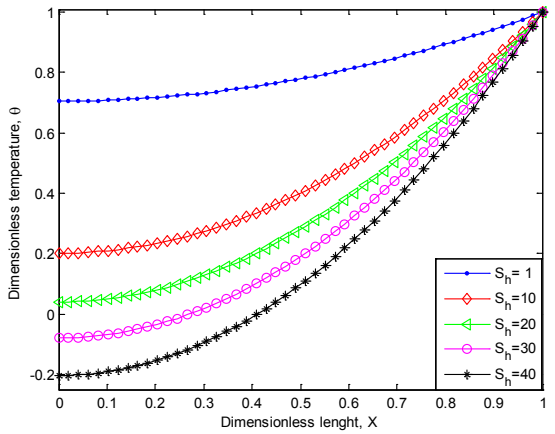

Figure 8. Effects of porous parameter on the temperature distribution in the fin parameters for constant thermal conductivity

The small value of the temperature difference between the base and the tip of the fin is attributed to lower thermal resistance offered by the material.Also, it should be noted that the temperature difference becomes more pronounced as the thermo-geometric parametric increases. From the Figure 1, except for stainless steel and brass, the thermal conductivities of most of the materials used for fins decreases as temperature increases. Therefore, the thermal efficiencies of these materials for the fins decrease as the fin temperatures increase.However, keeping other fin properties and the external conditions constant, the thermal efficiency of the palladium is constant as the temperature of the fin increases within the temperature range of -100°C and 227°C. The is due the temperature-invariant thermal conductivity of palladium.

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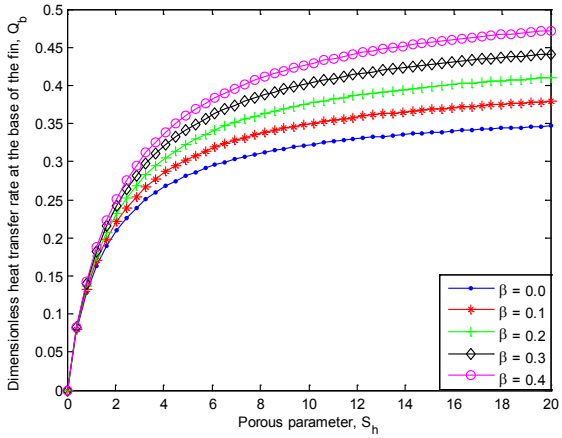

Figure 9. Effects of thermal conductivity and porosity on heat flux when M=0.5, Nr=0.2

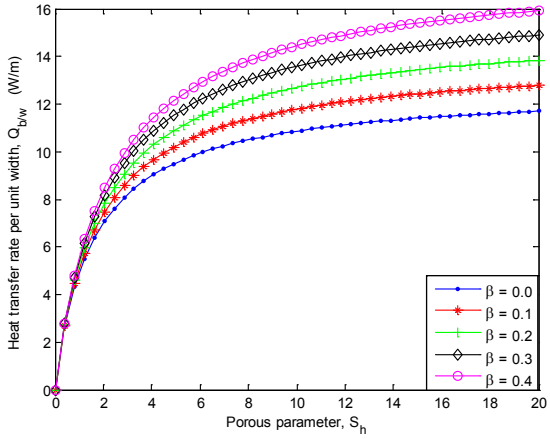

Figure 10. Effects of thermal conductivity and porosity on heat flux when M=2, Nr=0.3

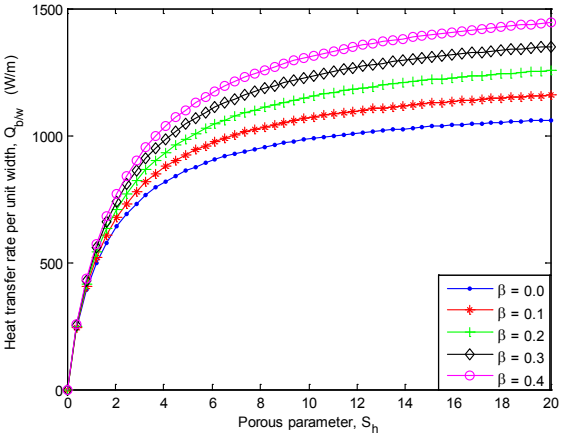

Figure 11. Effects of thermal conductivity and porosity on heat flux when M=2.5, Nr=0.4

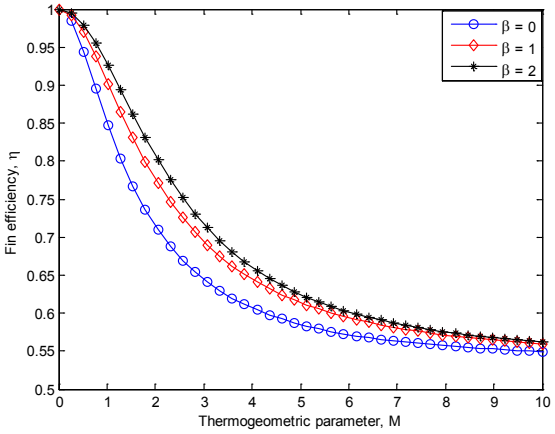

Figure 12. Effects of thermal conductivity and conductive-convective parameter on the fin efficiency when M=2, N=0.2, S=0.5

The impact of porous parameter on the adimensional temperature is presented in Figures 7 and 8. It is shown in the figures that when the porosity parameter increases, the adimensional fin temperature decreases and the heat transfer rate through the fin increases.

Figures 9, 10 and 11 show the effects of temperature-dependent thermal conductivity parameter on the adimensional heat transfer rate at the base of the fin at different radiation parameters.

Figure 12 shows that increase in the thermal conductivity parameter, the heat transfer rate through the fin and the thermal efficiency of the fin increase.Fin is more efficient and effective for larger value of thermal conductivity. This trend was also depicted in Figure 13.

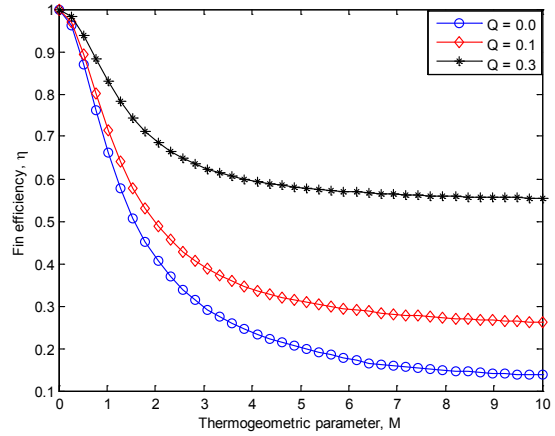

Figure 13. Effect of internal heat generation on the fin efficiency when Sh=0.5, Nr=0.2, γ=0.8

5. Conclusion

The thermal performance of fin made of palladium mate-

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rial under the influences of internal transfer mechanisms such as thermal radiation and temperature-dependent internal heat generation has been analyzed in this work. The developed thermal model for the extended surface made of palladium as the fin material was solved numerically with the aid of finite difference method. Effects of various parameters on the heat transfer model of the extended surface are investigated and the following are established:

(1) The results showed that the heat transfer rate through the fin and the thermal efficiency of the fin increase as the thermal conductivity of the fin material increases.

(2) This shows that fin is more efficient and effective for larger value of thermal conductivity.

(3) The thermal efficiencies of most materials (except for stainless steel and brass) for fins decrease as the fin temperatures increase.

(4) Keeping other fin properties and the external conditions constant, the thermal efficiency of the palladium is constant as the temperature of the fin increases within the temperature range of -100°C and 227°C. And outside the given range of temperature, the thermal conductivity of the material increases which increases the efficiency of the fin.

The selecting of proper material for the fin and in the design of passive heat enhancement go a long way in enhancing the heat transfer in thermal and electronic systems. Therefore, the present study will greatly help in this area of heat transfer augmentation in such systems.

Nomenclature

A Section Area of the fin

g Gravity constant

k The parameter describing the thermal conductivity variation. $\left(Wm^{-1}K^{-1}\right)$

h Convective heat transfer coefficient

L Length of the fin $\left(m\right)$

c_p Specific heat $\left(J\,kg^{-1}K^{-1}\right)$

v_w Velocity of fluid passing through the fin $\left(m\,s^{-1}\right)$

S_p Porosity parameter

N_r Radiation parameter

C_T Dimensionless ratio of ambient to difference between wall and ambient temp. $\dfrac{T_\infty}{T_b - T_\infty}$

W Width of section fin $\left(m\right)$

t Thickness of section fin $\left(m\right)$

$\dot{m}$ Mass flow rate $\left(kg\,s^{-1}\right)$

g Acceleration due to gravity $\left(9.81\,m\,s^{-2}\right)$

T Local fin temperature $\left(K\right)$

T_b Fin base temperature $\left(K\right)$

T_∞ Ambient or surrounding temperature $\left(K\right)$

x Axial coordinate $\left(m\right)$

X Dimensionless axial coordinate

Greek symbols

θ Dimensionless temperature

σ Stephen-boltzman constant $\left(5.67\times10^{-8}Wm^2s^{-1}K^{-4}\right)$

ε Emissivity of porous fin

ν Kinematic viscosity $\left(m^2s^{-1}\right)$

ρ Density $\left(kg\,m^{-3}\right)$

Subscript

b Condition at the fin base

∞ Condition of the ambient temperature

p Porous property

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REVIEW

Cybersecurity and Cyber Forensics: Machine Learning Approach Systematic Review

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ABSTRACT

The proliferation of cloud computing and internet of things has led to the connectivity of states and nations (developed and developing countries) worldwide in which global network provide platform for the connection. Digital forensics is a field of computer security that uses software applications and standard guidelines which support the extraction of evidences from any computer appliances which is perfectly enough for the court of law to use and make a judgment based on the comprehensiveness, authenticity and objectivity of the information obtained. Cybersecurity is of major concerned to the internet users worldwide due to the recent form of attacks, threat, viruses, intrusion among others going on every day among internet of things. However, it is noted that cybersecurity is based on confidentiality, integrity and validity of data. The aim of this work is make a systematic review on the application of machine learning algorithms to cybersecurity and cyber forensics and pave away for further research directions on the application of deep learning, computational intelligence, soft computing to cybersecurity and cyber forensics.

1. Introduction

Cyber space is a platform that support internet of things, networks, telecommunication systems and all other recent information and communication technologies raining today [1,3]. Global cyber security index 2017 revealed that 3.5 billion users are connected to the internet and also predicted that there will be 12 billion devices connected on the cyber space by 2020. It was also predicted that by the year 2020 80% of the youth population in this world would have a smart phone [48], moreover, almost 49.7% out of the 80% will be connected to the internet with an exponential growth of 936% globally between 2000-2017 [49]. Although threats and attack to these devices are becoming order of the day. It is at the heart of this research work to explore the critical research contributions of researches that used machine learning algorithms in cybersecurity and digital forensics.

2. Digital Forensics

Digital forensics is a field in forensic science that presented the methodologies of investigating crimes that take place on a digital devices of individual, private organizations or government institutions be it national or international [2]. Moreover, Nickson et al. [3] explored that Digital

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forensics is a field of computer security that uses software applications and standard guidelines which support the extraction of evidences from any computer appliances which is perfectly enough for the court of law to use and make a judgment based on the comprehensiveness, authenticity and objectivity of the information obtained. The information obtained should be able to present facts about the evidences; like the profile of who obtained the information? The address where the information obtained and where it has been stored and what happened to the information after collection. Moreover, Rukayat et al., [4] presented the major goals of forensics evidences are finding out the evidence, proper documentation and storage of the evidences, maintaining the evidence and moving it to the appropriate location without any alteration. In Anwar & Riadi [38] argued that digital forensics is perfectly relied on the information obtained with a degree of clear understanding and show clearly evidence of security breaches. In [46] "cyber forensics are scientific methods and methodologies in recent technologies to investigate, trace, and obtain and information from digital device which is going to be used in the court of law as evidence to make a judgment. Cyber forensics science is presented graphically by [50] as:

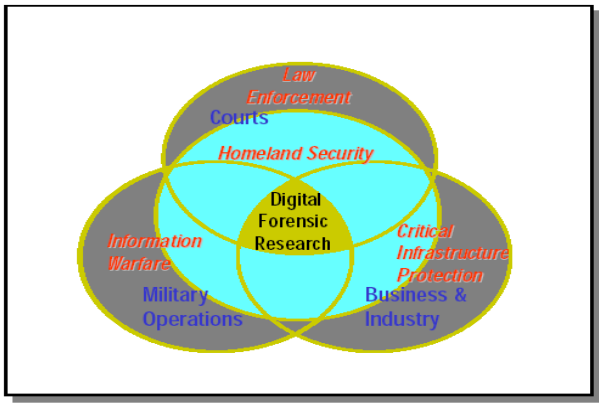

Figure 1. Digital forensics science [50]

2.1 Digital Crime

Intrusions, cyber-attacks, system, information and network breaches are becoming alarming day by day among internet of things [6]. David et al. [10] believed that cyber terrorism is the use of digital device to perpetrate crime that will affect either socio-economic, religion or political agenda of an individual, private organization, government institution or a nation. Capgemini research institute revealed that there was an incidence in which a hacker was able to breaches in to 27000 vehicles which led to the total shutdown the engine. "There is a compelling necessity among researchers to come out with methods and methodologies, tactics and techniques to help forensics scientist in finding out evidences that will be used in the court of law as evidence or make a case [5].

2.2 Cybersecurity

Cybersecurity is a field in computer science that includes; information security, cloud security, and system security. It is also agreed by the literatures that cybersecurity is mainly depend on three major things; confidentiality, integrity and availability, of information [28] highlighted that the major principles of cybersecurity are prevention detection and reaction. In addition to Central Intelligence Agency (CIA) show that the central goals of cybersecurity are confidentiality of information, integrity of information and availability of information. Furthermore, National Cyber Security Center (NCSC) UK highlighted ten (10) tips of cybersecurity these includes; Internet security, Public awareness, threat prevention, device access control, prevent access to configurations, monitoring users, monitoring and management mobiles communications [35]. Gyun [33] also revealed that artificial intelligence/computational intelligence techniques and deep learning and machine learning techniques are among the cyber tools for modeling behaviors of attacks and building systems for defense.

2.3 Cyber Attacks

According to United State intelligent unit revealed that in 2016 and 2017 there has been sponsored cyber-attack against Ukraine and Saudi Arabia which ended in targeting both government and non-governmental organizations. And also classified cyber-attacks based on the following; identity theft Unauthorized access and Deniel of service (DoS, DDoS). Cybersecurity experts revealed that in 2019 ransomware will damages almost $11.5 billion [44]. There has been a ransomware attack targeting England's National Health Service which affected 60 health trusts, 150 countries, and more than 200,000 computer systems [45].

3. Machine Learning Algorithm

Machine learning algorithms are technique in artificial intelligence and computational intelligence that uses algorithm to parse data, learn from the data and make a decision or classification, These algorithms are technically depend on the statistical and mathematical models. In recent time machine learning algorithm are applied in clustering, regression, anomaly detection, intrusion detection systems artificial immune systems, network security, pattern recognition and even forensics investigations [34]. Basically there are three types of machine learning algorithms these

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are; supervised learning, unsupervised learning and reinforcement. Supervised learning algorithms involve the use of datasets for training and testing the performance of the system build. Some supervised learning algorithm includes; decision tree, logistic regression, support vector machine, relevance vector machine, random forest, K-NN, bagging neural networks, linear regression and naïve Bayes which has been applied to cybersecurity, intrusion detection systems, network security and digital forensics [33]. Unsupervised learning algorithm required datasets for training and testing the system performances but require no labeled on the datasets. The two most common unsupervised learning algorithms are Principal Component Analysis (PCA) and clustering. Some of the unsupervised learning algorithms that are applied in cybersecurity are hierarchical, k-means, mixed model, DBSCAN, OPTIC, self-organizing mapping, Bolzan machine, auto encoder, adversarial network which has yield results [34].

4. Reviewed of Related Literature

Bandir [7] revealed that machine learning algorithms such self-organizing mapping, clustering will be very effective for digital forensics especially in a situation where large amount of data is going to be used. In [8] applied memetic algorithm in forensics analysis. In addition to [9] showed how machine learning algorithms are applied to security breaches. Malware classification system was also implemented using machine learning algorithms [16]. Hybrid system that is the combination of deep learning and machine learning algorithms was used to implement cybersecurity system in [15]. Intrusion detection system was also implemented in [14,51]. In [13] a systematic review was made on the combination of machine learning algorithms and data mining approach to cybersecurity. In [12] described how machine learning algorithms are good in the feature of cybersecurity. In the literatures researches and white papers are presenteds and published regarding the application of computational intelligence/ artificial intelligence techniques, machine learning, deep learning are applied to system security [16] and [18-22]. Cybersecurity system was modeled in [29]. Cybersecurity Framework was implemented in [30] using fuzzy logic algorithm.

Furthermore, [23] combined machine learning algorithm and deep learning algorithm for intrusion detection system. [24] Conducted a systematic survey on the anomaly based intrusion detection system. [25] Implemented intrusion detection system using machine learning algorithms for cloud mobile system in a heterogeneous network. Hybrid system for intrusion detection system was implemented in [26]. In addition to [27] has pave away for further implementation of industrial anomaly detection using machine learning algorithms. Anomaly detection system for mobile networks and automobile network was presented by [31]. Hybrid system for traffic control and monitoring was implemented in [32]. A review was made by [40] on the methods that are used for malware detection, and [41] applied machine learning algorithm to detect malware in android mobile devices. In [42] they conducted a review on malware detection using parallel computing. [43] made a comparative analysis on malware detection between static, dynamic and hybrid system. Digital Forensics analysis was also made on WhatsApp and Facebook to identify those that are using the application to commit a crime or illegal businesses [36-39]. In addition to Parag [47] Digital forensics framework was proposed and made a comparative analysis with other framework made with many artificial intelligence techniques and machine learning algorithms.

5. Conclusion

In recent time machine learning algorithms computational intelligence techniques, artificial intelligence techniques deep learning among other intelligent techniques are used to modeled or build a cybersecurity system such as internet security, information security, identity access security, cloud computing security, Internet of Things security, intrusion detection system, artificial immune systems, although majority of the security systems depend on the detection, prediction and response. Moreover, the main goals of cyber security are confidentiality, integrity and availability. In this research work it is also noted that there are ten steps to cybersecurity; network security, user education and awareness, malware prevention, removable media control, secure configuration, managing user privileges, incident management, monitoring and home and mobile working. In addition to AI and machine learning are among the good cyber tools for modeling the investigation system in digital forensics.

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ARTICLE

Assessing the Effectiveness of Adhoc-Network and Electronic Government in Abuja, Nigeria

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ABSTRACT

E-Government is the use of information and communication Technologies (ICT) such as internet, smart phones, telecommunication, mobile company among others to interact between government and the citizens in running the affairs of the country such as decision making etc. The impact and potential of ICTs have not been fully exploited in the Nigerian context, leaving government in a weak position to formulate policy comprehensively and implement plans effectively. In addition to the implementation of e-government in some part of the Federal Capital Territory (FCT) of Nigeria Abuja, but its effectiveness is not impressive. The citizens connection to the government is limited it can be improved more easily using electronic means of communication, A reduction in corruption cases as accountability and transparency can also be increased, Equal opportunity will be given to all to access information irrespective of the person's physical location or disability and the elimination of the bureaucracy experienced in government offices. This research work is aimed at assessing the effectiveness of e-government in federal capital territory of Nigeria Abuja using Seoul Metropolitan Government as a yard stick for measuring the effectiveness. Questionnaire was used as a primary method of data collection, internet and library as secondary data. The data obtained from the questionnaire has been analyzed using frequency table and percentage. The findings of this work shows that 41.91% of the respondents agree e-government initiatives have decreased civil servants corruption in Abuja, 46.81% of the respondents agree that E-government services has increased citizens trust in Abuja, 58.11% of the respondents believe that E-government initiative have increased the accessibility to the government in Abuja however 37.11% agree that Lack of Information Technology (IT) infrastructure is the major problem affecting E-government in Abuja.

1. Introduction

World is at a critical moment, that is much more than just about technologies, but also about the globe being a global round table where distance is never a barrier. We are witnessing the simultaneous advancement in artificial intelligence, nanotechnology, Neuro-computing, robotics engineering, big data, data science, precious agriculture, block-chain, and other fast emerging technologies specifically artificial intelligence.

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These frontier technologies are techniques used in food systems, water and sanitation, energy, to education, health care and social services among others.

1.1 Background to the Study

Globally, there is growing body of knowledge for acceptability of e-government [12-18]. With the innovations in IT collaboration, sharing, contributions, participating in government and even transparency between governance and citizens has become a reality. E-Government has created an interactive session between her governance and citizens in terms of taking decisions and running the affairs of the country ranging from economy to policy, leadership to security [19]. However, [5] described it as "The quest is multi-dimensional across leadership, policy, economic competitiveness, education, digital citizen's services, internal government operations, digital democracy, and enabling technologies for each dimension." She further believed that each dimension require leadership, strategy, cross-coordination and technical know-how all joint together with a technology strategy to take the vision to reality.

In addition to [1] assert that "Nigeria is regarded as the giant of Africa" in the international system, in terms of population density not in technological growth but he further agree that Nigeria, is like every other nation in the global community is striving to achieve a standard where e-governance becomes the order of the day. Awareness on the importance of E-government has grown significantly in developing countries, along with the exponential growth of technology and ICT convergence. Moreover, E-governance has created a virtual government that changes the traditional relationship between government and her citizens [4]. However, [2] believed that accessibility, security and privacy are three pillars of digital government. In the work of [9] described privacy as an essential pillar of trusted interactions in commerce, health care digital communications, financial matters, education among other areas.

1.2 Statement of the Problem

The impact and potential of ICTs have not been fully exploited in the Nigerian context, leaving government in a weak position to formulate policy comprehensively and implement plans effectively. Despite the fact that skeletal E-government has been implemented for a while now in federal capital territory of Nigeria Abuja, but its effectiveness is not impressive. The citizen's connection to the government is limited. The rate of corruption cases is alarming every day. Lack of transparency and accountability among civil servant is at increase day-by-day because there is no full implementation of e-government.

2. Literature Review

This section presents a thorough review of publications relating to electronic governance and it also provides a detail description of the area under study.

Electronic government is the application of information technology in deriving the processes of government, [6] assert that "The central goal of e-governance is to establish a concrete relationship between government officials in the state and the citizenry, providing full access of information to the citizenry and even the entire world; giving an avenue to the citizens to participate in making government decisions, such as by requesting government service and filing required documents through website; in addition to create more transparency and accountability among government officials in-line with this believed [6] also observed that E-government uses tools offered by information and communication technology in various aspect and processes of governance with the hope and hype of achieving efficiency, transparency, accountability and user friendliness in all the transactions that the citizens and businesses indulge with the government.

In the context of this research work E-government uses information and communication technology tools which are dependable and reliable to the various processes of government, citizen and businesses in a country. In the Nigerian context, the rapid growth of information technology in the 21st century has forced Nigeria to embrace e-governance. The privatization of NITEL in 2001 is the key factor that contributed to this development going by Nigerian Communications Commission (NCC) 2014 statistics, Nigeria has over 130 Million Active Mobile Phone Subscribers, of which 63 million are connected to the internet most probably through their phones (http://www.thenigerianvoice.com/). As indicated by [6] "In response to this growing reality and to move along with the global drift the Federal Government of Nigeria (FGN) adopted a national policy on Information technologies and is prepared to integrate Agriculture, health, education etc." According to [1] between 2011 and 2013, Nigerian government had adopted various online procedures such as mobile apps and mobile portals to directly support poverty eradication, gender equality, social inclusion and the promotion of economic development, environmental protection and disaster management.

Moreover, [11] identified six benefit of e-government these are; (1) Cost reduction and efficiency gains (2) Quality of service delivery to businesses and customers (3) Transparency, anticorruption, accountability (4) Increase

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the capacity of government (5) Network and community creation (6) Improve the quality of decision making and (7) Promote use of ICT in other sectors of the society. In addition to [8] assert that the traditional Government is confronted by new technologies in two different ways; e-policy and interactive e-government. E-policy entails the legal framework governing the use of IT (e.g. recognition of the digital signature), The second aspect is the interactive e-government that has to deal with defining its role as a market layer in the virtual environment, he further agree that e-government has two dimension; Endowing the economy with the necessary legal frame work and performing it work in an effective manner. With the exponential growth in information and communication technology today [7] suggested that the common phrases are e-governance, e-commerce, e-farming and e-financial wallet.

According to [10] Information technology provides a more diverse and extensive scope of information on politics and the political system of a country. He further say that It helps people to be better informed and educated about political affairs such that they develop the capacity to critically evaluate how democratic institutions operate in their country. In the same vein [20] also agree that Technological and communication breakthroughs have restructured the way governments and non-governmental organisation to interact with their citizens, especially given the population configuration which is mostly youth based. He further believe that Various stakeholders distressed with the challenges of manual methods of conducting elections in Nigeria, have begun a call for Election management bodies and government to explore the possibility of adopting e-voting system in the country. Although with the 2015 general election in Nigeria show a green light that Nigeria will embrace electronic voting in the near feature.

Abuja is one of the best city among Nigerian states in terms of infrastructure and technology. Information and Communication Technology (ICT) is today a crucial growth enabler with enormous impact in Abuja because everything is online. The nature of governance, business, education and social engagements is speedily and dramatically changing in the state. Almost all governmental and private organizations has a web site for dissemination and receiving of information these include Nigerian Communication Commission (NCC), Central Bank of Nigeria, all commercial Banks, National Information Technology development Agency (NITDA), all Nigerian Army Forces, Nigerian Police Force, Nigerian Immigration Service, Nigerian Custom Service, Nigerian Prison service, Nigerian Road safety Commission, Federal Inland Revenue, all Ministries, all academic institutions, Pension Commissions, Nigerian Bar Association, National Assembly, Nigerian National Petroleum Corporation (NNPC) and all other oil and gas companies, all aviation companies, Independent National Electoral Commission (INEC), all Mobile companies, presidency and Federal Capital Territory Abuja etc. with the emergence of smartphones in Abuja all of this are easy to locate by every citizen in the state.

Similarly, [3] indicate that most of the Nigerian institutions have a web site however majority of them are not up to date. They further indicate that e-government application in Nigeria includes Police dairy, public radio phone in program where citizens can interact with police laying complaints or reporting on right abuse. Others includes, e-passport, Voters registration, tax payment, land registration and e payment. There is a compelling necessity to integrate our entire website in Abuja in order to attain a full fledge e-government like Seoul in Korea. The Seoul Metropolitan Government is leading the world in smart administration it pursue drastic improvements in administrative efficiency and quality through the in cooperation of advanced information and communication technologies into its public services for citizens. Seoul discloses all of its administrative information to citizens and shares public data with them. Offering job opportunities for them, provide useful information such as real estate transactions and rental, cultural events etc. with the emerge of mobile devices Seoul uses e-voting system enable her citizens to participate in policy making process.

The aim of this research is to assess the effectiveness of E-government in Federal capital territory of Nigeria Abuja with concentration on the Behavioral, Technical, Law and policy levels. With the following objectives:

(1) To assess the effective use of IT appliances among citizens of Abuja

(2) To identify the major challenges hindering e-government in Abuja

(3) To recommend on how to achieved full fledge e-government in Abuja

3. Research Questions

(1) What is the effectiveness of E- government in Abuja?

(2) What are the challenges hindering the full implementation of e-government in Abuja?

4. Conceptual Framework

The effectiveness of e-government relied on the effective use of information and communication technology (ICT) in leadership, policies, economic, democracy, education, community, health, Security, legal framework so as to

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achieved transparency, trust in e-services, efficiency, accountability and accessibility etc. although, Edward and Charles [3] identified seven (7) challenges hindering e-government implementation in Nigeria are; Low ICT literacy rate, Lack of necessary regulatory/legal framework, Poor ICT infrastructure, Corruption, Lack of Committed Leadership, Epileptic Power supply and Bureaucratic Bottlenecks. For Nigeria to realized there dream in e-government and e-governance Kabir, [7] recommended that; (1) Encourage more private sector involvement in ICT capacity development and ICT provision in the country. (2) Involve information professionals in formulation of information policies. (3) Expedite actions on passing the data protection bill into law. (4) Collaborate with other countries within and outside the African continent to formulate information policy that can guide regional and international exchanges and transactions.

"Addressing the needs of the neediest especially the vulnerable groups such insurgencies, migrants and other humanitarian crisis that is affecting the rural people technologies offer a platform for them to be had [17]".

5. Method

This research must have a plan and strategy of investigation; it must have a format and a modus operandi, so as to obtain answer to research question and to control variables. This plan strategy of investigation is the research design. The research design is a program that guides the investigation in the process of collecting, analyzing and interpreting observations. In this study of survey research, both the questionnaire and interview approach was adopted. Here, the representation of the population was studied and the results were generalized. This is because of inability to visit the entire governmental and non-governmental organization in Abuja. Information for this research was gathered by issuing questionnaire to employees in the various sectors.

5.1 Research Population

In a bid to carry out a thorough, meaningful and all-embracing research study, the population for this research comprised civil servant which include IT professional non IT personnel security personnel, Bankers, business men and customers and citizens etc. from the sector which were chosen randomly. The random selection of the population is as a result of the need to have a cross section of opinions within the area of study and the little time and resources at the disposal of the researcher. However, it is believed and hoped that the population chosen would represent a true picture of what is on ground.

5.2. Sampling Techniques

The sample size of this research covers only some sectors in Abuja. Out of the whole states in Nigeria, Abuja was chosen by the researcher because of the fact that Abuja is close to the researcher whore enough information could be obtained for the purpose of the study. Also the selection of Abuja as a sample size saves the researcher the cost of touring round the entire states in the country. This has made the researcher to employ convenient sampling in the selection of Abuja. The sampling technique employed here is the random sampling. This is so as to have an effective result, from just a sample population of 120. This comprises both the citizens and the civil servants in the Federal Capital Territory of Nigeria Abuja.

5.3. Instrument Design

Questionnaire is the main instrument used in the collection of relevant data for this research, and it is designed in a way that although being very concise, would aid the collection of relevant material that would aid the research work. Please refer to appendix X for the instrument as designed and presented to would be respondents.

6. Results and Discussion

Simple percentage has been used to analyze the results throughout this research.

Table 1. Age of the Respondent

ITEMS (YEARS)	RESPONDENTS	PERCENTAGE (%)
18 – 29	27	43.54
30-39	21	33.87
40-49	8	12.91
50-59	4	6.45
60 and above	2	3.23
TOTAL	62	100

Source: Field survey, 2019.

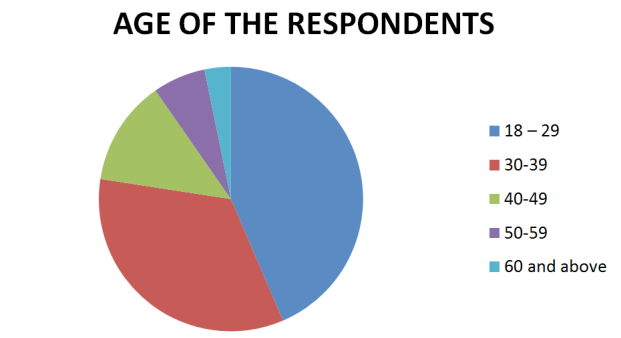

Figure 1. Age of the respondents

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The highest percentage of responses between the age of 18 – 29 years and it is 27 people which is 43.54%, 30 – 39 years is 21 people which is 33.87%, 40-49 years is also 8 people which is 12.91%, 50-59 years is 4 respondents which is 6.45% while 60 and above years had 2 people representing 3.23%. as shown in the pie chart below:

Table 2. Occupation of the Respondent

ITEMS (OCCUPATION)	RESPONDENTS	PERCENTAGE (%)
Bankers	3	4.84
Civil servant	31	50
Military/Paramilitary	4	6.45
Others	24	38.71
TOTAL	62	100

Source: Field survey, 2019.

The highest percentage of responses where civil servants and it is 31 people which is 50%, Bankers is 3 people which is representing 4.84%, Military/Paramilitary is 4 people which is representing 6.45% while others is 24 respondents which is representing 38.71% as shown in the figure below:

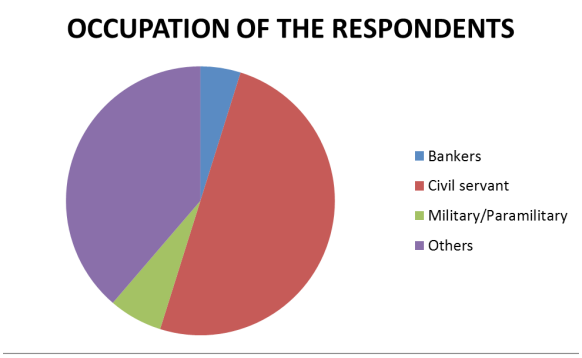

Figure 2. Occupation of the respondents

7. Discussion of the Findings

From the Table 3 above show the outcome from the respondent. It is clearly shown that electronic governance initiatives has decrease civil servants corruption in Abuja which about 41.9% of the respondent agree upon at this point now there is a compelling necessity to increase at least 80% so that Nigeria will maintain the level stated in [1] that Nigeria is a giant of Africa. 46.8% of the respondent

Table 3. The effectiveness of e-government in Abuja

S/N	Item	SA	%	A	%	N	%	DA	%	SD	%
1.	e-government initiatives have decreased civil servants corruption in Abuja	21	33.87	26	41.94	8	12.91	5	8.06	2	3.2
2.	E-government services has increased citizens trust in Abuja	14	22.6	29	46.81	10	16.1	8	12.91	1	1.61
3.	Government and private sector has reduced administrative cost due e-government services in Abuja	10	16.1	27	43.55	20	32.31	2	3.21	3	4.81
4.	E-government has bridge the gap between citizens and the governance in Abuja	14	22.61	22	35.51	17	27.41	8	12.91	1	1.61
5.	E-government initiative have increased the efficiency of system in general	17	27.41	19	30.61	15	24.21	8	12.91	3	4.81
6.	E-government initiative have increased the accessibility to the government in Abuja	13	20.96	27	43.51	2	3.21	10	16.11	10	16.11
7.	NITDA is contributing to the development of e-government in Abuja	9	14.51	36	58.11	9	14.51	4	6.51	4	6.51
8.	E-government has improved security in Abuja	7	11.31	23	37.11	14	22.61	11	17.71	7	11.31
9.	Health sectors, academics, businesses, transportation and judiciary utilize e-government services effectively in Abuja	9	14.51	20	32.31	13	20.96	12	19.35	8	12.91
10.	E-government has increased the quality of decision making in Abuja	6	9.71	14	22.58	22	35.51	12	19.35	8	12.91
11.	Lack of IT infrastructure is the major problem affecting E-government in Abuja	31	50	23	37.11	3	4.81	3	4.81	2	3.21
12	Corruption is the major factor affecting E-government in Abuja	31	50	20	32.31	4	6.45	5	8.06	2	3.21
13.	Lack of technical know-how in ICT is major factor affecting E-government in Abuja	28	48.21	22	35.51	3	4.81	7	11.31	2	3.21
14.	Bureaucratic system is the major factor affecting e-government in Abuja	20	32.21	27	43.51	10	16.11	3	4.81	2	3.21

Source: Field survey, 2019.

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agreed that electronic government has increased citizens trust particularly in Abuja which shows positive impact. In both the private and government sector electronic government decrease running cost of the organization where 43.5% of the respondent agreed upon. Also 35.5% of the respondents agreed that electronic governance bridge the gap between the citizens and the government in Abuja there is a need to increase to at least 80% so as to maintain the level as compare with [20]. The respondent from the table 3 above 30% of the respondents agreed electronic governance initiatives help in increasing the efficiency in system of governance in general, it also increase the accessibility to the government where about 43.5% of the respondent agreed. It is given from the table 3 above about 58.1% of the respondent agreed that NITDA is also contributing a lot in promoting e-government in Abuja. 37.1% of the respondents agreed that e-government has improved the security in Abuja there is a need to increase so as to confirmed what [2] and [9] ascertained. The outcome from the respondents in Table 3 above shows that health, transportation, businesses, judiciary, and academic institutions are benefiting from the current state of e-governance in Abuja in which 32.3% of the respondents agreed upon however, the percentage here is less to confirmed with the assertion of [9]. Moreover, 35.5% of the respondents are neutral in terms of the effectiveness of e-governance in relation to decision making that is either e-governance increase the quality of decision making in Abuja or not. About 50% of the respondents strongly agreed that lack of information technology infrastructure is the major problems affecting e-government in Abuja. Also 50% of the respondents strongly agreed that corruption is one of the major factors that affect e-government in Abuja. It was also shown that lack of technical know-how in ICT is major factor affecting electronic government in Abuja in which 45% of the respondents strongly agreed upon. Finally, 43.5% of the respondents agreed that bureaucratic system of government is also a bottle neck to e-government in Abuja.

8. Conclusions

E-government has the potential to greatly improve how government operates internally and how it serves its customers. E-government is much more than a tool for improving cost-quality ratios in public services. It is an instrument of reform and a tool to transform government. Thus, e-Government is not primarily about automation of existing procedures but about provide new ways of doing businesses and service delivery using recent technologies. Based on this research work e-government have decreased civil servant corruption in Abuja, government organization and private sector have reduced administrative cost in Abuja, and e-government initiative have increased the efficiency of the system of administration and the study shows that e-governance has increased security in Abuja. From this perspective, the success of e-government is the result of organizing human, material and technical resources through the backing by the strong determination and leadership of the president, which were efficiently utilized to achieve the objective of administrative efficiency, improve service to mass public, improve administrative process transparency, and citizens participation and applied the advancing information technologies. Simultaneously, information industry promotion with the objective of advancing the IT industry was also implemented in each stage of the project as well as applying feedback and research results of previous experience on the next phase planning. Moreover, the findings shows that lack of IT infrastructure is one of the problems affecting e-government in Abuja it also reveal that corruption is affecting the e-government in Abuja.

9. Recommendation

The key strategy to make e-governance effective is formation of right institution and agencies and identifying the right human resources for the same. Based on the findings of this work the following recommendation has been made;

(1) Full implementation of E-government in Nigeria will reduce high level of corruption

(2) To create a central payment system of the entire country staff to avoid Goss workers.

(3) To develop smart city for the entire state of Abuja there by making decision by the citizen of the state.

(4) To have one central free internet service for all the state to enable people have access to information at all the time

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