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DEVELOPMENT OF GHOST WORKERS DETECTION SYSTEM USING ARTIFICIAL INTELLIGENCE BASED BIOMETRIC TECHNOLOGY

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Abstract

This paper presents the development of ghost worker detection system using artificial intelligence based biometric technology. The study began with literature review of related works which revealed the impact of ghost worker syndrome on the global economy in general. Also, it has affected the productivity of many local government headquarters and has remained a major challenge over the years. The study proposes to solve this problem using machine learning based biometric technology.This was achieved using Object oriented analysis and design methodology to develop. Other methods used were data collection, data acquisition, computer vision, fingerprint verification and results. The methods were designed using structural and mathematical approaches and then implemented with MATLAB. The result was tested and it was observed that the K-NN algorithm improving the fingerprint scanner was 88.26% accurate and 0.99 Area under curve performance which implied very good result. The algorithms were integrated and developed as a biometric ghost worker verification system for Oji River Local Government headquarters and the result showed that it was able to verify staff identities and check ghost workers.

Keywords: Ghost Worker; Biometric Technology; K-NN; Fingerprint; Matlab; AUC.

1. INTRODUCTION

In recent times, the numbers of employees on the government payroll who do not actually work in the workforce and whose names are kept on the payroll but continue to receive a salary are quite increasing in many organizations and Human Resource Management (HRM). Staff punctuality to work is not taken seriously, absenteeism from work is not checked, and in some case, an employee shows up for brief periods at work and disappears for much of the time. The improved management of human resources is the essence of successful business achievement.

Information technology is the pivot on which process engineering is hinged. Strategizing information technology can improve effective and efficient information use to enhance performance and coordinate activities across functional units as well as interact with external entities. Lack of the application of information technology in organizational management could lead to inconsistent data, non-uniformity in the management of personnel records in the ministries/departments, problems in recruitment, training problems, postings issues, transfer difficulties, promotions issues, retirement issues, and salary related issues. These situations have constituted the "Ghost worker's phenomenon". Ghost workers are individuals fraudulently placed on payroll without performing any meaningful activities or providing value to the civil service (Eromosele, 2016; Gladys et al., 2018; Ikuomola, 2015; Katrina, 2018).

Fingerprint ID is one of the most common forms of biometric authentication because of its reliability, convenience, and historical success. Almost all smart phones use fingerprint identification to quickly verify the user's identity. The reliability of this technology comes from its lack of reliability. The average person would find it hard to manipulate another person's fingerprint to access a device or physical location. Even the fingerprint hacks reported in 2016 required access to not only the fingerprint of the individual but also a sophisticated 3D printer (Eromosele, 2016). It is therefore very important to develop a biometric-based solution that addresses this problem of ghost workers using fingerprint verification characterized by the public staff especially. This when achieved will go a long way to boast the economy's GDP and also eradicate the high level of corruption in Nigerian public and private enterprises.

2. LITERATURE REVIEWS

Josephineleela and Ramakrishnan (2012) presented research on effective automated attendance system using fingerprint reconstruction technique. The study used the fingerprint technology to improve the performance of person identification and verification system. The system when implemented and tested showed good performance when compared to the state-of-the-art attendance management system, but the accuracy of recognition can be improved using artificial intelligence.

Manju et al. (2014) presented a work on human resources information systems (HRIS): A review across all states in India. The research was aimed at critically collecting and reviewing basic information on various state-level using web-based information approaches. The study pointed out the need for a national HRIS framework to move all states to a web-based platform with common technologies and data structures. The study presented a platform for developing deploying, adjusting and maintaining HRIS, but lack reliability and autonomy.

Shoewu and Idowu (2012) presented research on the development of attendance management system using biometric technology. The research revealed that the only way to make management system more authentic is the integration of biometric solutions such as face recognition,

fingerprint verification among others. This biometric technology can be made reliable using artificial intelligence.

Mgbeafulike and Ndigwe (2020) presented research on the design and implementation of biometric authentication system for the verification of students. The study was developed using object-oriented analysis and design methodology. The database was designed using micro soft access and implemented with visual basic programming language as an attendance monitoring system to replace the conventional manual approach. The result when tested showed that it is working correctly, but despite the success still gives room for improvement using artificial intelligence technique.

Taiwo et al. (2019) presented research on the development of lecture attendance system for staff performance rating in higher institution using fingerprint technology. The research reviewed many literatures and submitted that biometric solution will address the many challenges with the conventional means of staff identification and verification which are unreliable, cumbersome, lack of accuracy among others. The new system was implemented with MQSL and tested. The result showed a recognition accuracy of 98.51%. However, despite the success never considered lateness to work.

Gladys et al. (2018) presented research on the use of biometric attendance system to evaluate the performance of government employees in Cabanatuan city. The research used a questionnaire and data analysis to evaluate specified number of respondents on the need of the biometric technology to facilitate reliable human resource management. The study concluded that biotech, has the positive impact on work performance of the employees, even though the implementation suffers some technical challenges like poor accuracy, but this can be addressed using artificial intelligence technique.

3. METHODOLOOGY

The methodology for the study involved data collection of fingerprint samples, the data collected was processed and then trained with adopted K-NN algorithm to develop a fingerprint classification model which was used for the detection of ghost workers at the Orji-river local government headquarters. The classification model developed was implemented with high programming language and then validated.

3.1 Data collection

The primary source of data collection for this study is the Orji-river local government headquarters. The public organization provided biometric data of 1817 staffs containing fingerprint biological data. The secondary sources of data collection are 30 self-volunteeredpersons who provided their fingerprints to use and test the system. The total sample size of data collected is 1847 data of fingerprints. These data were used to develop the training and testing dataset used for the paper. Some of the data samples are presented in figure 1;

Figure 1: Fingerprint data samples

3.2 Data acquisition

This is a process of collecting data from the sample size individuals using data acquisition device for verification. The data acquisition devices used in this case are fingerprint scanners.

3.3 Fingerprint identification

This process involves the collection or capturing of fingerprint data using the scanner. Unlike the camera used for image acquisition for face detection, here the scanner requires no computer vision algorithm, but rather has the ability to read pattern of fingerprint using optical technology and then produce the finger print output.

3.4 Data processing

The data processing was done using discrete wavelet transform. The wavelet transform is a process whereby the features of the fingerprint image are localized in scales while removing noise. The basic idea behind wavelet filtering is to transform and spatially represent finger print features in the magnitude of wavelet coefficient. Wavelet coefficients are small value of noise which are transformed without affecting the quality of the main image and then reconstruct.

3.5 Data Classification with K-Nearest Neighbor

This is the classification algorithm which was utilized for the development of the system. This was achieved adopting the K-NN algorithm from (Padraig and Sarah,

2007) used to train the data collected to develop the fingerprint verification system.

3.6 Fingerprint recognition system

This is pseudopodia developed with the KNN trained with the fingerprint data in the previous section for time series verification of staffs and identification of ghost workers. The algorithm was modeled in the system design section.

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. Model of the wavelet fingerprint data processing was developed, and proceed by the fingerprint verification algorithm.

4.1 Development of the training dataset

In this study, dataset was used for the fingerprint verification and the dataset for fingerprint training requires no configuration as the data was collected based on the specifications of the fingerprint scanner model

4.2 Development of Fingerprint Recognition System

The finger print recognition algorithm was developed using K-NN technique. The reason for this KNN as a choice of classification algorithm, ahead of other machine learning counterparts was due to the similarities in the features of finger print dataset. These features are better trained using classification technique which employed the equidistance model in equation 1 to compute the nearest neighbor between the clusters and match as the desired finger print (Padraig and Sarah, 2007).

$$D = \sqrt{\sum_{i=1}^{x}(X_A - X_B)^2} \quad (1)$$

Where X_A is clusters of training; X_B is clusters of query data; x is the number of features; D is distance between clusters.

The figure 2 presented the data flow diagram of the K-NN algorithm.

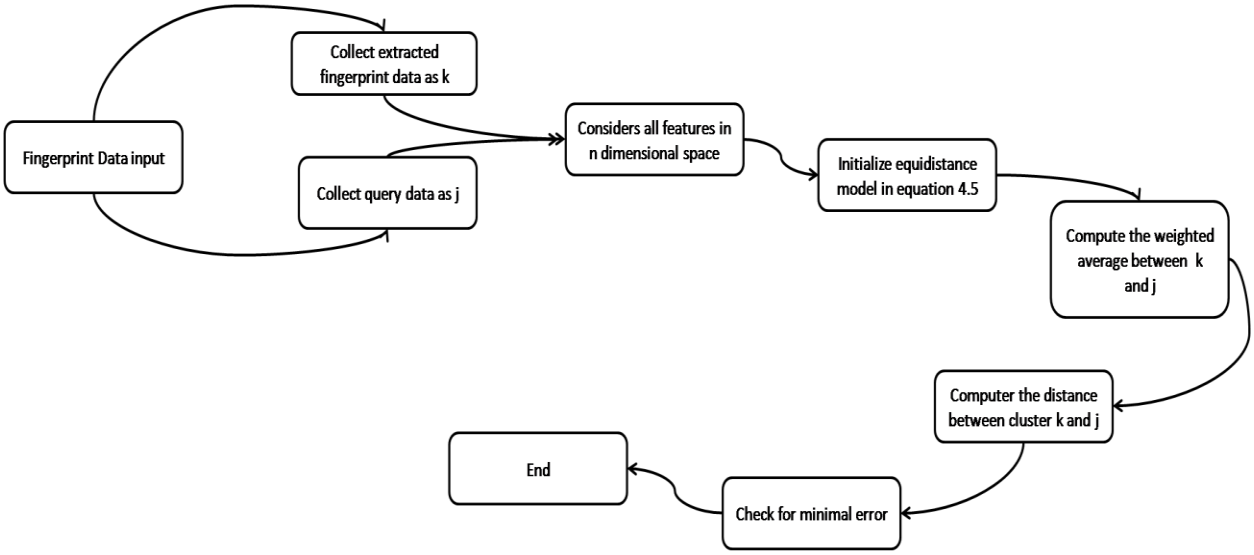

Figure 2: Data flow model of the K-NN algorithm for fingerprint recognition

The figure 2 presented the logical data flow model of the K-NN based classification algorithm used for the training of the fingerprint data collected before recognition output. The complete fingerprint recognition algorithm is presented in figure 3;

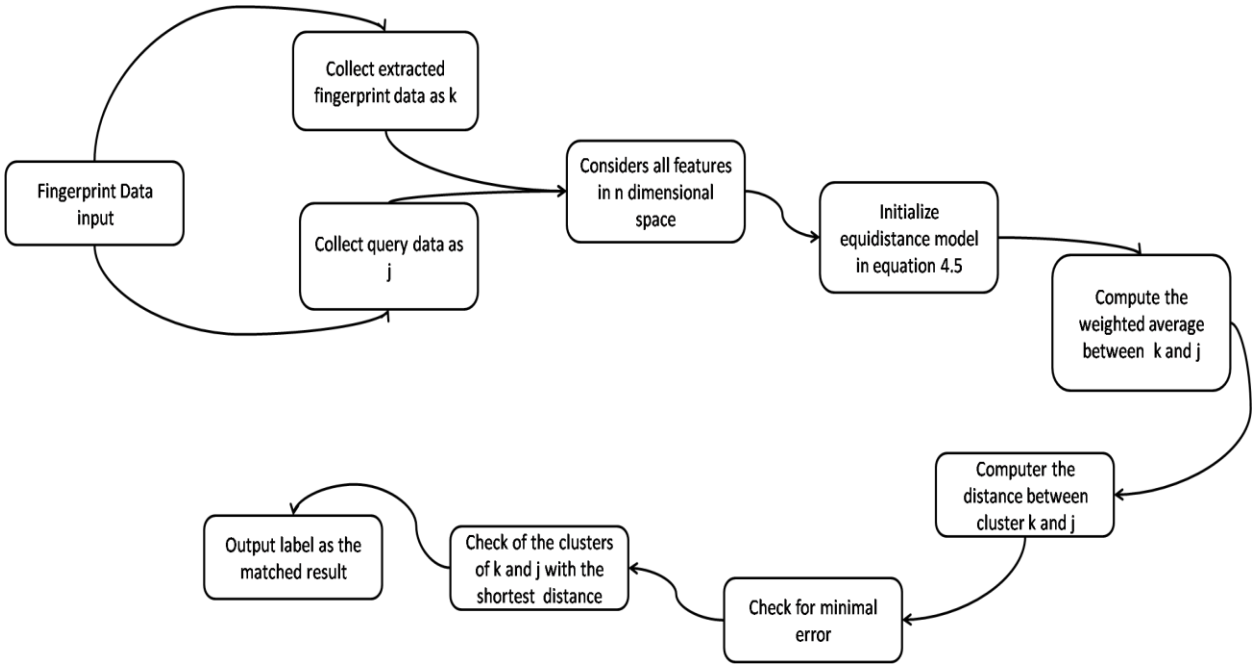

Figure 3: data flow model of the fingerprint verification system

The data flow model in figure 3 presented the logical data interaction from the fingerprint dataset and query staff which made up the fingerprint data input block to the extraction block which identified the clusters for each input class and compute the equidistance between the features to match a person as staff or ghost worker.

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, the classification app was used to import the fingerprint dataset as shown 4;

The classification app was used to train the fingerprint data and generate the fingerprint verification reference model. This algorithm was implemented as a biometric ghost worker verification system as shown in figure 5;

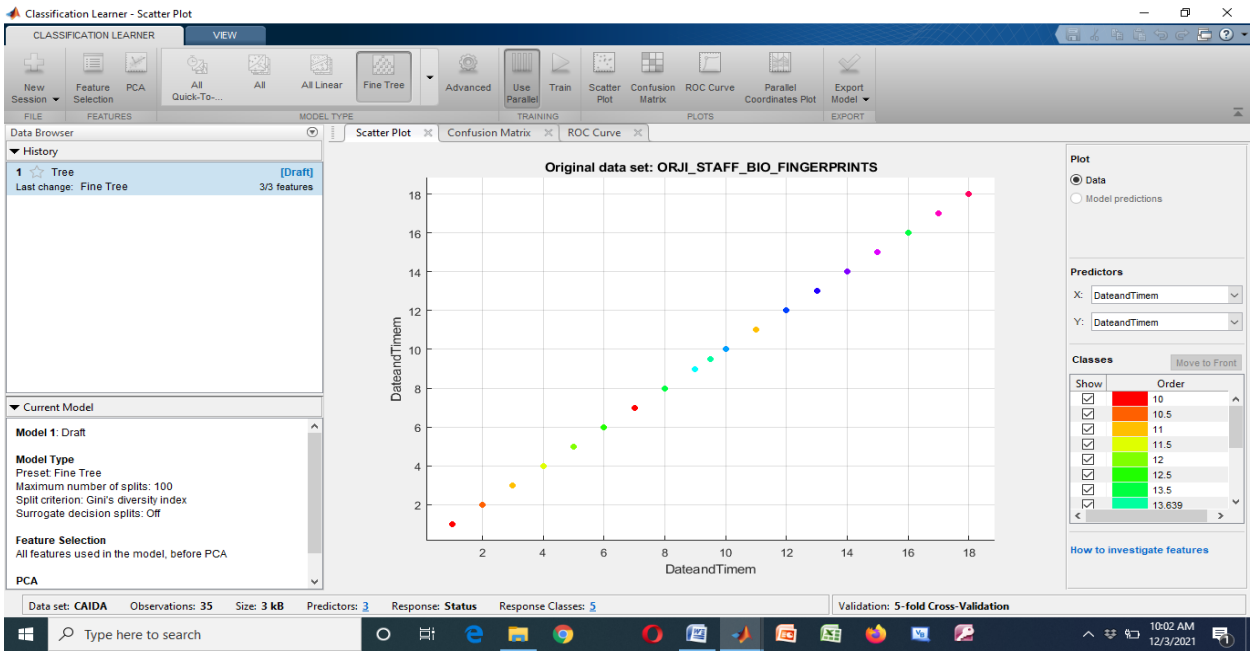

Figure 4: The classification app for training fingerprint

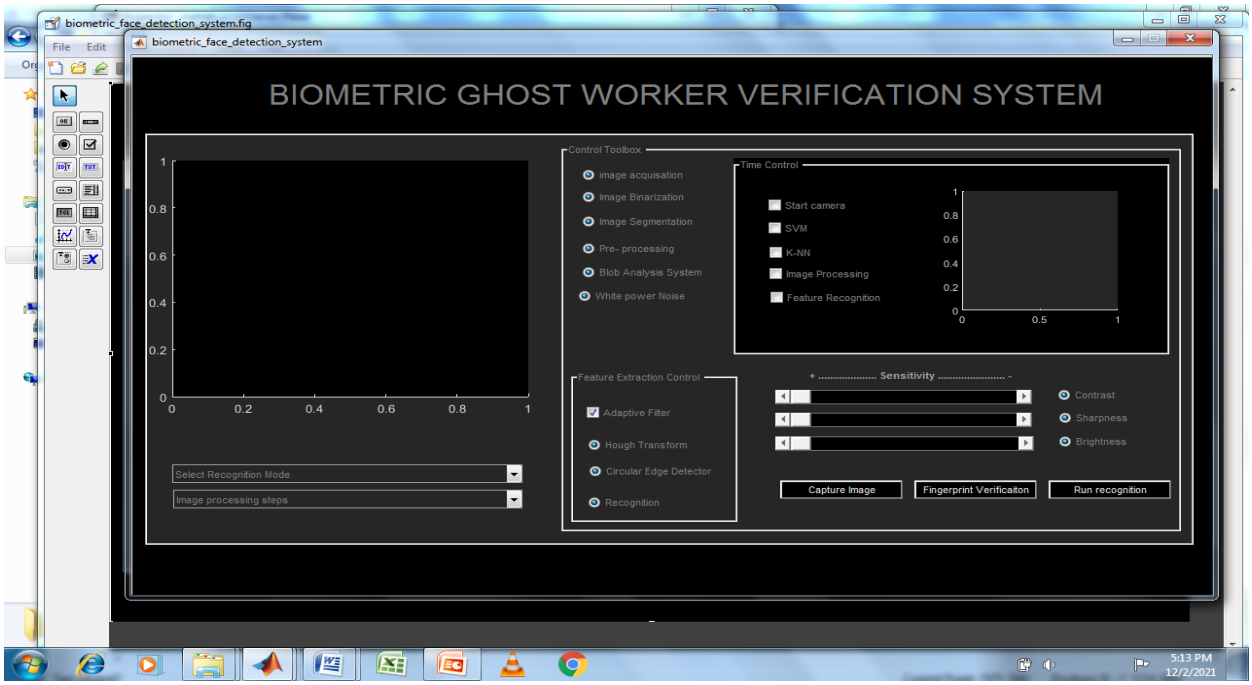

Figure 5: System implementation result

The system in figure 5 presented the ghost worker verification system. This was developed a prototype model to show the impact of the biometric system towards staff verification to eliminate ghost worker activities.

6. SYSTEM TESTING AND 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 K-NN algorithm evaluated in the section to determine how well the fingerprint data were learned for verification.

To test the performance of these algorithms, the sensitivity (true positive rate) and specificity (false positive rate) measures was used respectively. Sensitivity is also referred to as the proportion of correctly classified face, while specificity is the false positive rate is the proportion of correctly detecting a ghost worker who did not exist in the organization. These models are presented in equation 2 and 3 respectively.

$$True\ \ Positive\ Rate\ (TPR) = \frac{TP}{TP+FN} 2$$

$$False\ positive\ Rate\ (FPR) = \frac{TN}{TN+FP} 3$$

Where TP is true positive, FN is false negative, TN is true negative and FP is false positive. The overall accuracy of a classifier is estimated by dividing the total correctly classified positives and negatives by the total number of samples in the dataset. The accuracy of the classifiers was measured using the relationship between equation 2 and 3 as shown in the model of equation 4;

$$Accuracy\ (ACC) = \frac{TP+TN}{TP+TN+FP+FN} 4$$

The performance of the deep learning training algorithm was measured using the accuracy model in equation 4

To measure the performance of the K-NN training algorithm developed the models in equation 2 to 4 was used by the classification app to generate the analyzer as shown in figure 7;

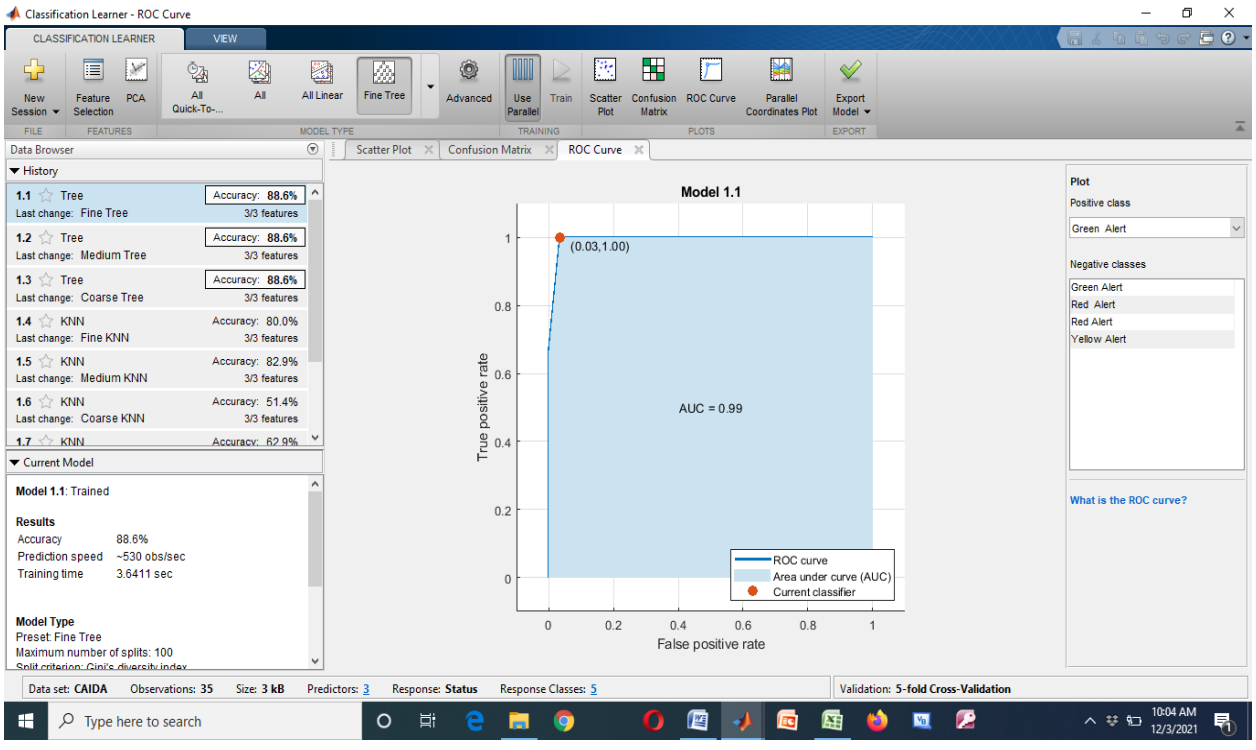

Figure 7: Training of fingerprint by the K-NN algorithm

The figure 7 presented the training performance of the K-NN algorithm. The algorithm extracted fingerprint patterns from the dataset class model and then train with the K-NN algorithm IN figure 2 into clusters. These clusters are learned and used for classification of matched staff fingerprint verification result based on the equidistance model in equation 1.

The training performance in figure 7 shows that the accuracy is 88.6% which is good; the area under curve performance which is standard to measure the correct classification of clusters in the extracted fingerprint features recorded 0.99 which is very good. The implication of the result shows that the ability of the system to verify staffs with fingerprint is very good and reliable.

The fingerprint verification system was used to verify attendance of the staffs using fingerprint data acquisition as in the figure 8;

Figure 8: The query staff fingerprint

The result in figure 8 presented the query staff finger print result showing how the fingerprint was identified by the system and the used the K-NN algorithm developed in figure 7 to train the clusters of the training and inputted query staff fingerprint using the equidistance model in equation 1 to recognize the data and make classification result as shown in figure 8;

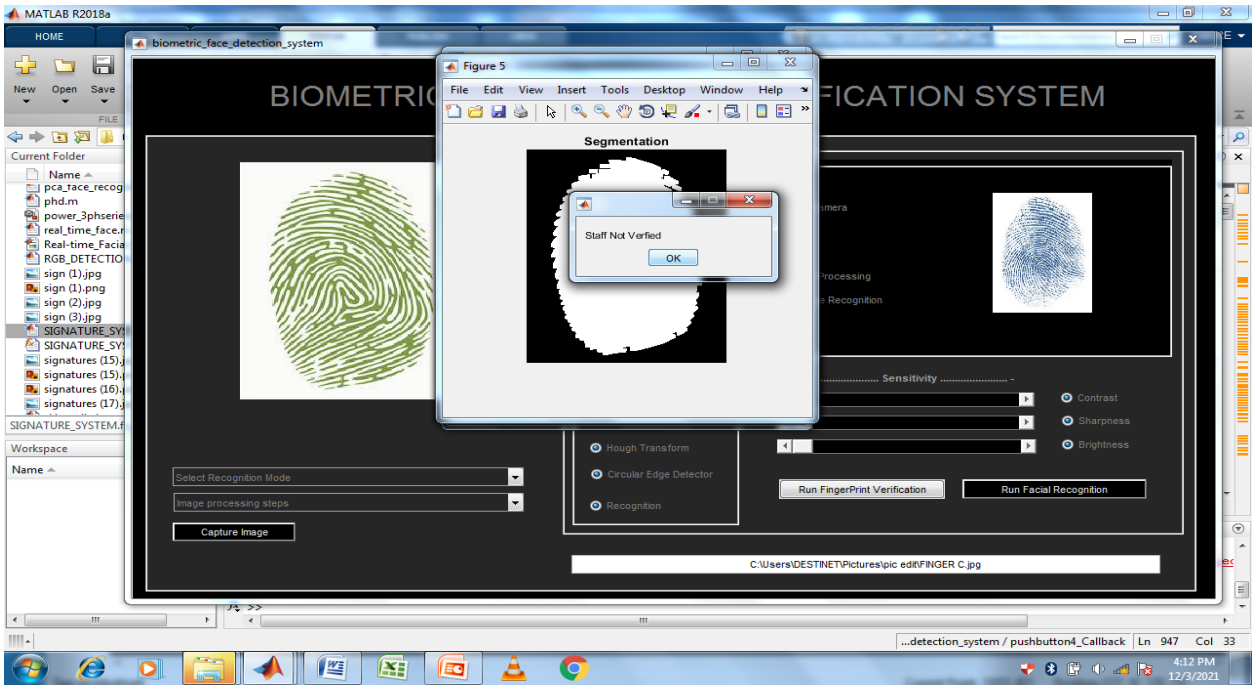

Figure 8: Result of the Staff verification system via fingerprint

From the result in figure 8 it was observed that the staff did not match the training fingerprint clusters used to develop the K-NN algorithm. The implication of the result shows that the staff is a ghost worker as the data was not in the system.

7. CONCLUSION AND RECOMMENDATION

The study has successfully developed a ghost worker detection system with repercussion for lateness and absenteeism using artificial intelligence based multi biometric technology. This was achieved using data collected from the Oji River LGA and develops a finger print verification system. The performance of the fingerprint verification accuracy was also 88.6% which is good and AUC result of 0.99 which implies high reliability. The system was deployed at the case study local government and tested with fingerprint of staffs.

8. ETHICS

The author declares no conflicting interests.

9. ACKNOWLEDGEMENT

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