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DEVELOPMENT OF GHOST WORKERS DETECTION SYSTEM USING BIOMETRIC BASED CONVOLUTIONAL NEURAL NETWORK

[1]Nzeh Chika D., [2]Inyama Hyacinth C.

[1,2]Department of Computer Science

[1,2]Enugu State University of Science and Technology, Enugu, Nigeria

[1]dorachik@yahoo.com ; [2]drhcinyiama@gmail.com

Abstract

This paper presents the development of ghost workers detection system using biometric based convolutional neural network. The study started with literature review of related works which revealed the impact of ghost worker syndrome on the global economy in general. The study proposes to solve this problem using machine learning based biometric technology.This was achieved using Object oriented analysis and design methodology. The methods used were data collection, data acquisition, computer vision, face detection, Convolutional Neural Network (CNN), face recognition and results. The methods were designed using structural and mathematical approaches and then implemented with MATLAB. The CNN algorithm for facial recognition was evaluated and the result showed accuracy of 99.28%.

Keywords: Face detection; machine learning; Biometric; CNN; Computer Vision

1. INTRODUCTION

Everyday beings a story and today the narrative begin with the current trend in the social media, newspapers, and media houses tagged “Ghost worker syndrome”. Ghost worker is a process whereby unknown individuals are fraudulently placed on payroll without performing any meaningful activities or providing value to the civil service (Obaza, 2017).

This ghost worker has remained a global issue over the years and has affected the public sector more. According to Ian (2015), over 29% of all organizations globally experiences payroll fraud; In Manila Philippine, the problem of ghost worker was reported in (Ombudsman, 2016). In Kenya, Afghan and other countries, the problem of ghost worker related issues was reported in (Paul, 2014; Ian, 2015).

In Nigeria, this problem of ghost worker has gain so much attention lately as it has eaten deep into the ecosystem of the Nigerian

public and private enterprises. For instance, the recently Integrated Payroll and Personnel Information System (IPPIS) revealed over 65000 ghost workers according to the Bureau of Public Service Reforms (BPSR, 2016). According to (Vanguard; 2nd January, 2021), in Borno state Nigeria, 22556 ghost workers are currently integrated into the government payroll system, with an estimated N420 million per month. In the same vein, between September 2013 and May 2015, an estimated N220billion was paid to 103,000 ghost workers and the worst-case scenario is that till date a solution to completely eradicate this problem remains a "Mystery unknown even to the incurable ignorant" Chinua Achebe (1988).

Over the year many administrative solutions have been proposed like the IPPIS which has help solve this problem to an extent, but despite the success, it lacks the ability to address the problem of lateness and absenteeism.

Biometric technology has been singled out by (Mohammed et al., 2020; Nirmalya et al., 2012; Mgbeafulike and Ndigwe, 2020) as the path to combat ghost worker syndrome completely. Biometric is a technology which verifies person's identity based on their body features like face, fingerprint, voice, iris among others.

In the past decades, many researchers like (Eromosele, 2016; Gladys et al., 2018; Ikuomola, 2015; Katrina, 2018) among others have tried to solve this problem of human resource management fraud using artificial intelligence based biometric technology with fingerprint and face recognition system singles out as the most effective biometric trait to address this problem. However, despite their success none considered the problem of lateness to work, absenteeism and furthermore, none provided a redundancy measure for staff verification, incase face or fingerprint system experiences technical faults. It is therefore very important to develop biometric solutions which address this problem of ghost workers, characterized by the public staffs especially. This when achieved will go a long way to boast the economy's GDP and also eradicate the high level of corruption in the Nigerian public and private enterprises.

2. LITERATURE REVIEW

Tolulope et al. (2014) presented a study on the development of a network-based thumb print staff attendance management system. The research used fingerprint technology to improve the reliability of staff attendance verification system. The material used are fingerprint scanner, Griaule fingerprint software development kit, service-oriented application, back-end database, camera and web server. The system was designed using universal modeling diagrams and then tested. The result was good but never considered lateness to work problem.

Chiwa et al. (2014) presented a secured employee attendance management system using fingerprint. The study reviewed literatures and identified biometric technology as solution to improve the reliability of management system. This was proposed and implemented with fingerprint technology. The result when tested showed good performance, but never considered lateness to work problem.

Shakil and Rabindra (2013) presented research on attendance management system for industrial workers using fingerprint scanner. The study revealed that fingerprint is one of the reliable biometric means to solve the problem of person identification systems. This was proposed and used in the research to improve a staff management system. This was achieved with CSS, HTML, JavaScript, smarthy and MYSQL software. The result when tested showed improve performance, but despite the success never considered staff lateness to work problems.

Rishab et al. (2016) presented a study on student attendance system based on fingerprint recognition and one too many matching techniques. The study proposed the use of biometric technology to address the problem of calls attendance and impersonation. The research revealed that the conventional management system which lack biometric technology is not reliable. The new system was achieved using MYSQL and other necessary tool and then implemented for use. The result showed good performance, but can be further improved with artificial intelligence

3. RESEARCH METHODOLOGY

The methodology employed for this paper is the Object-Oriented Analysis and Design Methodology (OOADM). This OOADM is a technical approach for the analysis and modeling of an application system. The methodology accomplished the design goals via the object definition, organization, description of how the objects react and interact with each other, definition of the object internal and external behavior. This methodology was adopted for this study due to its capacity to improve system analysis quality and productivity of design by making it more users friendly. Furthermore, it provides the desired gap between problem formulation and solution. It facilitates system changes at low cost and accommodates component reuse to save cost and ensure that projects are accomplished within the stipulated work plan and time.

Data collection

The primary source of data collection for this work is the Oji-river local government headquarters. The public organization provided biometric data of 1817 staffs containing information such as faces. The secondary sources of data collection are 30 self-volunteered persons who provided their faces to use and test the system. The total sample size of data collected is 1847 of face data. These data were used to develop the training and testing dataset used for the study.

Computer vision

This is an artificial intelligent algorithm which controls the data acquisition focus behavior for accurate facial data collection. The computer vision algorithm was used to configure the camera used for the face data collection to ensure that the data captured contain facial information of all the staffs. The computer vision algorithm was developed using Viola Jones algorithm in the system design section.

Face detection

This is the ability of the camera to detect and capture the staff data containing a face. Face

detection is the first step in solving facial recognition problem as it ensures that the desired face data is collected for face detection. The accuracy of this face detection is dependent on the efficiency of the computer vision algorithm used. In this case the Viola Jones algorithm which is adaptive and has the ability to track facial features based on Haar classified features was used to ensure optimal face detection performance.

Training

After face detection, the next process was to train the data. This was done using machine learning algorithm. In many works reviewed, at this point image processing is required, to filter the face data detected, however in this case it is not necessarily due to the advance machine learning scheme employed for the research called deep learning.

Deep learning is the most advanced type of artificial neural network which are designed with specialty in solving pattern recognition problems. Deep learning has many algorithms, but the convolutional neural network has evolved over the years as the most effective in solving image classification problems with accuracy revering human intelligence in some cases.

Convolutional Neural Network (CNN)

CNN is a branch of deep learning algorithm developed with filters, and series of artificial neural network. The CNN is made up of three layers which are the input layer, convolutional layer, fully connected layers and output layer. These layers work together to dimension the input data, extract the features in convolutional series, train and make précised prediction

4. SYSTEM DESIGN

The system design was designed using structural and mathematical method. This begins with the development of a logical flow model for the development of the training dataset. Then the computer vision algorithm for the optimization of the image acquisition algorithm was developed for face detection enhancement. The model of the face detection was developed and the deep learning based convolutional neural network training algorithm was developed as the face recognition model.

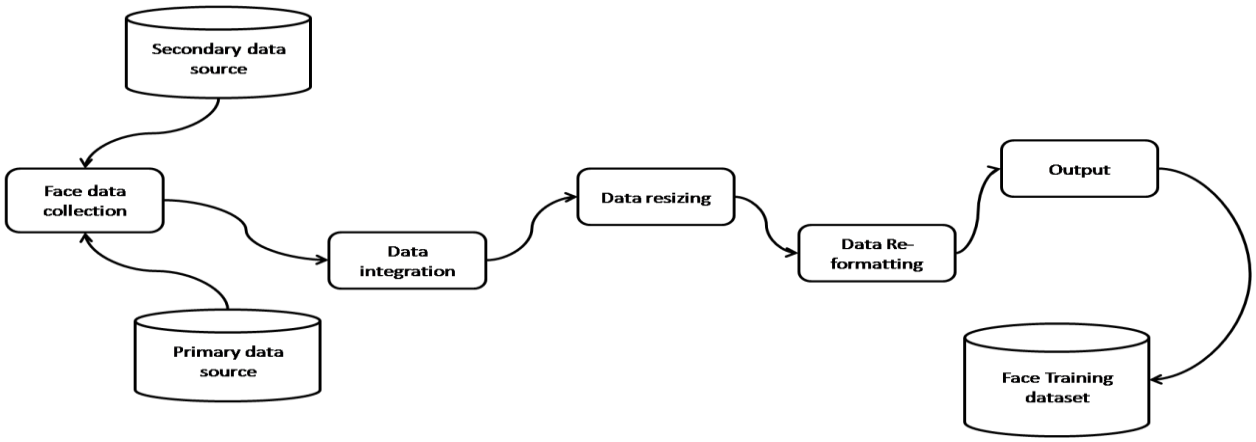

Figure 1: data flow model of the face training dataset

From the data flow diagram, the faces collected from the primary and secondary data sources are integrated on one platform and then used image processing tool in MATLAB to resize into 180 x 120pixels size before converting into jpg format and save as the training face dataset.

Development of computer vision algorithm

The computer vision algorithm was developed using Viola and Jones algorithm which used Haar classifier (face like features) to search and detect face in a computer image. The algorithm first converts the face data integral image (i.e., decompose the image into segments), then Haar features are used to search face like features in the segment and extract using Adaboost. The extracted outputs are classified as face data required for collection. The data flow model of the algorithm is presented in figure 2;

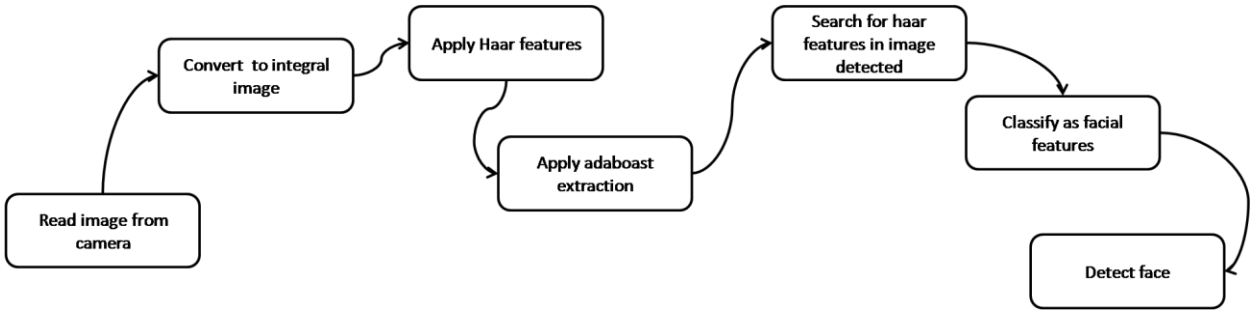

Figure 2: The data flow model of the Viola Jones algorithm

The figure 2 presented the data flow diagram of the Viola Jones algorithm which was used to improve the efficiency of the camera to ensure that only face like data is captured for recognition.

Model of the Face Detection System

The face detection model was developed using the Viola Jones algorithm developed to capture and detect a face from computer image. The data flow model of the face detection system is presented in figure 3;

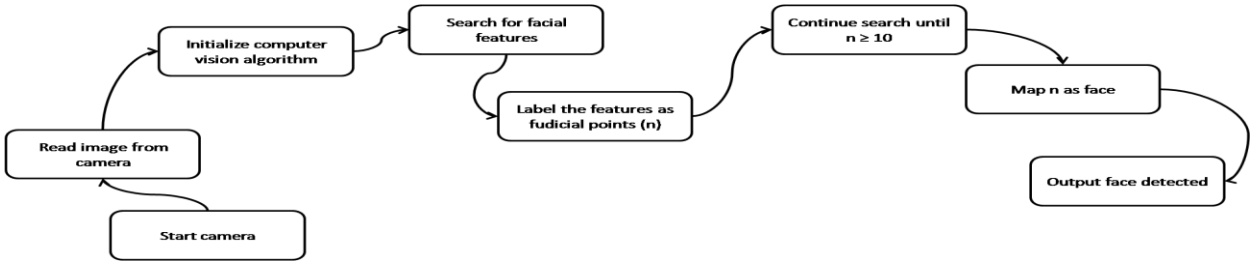

Figure 3: face detection model

The figure 3 presented the face detection model, showing how the compute vision algorithm was used to configure the camera to intelligently detect the face and capture for training.

Model of the Face Training System

The training algorithm was developed using convolutional neural network which have four main layers called input layer responsible for the dimensioning of the input facial data to the system, then the convolutional layer, fully connected layers and the output layers as shown in the structural model in figure 4;

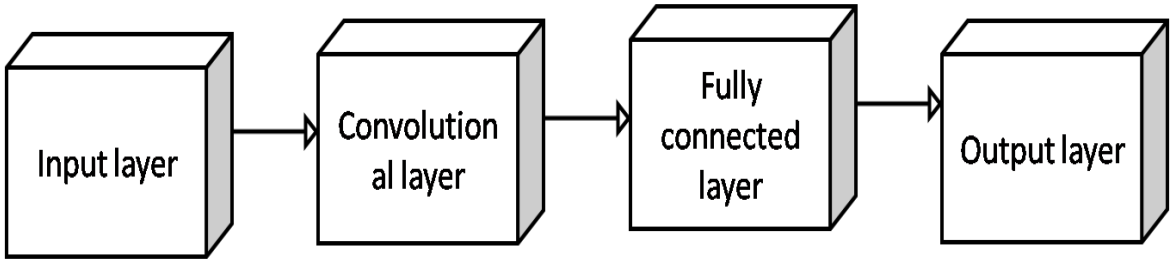

Figure 4: block diagram of the CNN

The figure 4 shows the standard model of a convolutional neural network model. However, the new system improved the performance of the CNN using three convolutional layers with the aim of improving the filtering, extraction and learning accuracy of the system for précised facial recognition performance. The model of the improved CNN is presented in figure 5;

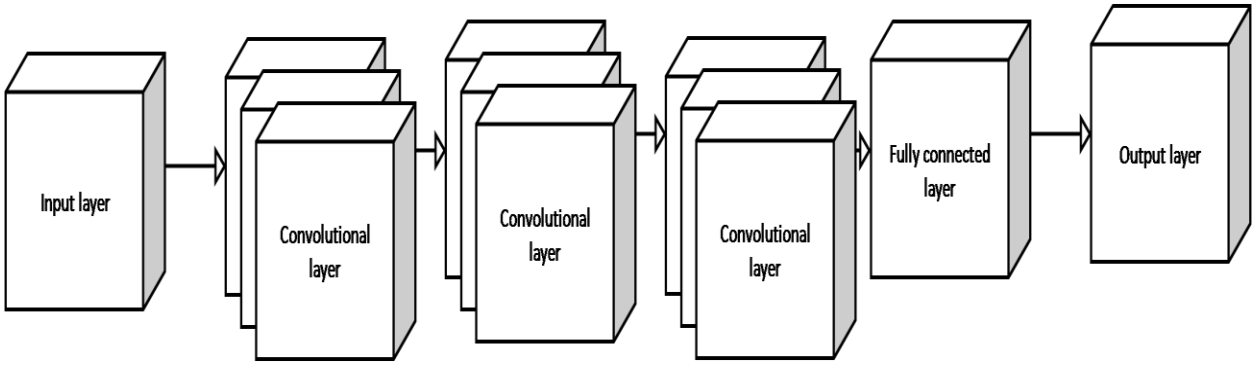

Figure 5: Block Model of the new CNN

The figure 5 presented the model of the CNN showing how the layers are configured for optimal learning of the facial features and then recognition of faces.

The Facial Recongition System Pseudocode

Start

1) *Activate camera*
2) *Initialize computer vision*
3) *Start Face deteciton*
4) *Extract facial features*

5) *Train with the extarceted features with facial referenc model in algorithm (1)*
6) *If*
7) *Extracted feature matched the reference model*
8) *Then*
9) *stop training*
10) *Presented output person identified*
11) *Else*
12) *Present output person does not exist*
13) *End*

5. SYSTEM IMPLEMENTATION

The system was implemented using optimization toolbox, neural network toolbox, wavelet toolbox, image acquisition toolbox, image processing toolbox, compute vision toolbox and Simulink. The toolbox was configured using the models and algorithm developed in the previous section to implement the biometric ghost worker verification system. To achieve this, deep learning tool was used to import the face dataset and then trained with the convolutional neural network algorithm.

6. RESULTS

Testing is a set of activities that can be planned in advance and conducted systematically. A program is not considered completed until it has gone through different testing procedure and passed. The section presents the performance of the convolutional neural network training process to show how well the deep learning algorithm learn then facial recognition result.

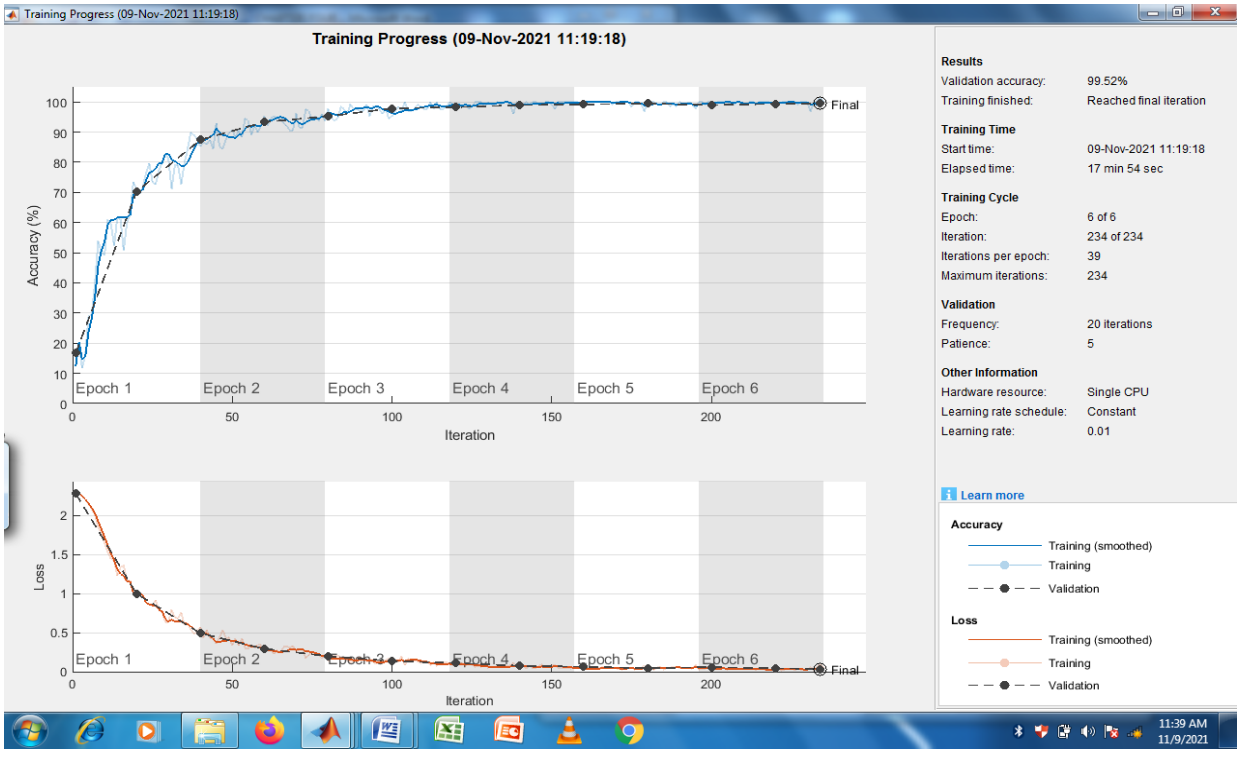

Figure 7: CNN training of the face result

The figure 7 presented the performance of the CNN training algorithm developed in the Previous section. The algorithm after the extraction of the facial features to form the convolutional layer used artificial neural network back propagation algorithm to train the data and learn the features. The training performance measured here using the accuracy model shows that the training accuracy is 99.520% which implies the high level of learning by the developed CNN algorithm.

The algorithm was integrated as a ghost worker verification system for attendance and staff verification software and the result was evaluated. The result begins with the performance of the staff verification system using facial recognition. Before the process begins the optimization algorithm enables the facial recognition system at appropriate time, then the staff data was captured as shown in figure 8.

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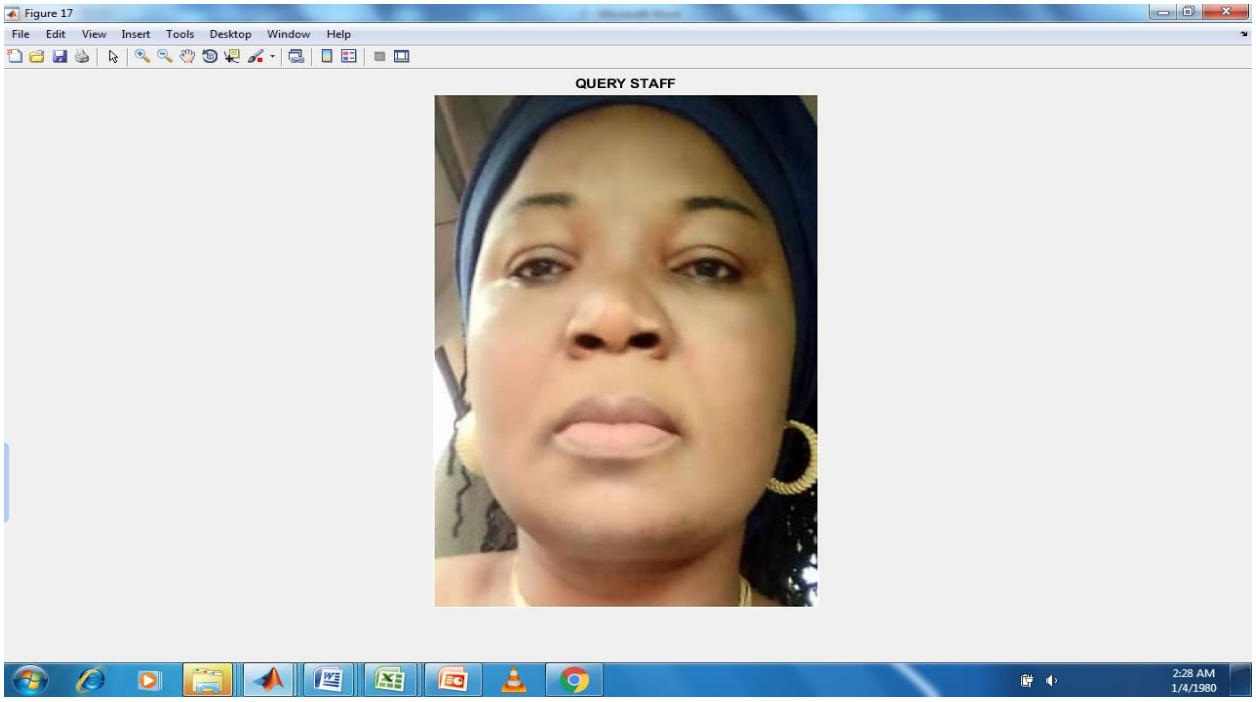

Figure 8: Query Staff Face

Here the query face of the staff was captured for recognition. The face was acquired using the computer vision-based face detection algorithm to capture the staff face. Then the CNN training algorithm developed in the architectural model was used to extract the input faces in series of convolution as presented in figure 9;

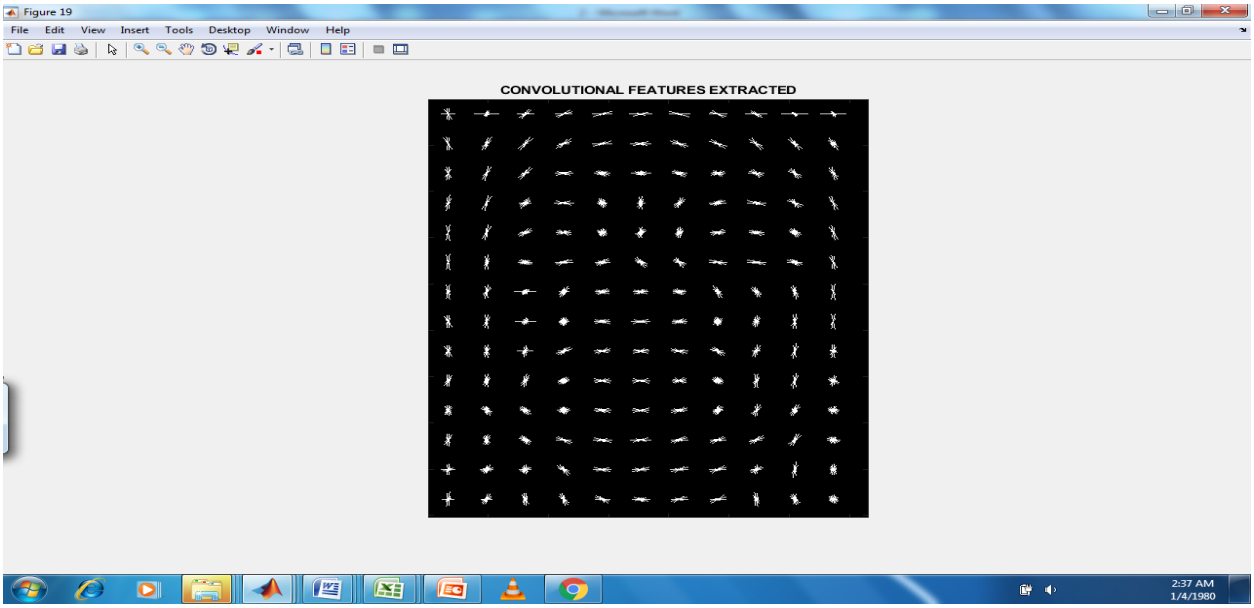

Figure 9: Convolutional features

The result in figure 9 presented the output of the extracted facial features which formed the convolutional layers for training using the artificial neural network algorithm. The training process compared that feature of the input face data with that of the convolutional trained model based on the facial recognition algorithm to recognize the staff and update the attendance. The recognition result is presented in figure 10;

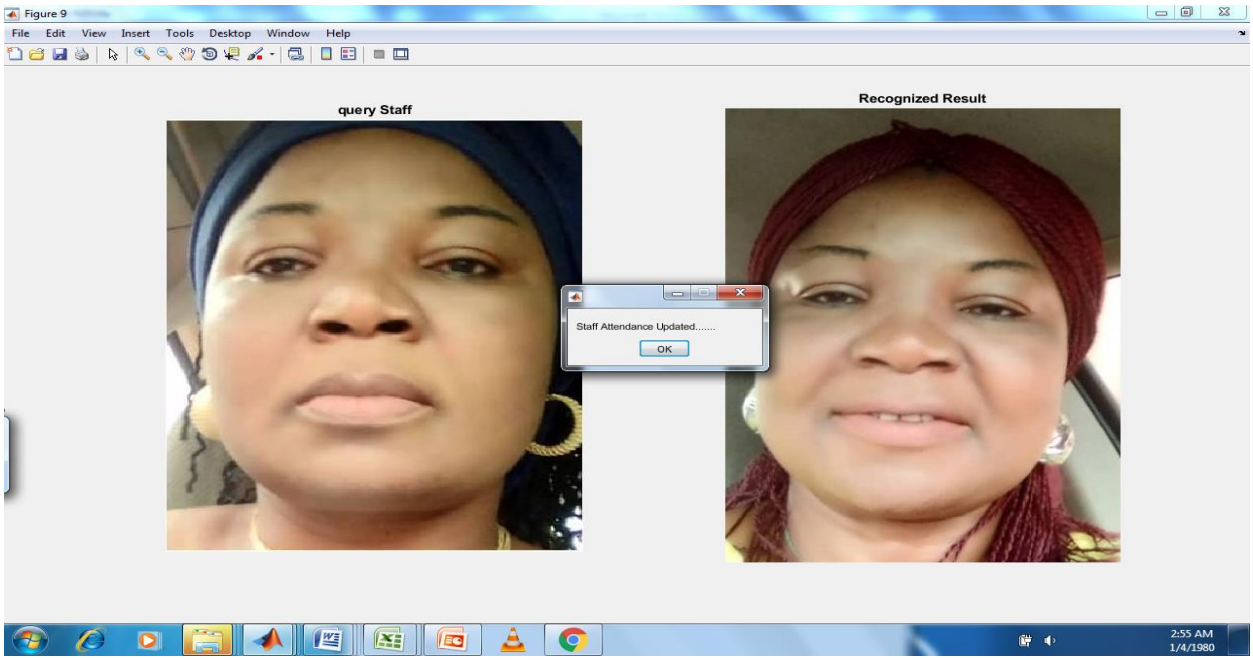

Figure 10: The facial recognition result

The result in figure 10 presented the performance of the staff attendance verification system via facial recognition. The result showed that the system was able to correctly recognize the face of the staff as a worker of the Oji-river local government headquarters.

7. CONCLUSION

The study has successfully developed a ghost worker detection system using facial recognition. The system was achieved utilizing a convolutional neural network algorithm and trained with staff data collected from Oji river local government. The facial recognition system developed was implemented with deep learning toolbox and then used to solve the problem of ghost workers in the Nigeria local governments.

8. ETHICS

The author declares no conflicting interests.

9. ACKNOWLEDGEMENT

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