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PERFORMANCE EVALUATION OF APPEARANCE AND GEOMETRY BASED ALGORITHMS FOR FACIAL FEATURE EXTRACTIONS

Ganiyu Rafiu Adesina, Adeyemo Isiaka Akinkunmi, Olabiyisi Stephen Olatunde, Akande Noah Oluwatobi

Onuiyi Road, Nsukka, Enugu State, Nigeria.

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***Corresponding Author**
Adeyemo Isiaka Akinkunmi
Onuiyi Road, Nsukka,
Enugu State, Nigeria.

ABSTRACT

Facial feature extraction is an important step towards the development of any facial recognition system. Many algorithms have been used to improve feature extraction but little research work has been done to evaluate their performances in order to determine the most efficient. This paper focuses on the performance evaluation of appearance and geometry based facial features extraction techniques using Gabor Wavelet (GW) and Local Binary Patterns (LBP) algorithms, respectively. The GW and LBP algorithms were implemented using MATLAB 8.1 (R2013a) with Euclidean distance as similarity metric between each testing and training. Each of the implemented algorithms was used to extract facial features. The GW algorithm was used to extract facial features such as projection axes, edge, valley and ridge contours while features such as histograms, pixel values, lines, edges and corners were extracted using the LBP algorithm. The results of evaluation showed that GW feature extraction technique assumed an average Computational Time of 3.92seconds while LBP yielded an average Computational Time of 6.0seconds. Also, GW yielded 56.2% False Acceptance Rate while 82.5% False Acceptance Rate was recorded for LBP. Similarly, the False Rejection Rate of GW was 88.7% while that of LBP was 48.5%. The results obtained in this study implied that GW facial features extraction technique is more efficient than LBP in terms of Computational Time, False Acceptance Rate and False Rejection Rate. Also, it could serve as a guide for researchers to choose appropriate algorithm for facial features extraction.

KEYWORDS: Facial Images, Features Extraction, Geometry features, LBP, Gabor Wavelet.

I. INTRODUCTION

The ideal of features extraction is to find a specific representation of the data that can highlight relevant information.[1] The reliability of face recognition schemes is a great challenge to the scientific community. Falsification of identity cards or intrusions of physical and virtual areas by cracking alphanumerical passwords appear frequently in the media. These problems of modern society have triggered a real necessity for reliable, user-friendly and widely acceptable control mechanisms for the identification and verification of the individual. Biometrics, which is based on authentication on the intrinsic aspects of a specific human being, appears as a viable alternative to more traditional approaches such as PIN codes or passwords.[2]

Some facial recognition algorithms identify facial features by extracting landmarks, or features, from an image of the subject's face. For example, an algorithm may analyse the relative position, size, and or shape of the eyes, nose, cheekbones, and jaw. These features are then used to search for other images with matching features. Other algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that is useful for face recognition. A probe image is then compared with the face data. One of the earliest successful systems is based on template matching techniques applied to a set of salient facial features, providing a sort of compressed face representation. Recognition algorithms can be divided into two main approaches, Geometric, which looks at distinguishing features, or Photometric, which is a statistical approach that distils an image into values and compares the values with templates to eliminate variances. Popular recognition algorithms include Principal Component Analysis using Eigen faces, Linear Discriminate Analysis, Elastic Bunch Graph Matching using the Fisher face algorithm, the Hidden Markov model, the Multi-linear Subspace Learning using tensor representation, and the neuronal motivated dynamic link matching.[8]

II. RELATED WORKS

Several works have been done in the area of features extractions and different approaches have been considered for the evaluation, in,[3] Gabor feature for face recognition from the new angle of its robustness to misalignment using a novel quantificational evaluation method combining both the alignment precision and the recognition accuracy. Their experiments showed that, the gray-level intensity, Gabor feature is much more robust to image variation caused by the imprecision of facial feature localization, which further support the feasibility of Gabor representation. Also, it was suggested in[4] that the performance of face recognition system is determined by how to extract feature vector exactly and to classify them into a class correctly. Therefore, it is necessary to pay close attention to feature extractor and classifier. They proposed a methodological improvement to raise face recognition rate by fusing the phase and magnitude of Gabor's representations of the face as a new representation, in the place of the raster image, although the Gabor representations were largely used, particularly in the algorithms based on global approaches, the Gabor phase was never exploited, followed by a face recognition algorithm, based on the principal component Analysis approach and Support Vector Machine (SVM) is used as a new classifier for pattern recognition. Local binary pattern (LBP) is a nonparametric descriptor, which efficiently summarizes the local structures of images.[5] It has aroused increasing interest in many areas of image processing and computer vision and has shown its effectiveness in a number of applications, in particular for facial image analysis, including tasks as diverse as face detection, face recognition, facial expression analysis, and demographic classification.

The classified problems of LBP feature selection techniques were categorised into two. The first one is to reduce the feature length based on some rules (like uniform patterns), while the other one exploits feature-selection techniques to choose the discriminative patterns. Both streams have their own merits and drawbacks: the first one is simple, but has limited features election ability; on the contrary, the second one has a better feature-selection capacity, but usually requires offline training that could be computationally expensive.[3]

Also in,[6] the use of Gabor wavelets for efficient face representation was established. Face recognition is influenced by several factors such as shape, reflectance, pose, occlusion and illumination which make it even more difficult. Today there exist many well-known techniques to try to recognize a face. The introduction of the Gabor wavelets for an efficient face recognition system by simulating human perception of objects and faces. The demonstrated technique was technically feasible to scan pictures of human faces and compared them with ID photos hosted in a centralized database using Gabor wavelets.

Similarly, the approach appears to be quite perspective, insensitive to small changes in head poise and homogenous illumination changes, robust against facial hair, glasses and also generally very robust compared to other methods. However it was found to be sensitive to large facial expression variations. Also, it was found that placement of wavelets should be consistent for efficient recognition. It is worth mentioning that Gabor wavelets technique has recently been used not only for face recognition, but also for face tracking and face position estimation.[6] Face recognition using both shape and texture information empirically evaluated to represent face images based on Local Binary Patterns for person independent face recognition. The face area is first divided into small regions from which Local Binary Patterns (LBP), histograms are extracted and concatenated into a single feature vector. This feature vector forms an efficient representation of the face used to measure similarities between images.[7] A comparison was explored in[8] between geometry-based and Gabor-wavelets-based facial expression recognition system without dealing with facial expression information extraction in an automatic way. They use 34 facial points for which a set of Gabor wavelet coefficients is extracted. Wavelets of three spatial frequencies and six orientations have been utilized. Furthermore,[8] deal only with pixels frontal view images of nine female Japanese subjects, manually normalized so that the distance between the eyes is 60 pixels.

III. RESEARCH METHODOLOGY

The research approach to carry out the performance evaluation of Feature extractions consists of Face Acquisition, Face Pre-processing, Feature Extraction, Training and Feature matching/ Recognition.

i. **Face acquisition:** Facial images of 175 students of Computer Science and Engineering, Department of Ladoke Akintola University of Technology, ogbomoso was used as a case study with a SAMSUNG 201 digital camera and normalized to a uniform size of 300 x 300 pixels Images and converted into values suitable for processing by the computer.

ii. **The pre-processing** of the face images used to create the training database was performed, pre-processing automatically reduces every face image size in order to enhance the data. The pre-processing steps considered are:

(a) **Cropping:** face images were cropped out from the original captured images of 450 x 450 pixels to 300 x 300 pixels in order to extract major features like axes, edge, valley and ridge contours, histograms, pixel values, lines, edges.

(b) **Grayscale conversion:** The captured coloured images were converted into grayscale of two dimensional to suitable for the face processing.

(c) **Conversion:** The face images were converted 2D (dimensions matrix) into 1 dimension vector and all the images were grouped into a large matrix.

iii. **The feature vector:** The feature vector of the faces were extracted from each face image. GW and LBP algorithms were employed in obtaining the Eigen faces that represent significant features which enhanced the extractions stages.

iv. **Training:** 100 images were used for training while the remaining 75 images were used for testing purposes. The GW algorithm was used to extract facial features such as projection axes, edge, valley and ridge contours while features such as histograms, pixel values, lines, edges and corners were extracted using the LBP algorithm. The collected black facial images were used to train the Images employed into the Gabor Wavelet (Geometry based features extraction method) and the Local Binary Pattern (Appearance based features extraction method) techniques which were later implemented on a MATLAB 8.1.604 (R2013a) programming environment. Figure 1 shows MATLAB interface of the process, Figures 2 and 3 also showed how the processes are be implement during the experiments.

v. **Feature matching:** This is the actual recognition process. The feature vector obtained from the feature extraction was matched into classes (persons) of facial images already enrolled in a database.

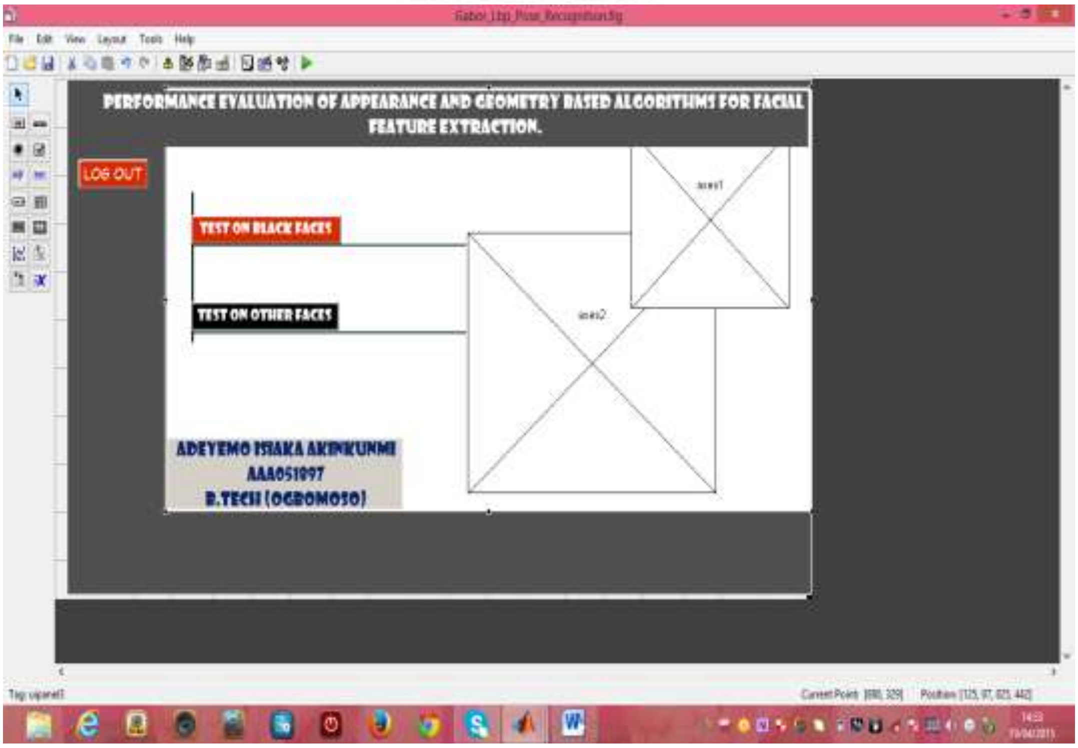

Fig. 1: MATLAB interface of the Acquisition process.

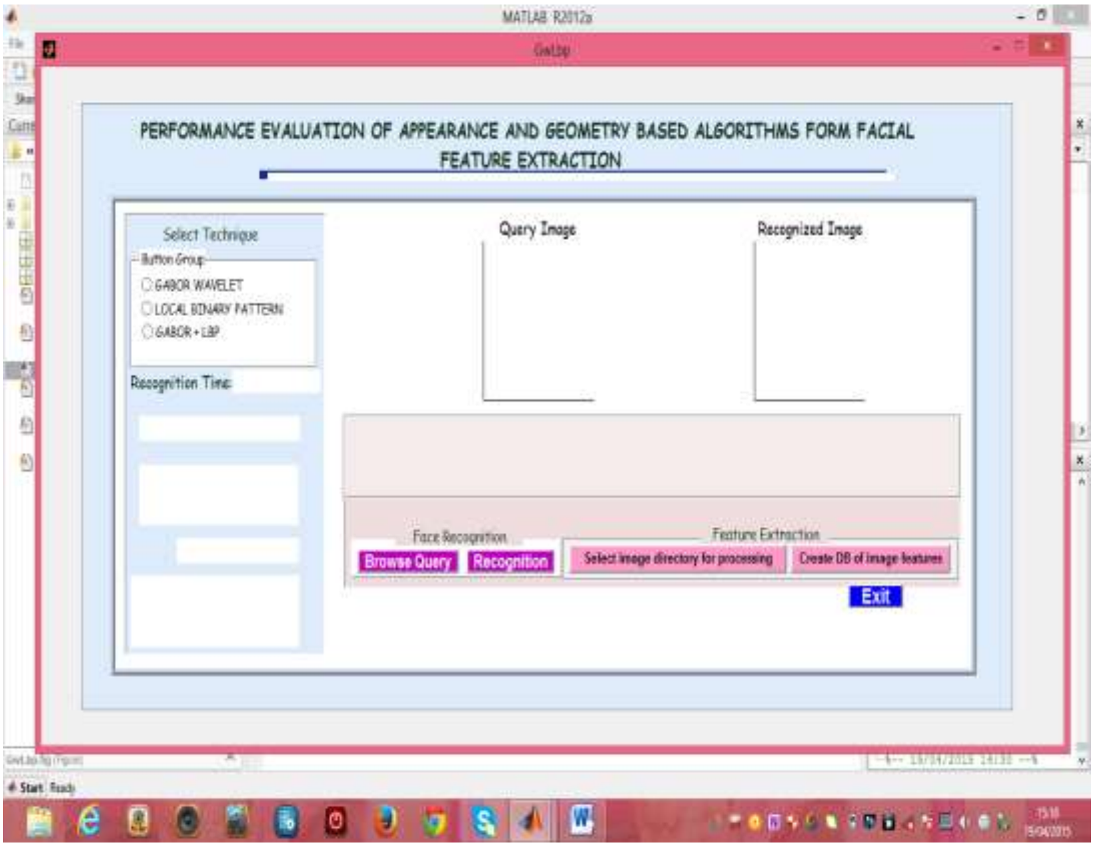

Fig. 2: Implementation Process of GW and LBP.

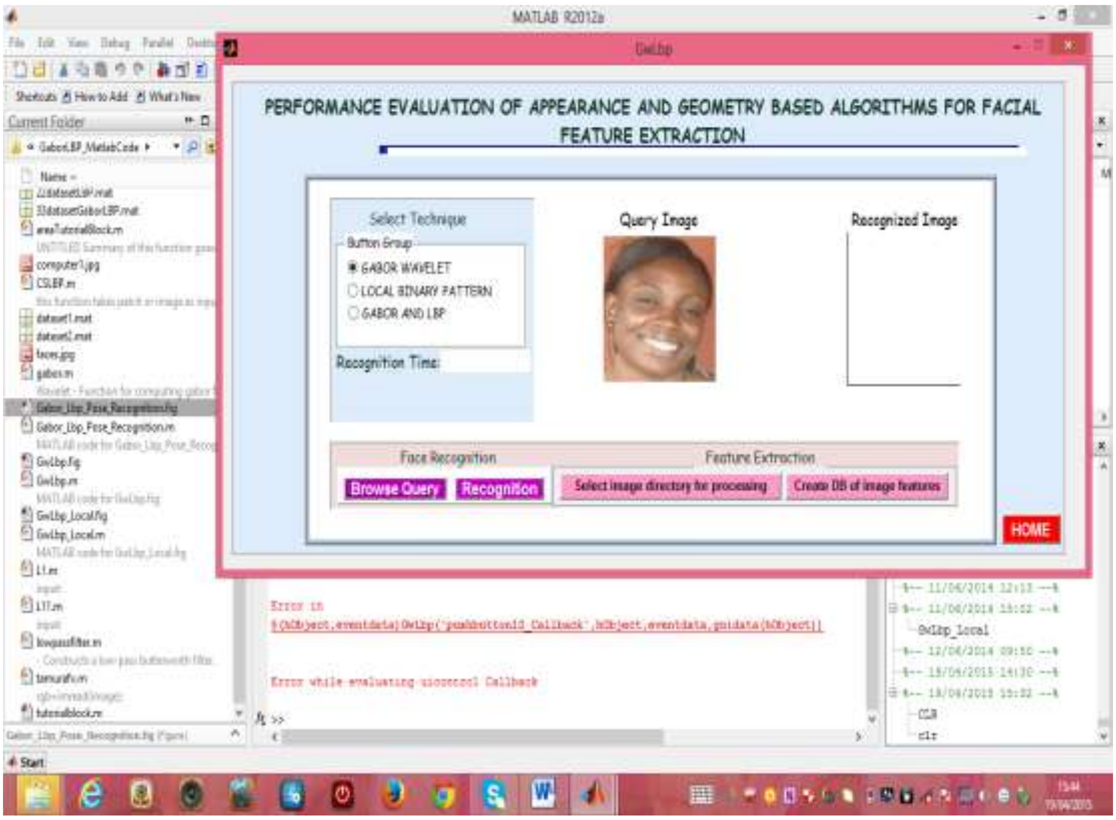

Fig. 3: Implementation Process of feature Matching.

A. Similarity Measures of GW and LBP Eigen Vector

Eigenvector were calculated using LBP, GW algorithm and experiment were performed by varying the number of eigenvectors used to calculate the feature of the images. Facial images in the training stage were projected onto the eigenvectors to obtain a set of weight (feature vectors). The face was recognized by finding the different between the projected training and testing images using Euclidean distance as similarity measuring technique.

- **Algorithm 1: GW**

The implementation of Gabor Wavelet was carried as enumerated:

1) The images were fed into the developed features extraction platform; this involved specifying the images filename
2) An interface that showed selected images was displayed
3) The initial points that was employed to extract the wavelet features on the facial images was determined
4) The dimensions of the inner region of the face depending upon the ratios of the distances between the wavelet points were calculated. A selection of 3X 3 points gives the ideal trade-off between image representations
5) The set of frequencies are chosen from $\frac{1}{16}$ to $\frac{1}{2}$
6) The number of orientations is chosen to be 6
7) Total number of iterations is 16 * 6 * 10 (*P***Q***R*). Successive images of the reconstruction process
8) This images were written and named appropriately by the program; specifying the number of wavelet points, number of frequencies used and number of different orientations chosen
9) As the reconstruction process took place, the projections (weights) are calculated. These weights are stored in an array and the array was bubble sorted and the highest 50 projections (in terms of magnitude) and corresponding frequencies and orientations were chosen. These 150 parameters form the feature vector which is fed to the black database.

- **Algorithm 2: LBP**

Input: Training Images

Output: Feature extracted from face image and compared with centre pixel and recognition with unknown face image

1. Initialize temp = 0

2. FOR each image I in the training image set
3. Initialize the pattern histogram, H = 0
4. FOR each centre pixel tc Є I
5. Compute the pattern label of tc, LBP (1)
6. Increase the corresponding bin by 1
7. END FOR
8. Find the highest LBP feature for each face image and combined into single vector
9. Compare with test face image
10. If it matches it most similar face in database then successfully recognized.

IV. RESULTS AND DISCUSSION

The results of this research work were evaluated based on the following parameters: Computational Time, False Acceptance Rate and False Rejection Rate. Experiments were conducted on the images using GW and LBP techniques. Three selected eigenvectors: 240, 120 and 60 were considered for each of the algorithms. This was taking into consideration the effects of the selected size of eigenvectors on the parameters.

In Tables 4.1, 4.2 and 4.3, the result showed that GW, LBP had the Computational time of 3.92seconds, 6.0seconds. False acceptance Rate of 56.2%, 82.5% and False Rejection Rate of 88.7%, 48.5%. When 100 of eigenvectors were selected, we had 70.49, 60.0%, 70, 55.0% and 65%, when 50 eigenvectors were selected, we had 60.0, 71.0%, 73.0, 59.0% and when 25 of eigenvector were selected, we had 53.0, 60.0%, 61.0, 59.0%

The system also had the recognition time 10.3 seconds, 14.5 seconds and 52.4seconds when 100 eigenvectors were selected for the training while 8.3seconds, 9.2seconds and 50.2seconds were acquired for 75 eigenvectors.

Table 4.1: Simulation Results for 300 x 300 pixels for 275 selected eigenvectors.

	TNI	TTI	RR (%)	EV	TR(secs)	CT	FRR(%)	FAR(%)
GW	275	100	138.7	275	3.92	3.92	56.2	88.7
LBP	275	100	137.2	275	6.0	6.0	82.5	48.5

Table 4.2: Simulation Results for 300 x 300 pixels for 100 selected eigenvectors.

	TNI	TTI	RR (%)	EV	TR (secs)	CT	FRR (%)	FAR (%)
GW	275	100	70.49	100	3.92	10.3	70.0	60.0
LBP	275	100	70.0	100	6.0	14.5	82.5	55.0

Table 4.3: Simulation Results for 300 x 300 pixels for 50 selected eigenvectors.

	TNI	TTI	RR (%)	EV	TR(secs)	CT	FRR (%)	FAR (%)
GW	275	100	65.3	50	3.92	10.3	60.0	71.0
LBP	275	100	55.2	50	6.0	14.5	73.0	59.0

V. CONCLUSION AND FUTURE WORK

This paper has successfully evaluated the appearance and geometry based algorithms for facial feature extraction based on the following parameters: Computational Time, False Acceptance Rate and False Rejection Rate. Experiments were conducted on the images using GW and LBP techniques. Three selected eigenvectors: 240, 120 and 60 were considered for each of the algorithms. This was taking into consideration the effects of the selected size of eigenvectors on the parameters. Also, experiment showed that GW and LBP have comparable performance with the similarity measures considered in facial features training and testing with significant speed improvement because they did not have learning phase where they can be repeatedly learn. Conclusively, this work evaluated the efficiencies of Appearance and Geometry based features extraction techniques.

The results obtained imply that GW facial features extraction technique is more efficient than its LBP counterpart. However, it is recommended that use of more morphological technique for feature extraction could be considered for the improvement on the recognition accuracy of different extraction and LBP and GW can also be used for the Hybridization of two algorithms in facial features implementation.

REFERENCES

1. Arun Ross., “Face Recognition: the Path Forward”. A publication of the IEEE Computer society, 2010; 10: 30-35.
2. Ahonen, T., Hadid, A., Pietikainen, M, “Face Recognition with Local Binary Patterns”, In: Pajdla, T., Matas, J(G.) (eds.), 2007; 3021: 469-481.
3. Shiguang, Wen, Yizheng, Bo, and Pang: “Strength of Gabor Feature Extraction for Face Recognition’’, International Journal of Innovative Technology and Exploring Engineering (IJITEE), 2004; 2: 76-78.
4. Bermani, Ghalwash and Youssif: “an Automatic System for Facial ExpressionRecognition’’, International Journal of Electronic Imaging, 2012; 8: 1-15.
5. Huang, J. “Detection strategies for Face Recognition using Learning and Evolution”, Unpublished Ph.D thesis, George Mason University. Washington D.C., 2011.

6. Kumar and Murthy "Gabor Wavelets for Efficient Face Representation by Several Factors", International Journal of Engineering and Technology (IJET), 2006; 5: 27-36.
7. Rahim, Azam, Hossain and Islam: "Empirical Evaluation of Face Recognition", 2013.
8. Lee. T, "Image Representation using 2D Gabor Wavelets.", IEEE Transactions of Pattern Analysis and Machine Intelligence, 1996; 18: 156-158. for both Shape and Texture Information '', Symposium on Bio-inspired learning and intelligent systems for security, IEEE computer society, 4: 188-201.
9. Zhang & Gao: Critical Survey of Researches on Image-based Face Recognition across Pose'', International Journal of Innovative Technology and Engineering (IJITE), 2009; 10: 108-201.

BIOGRAPHY

Adeyemo I. A is Assistant Lecturer in University of Nigeria, Nsukka, Enugu State, Nigeria. He graduated with B. Tech and M. Tech, from Computer Science and Engineering Department, Ladoke Akintola University of Technology, Ogbomoso, Nigerian the year 2010 and 2015 respectively. He is presently pursuing his Ph.D in the same institution. His research interests are Biometrics information, Pattern Recognition, Data and Information Security. He can be reached through this email: isiaka.adeyemo@unn.edu.ng.

Ganiyu R. A. is a Senior Lecturer in the Department of Computer Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. He graduated with a B.Tech. degree in Computer Engineering from Ladoke Akintola University of Technology,Ogbomoso, Nigeria in 2002. Also, he obtained M. Tech and Ph. D degrees in computer science from Ladoke Akintola University of Technology, ogbomoso, Nigeria, in 2008 and 2012 respectively. He has published in reputable (local and international) journals. His research interests include: Modelling and Simulation of physical Systems Using Petri Nets, Biometrics-based algorithm and its applications, Dynamic programming as well as Microprocessor system design. He belongs to the following professional bodies: Full member, Computer Professionals (Registration) Council of Nigeria (MCPN); Registered Engineer, Council for the Regulation of Engineering in Nigeria (COREN). He can be reached through this email: raganiyu@lautech.edu.ng.

Olabiyisi, S. O. received his B. Tech., M. Tech and Ph.D degrees in Mathematics from Ladoke Akintola University of Technology, Ogbomoso, Nigeria, in 1999, 2002 and 2006 respectively. He also received M.Sc. degree in Computer Science from University of Ibadan,

Ibadan, Nigeria in 2003. He is currently a Professor in the Department of Computer Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. He has published in reputable journals and learned conferences. Prof. Olabiyisi is a full member of Computer Professional (Registration) Council of Nigeria (CPN). His research interests are in computational mathematics, theoretical computer science, information systems and performance modelling and simulation. He can be reached through this mail: soolabiyisi@lautech.edu.ng.

Akande N. O is Assistant Lecturer in Landmark University, Omu-aran Kwara State. He graduated with B. Tech and M. Tech, from Computer Science and Engineering Department, Ladoke Akintola University of Technology, Ogbomoso, Nigerian the year 2010 and 2015 respectively. He is presently pursuing his Ph.D in University of Ilorin. His research interests are Biometrics information, Pattern Recognition, Data and Information Security. He can be reached through this email: akande.oluwatobi@lanmark.edu.ng.