FACIAL RECOGNITION SYSTEM: A SHIFT IN STUDENTS ATTENDANCE MANAGEMENT

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ABSTRACT: It was observed that the habitual method of taking attendance easily allow impersonation and time consuming. In the global community, various facial recognition based attendance frameworks have being proposed and successfully implemented, many of which are of one limitation or the other. Hence, this study proposed a multi-algorithm approach to design and implement an automated and reliable system using biometric for effective attendance taking in Nigerian institutions. The system employed bimodal biometric technique for combining Principal Component Analysis (PCA) with Histogram of Oriented Gradient (HOG) for feature extraction and Artificial Neural Network (ANN) combined with Support Vector Machine (SVM) for classification. For the design and implementation, the system made use of the in-built webcam to capture its images for enrolment and verification. The system was trained with five hundred registered and fifty unregistered facial images;
KEYWORDS: PCA, HOG, ANN, SVM, C#, SQL.

1. INTRODUCTION

Detection of human beings via biometric know-how is becoming universal with diverse biometric technologies like finger, face, voice, iris, DNA etc. and the use of behavioral or physiological characteristics of human beings for recognition is increasing. With increase in the use of information technology and need to safeguard data, the archaic practice of recognition such as Token-based and Knowledge-based system of recognition has played a vital role, but these methods of recognition have flaws ([SD13]). However, biometrics provides solution to these snags. Nonetheless, individuals have distinctive and unique traits that can be used to distinguish them from other human beings, acting as a form of identification ([Oye15]). Biometric systems are popular methods for personal identification; biometric system works by capturing and storing the biometric information and then comparing the scanned biometrics with what is stored in the repository ([SD13]).

Human beings have always had the ability to recognize and distinguish between face features and with advent of machine and deep learning, computers have been shown to have the same ability to recognize and distinguish between face features. In the mid of 1960s, scientists began work on using the computer to recognize human faces, since that time, the facial recognition software has come a long way that the government and private corporations start to use the facial recognition system ([SO19]). In recent years, facial recognition has received substantial attention from researchers in biometrics, pattern recognition, and computer vision communities ([Asm14]). The machine learning and computer graphics communities are also increasingly involved in facial recognition. This common interest among researchers working in diverse fields is motivated by the remarkable ability to recognize people and the fact that human activity is a primary concern both in everyday life and in cyberspace. Besides, there are large numbers of commercial, security, and forensic applications requiring the use of facial recognition technologies ([Asm14]).

It is a true challenge to build an automated system with equal human ability to recognize faces although humans are quite good identifying known faces but are not very skilled when dealing with a large number of unknown faces ([Asm14]). The computers, with an almost limitless memory and computational speed, should overcome these human limitations. Thus, face recognition remain a demanded technology as there are many different industrial areas that are interested in what it could offer. Some examples include video surveillance, human-machine interaction, photo cameras, virtual reality or law enforcement ([S+15]). This multidisciplinary interest instigates research and attracts interest from diverse disciplines. Therefore, it is not a problem that is restricted to computer vision research as face recognition is a relevant subject in pattern recognition, neural networks, computer graphics, image processing and psychology ([C+10]).

2. EXISITNG MEASURES

Many researchers proposed numerous methods for student attendance automation such as Fingerprint-Based by ([A+13]), Android Platform by ([K+14]), Radio Frequency Identification Technology (RFIT) by ([PPG12]). Fingerprint technology for student attendance management has been found out that is time consuming and prone to error; as students have to be verified in real time after enrolment one after the other even before or after the commencement of the lecture which is an obstruction to other classes. Other biometric techniques like Hand Geometry, Retinal Pattern, Signature, Gait, DNA, Iris, and Palm Print recognitions among others are much more expensive to implement and as a matter of fact, it has been regarded as intrusion to one's privacy at the highest level.

A new method which uses Principal Component Analysis with Artificial Neural Network for the purpose of face recognition in Attendance management was introduced ([KP14]). Additional to it they also introduce a function which analyzes the percentage of attendance for a student. ([KP14]) recognition accuracy was not recorded in their study. System provides features such as detection of faces, extraction of the features, detection of extracted features, analysis of students' attendance and monthly attendance report generation was proposed ([S+15]). The proposed system ([S+15]) integrates techniques such as image contrasts, integral images, Ada-Boost, Haar-like features and cascading classifier for feature detection. Faces are recognized using advanced LBP using the database that contains images of students and is used to recognize student using the captured image. Better accuracy is attained in results and the system takes into account the changes that occur in the face over the period of time with recognition accuracy of 83.2%.

How to take student's attendance using face recognition was described by ([KB15]). The face recognition is implemented with the help of Principal Component Analysis (PCA) algorithm. The system will recognize the face of the student and saves the response in database automatically. The system also includes the feature of retrieving the list of students who are absent in a particular day with recognition accuracy of 94%.

In order to solve the problem of low accuracy of face recognition under non – restrictive conditions, a new method of face recognition based on Haar feature classifier, HOG feature extraction and fast-PCA dimension reduction is proposed ([LL17]) in their study titled Face Recognition Based on HOG and Fast PCA Algorithm. Firstly, the Haar feature classifier is used to extract the background interference data at the same time in the original data preprocessing stage. Then, the feature data of the face is extracted by the method of HOG feature extraction. Then, the extracted data PCA algorithm is reduced the size of the final use for the training and testing of the amount of data. Finally, the use of SVM algorithm is to identify and identify the face. It is verify the effectiveness of the method with the experimental results.

([AP17]) also implemented a facial recognition system using a global-approach to feature extraction based on Histogram-Oriented Gradient. They extracted the feature vectors for various faces from the AT and T and Yale databases and used them to train a binary-tree structure SVM learning model. Running the model on both databases resulted in over 90% accuracy in matching the input face to the correct person from the gallery. They noted one of the shortcomings of using a global approach to feature extraction, which is that a model trained using a feature vector of the entire face instead of its geometrical components makes it less robust to angle and orientation changes. However, when the variation in facial orientation is not large, the global-approach is still very accurate and simpler to implement than component-based approaches.

The design and use of face recognition for the purpose of attendance marking is a smart way of student attendance management system which has not been generally implemented in institutions across a developing country like Nigeria, this is the thrust of this study

3. METHODOLOGY

In order to accomplish the objectives of this study, a review of the existing system of taking attendance was done. The model for the automated student attendance management was design using facial recognition approach (see figure 1 below). The model was implemented using C#. Histogram of Oriented Gradient (HOG) combined with Principal Component Analysis (PCA) was used for feature extraction and Support Vector Machine (SVM) combined with Artificial Neural Networks (ANN) was used for classification. The recognition accuracy of the system was evaluated using the following metrics: False Acceptance Rate (FAR), False Rejection Rate (FRR), Execution Time (ET) Total Percentage Accuracy (TPA) and Equal Error Rate (EER).

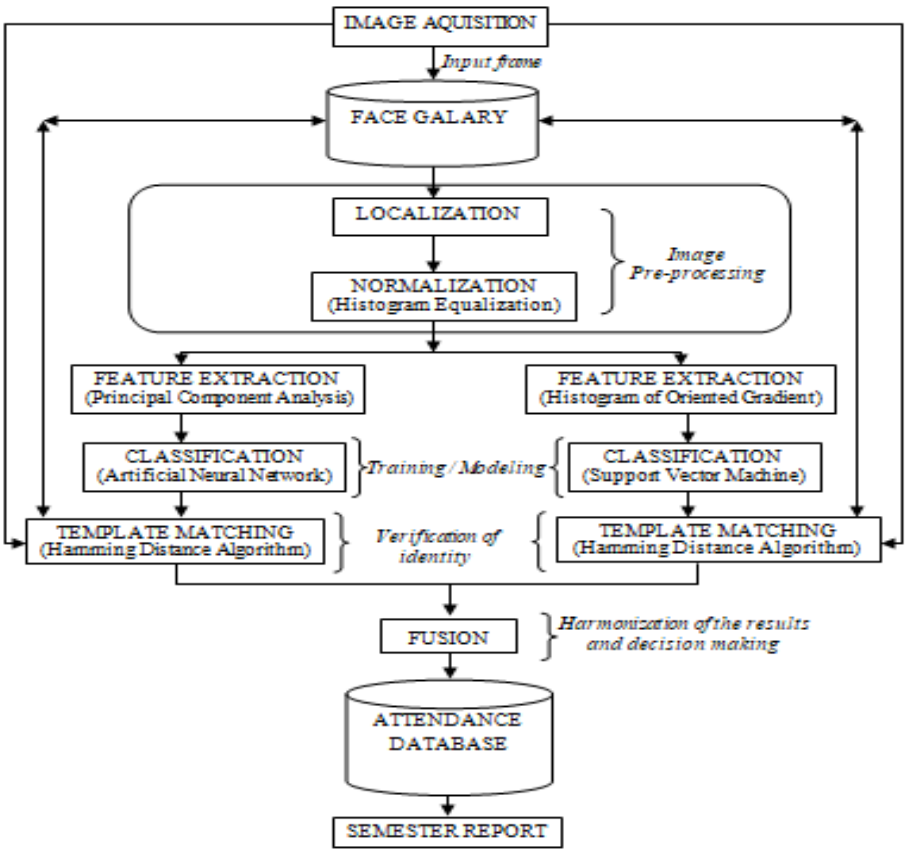

Figure 1: The proposed framework for computerized student attendance management system

4. RESULT AND DISCUSSION

The experiment was conducted in accordance to the proposed framework (see Figure1). Thus, the implementation of the framework was done using C# on Microsoft Visual Studio 2015 platform while the database was implemented on Microsoft SQL server 2012. The experiment was performed using single image, the image was localized and normalized using histogram equalization algorithm. The facial features of the normalized image was extracted using principal component analysis algorithm combined with Histogram of Oriented Gradient while the extracted features were classified using artificial neural network combined with support vector machine, template of the original image and verified image was matched (template matching) using Hamming Distance Algorithm. The result of the experiment was mainly used to update the database (that is, to establish the absenteeism and presence of a particular student in a specified class/lecture room).

A. Total Time Execution

The recognition time for the input image was approximately 2.00 seconds while it took approximately 4. 00 seconds to verify the image.

B. False Acceptance Rate (FAR)

The False Acceptance Rate is to measure the likelihood that this system will incorrectly accept an access attempt by an unauthorized user. It is the ratio of the number of false acceptances divided by the number of identification attempts. For the purpose of this study, five hundred facial images were registered and verified, in which one of the unregistered image were accepted. Hence,

$$\text{FAR} = \frac{\text{Number of false accepted image}}{\text{Number of registered image}} \text{ X } 100 \quad (1)$$

$$\text{FAR} = \frac{1}{500} \text{ X } 100$$

$$\text{FAR} = 0.002 \text{ X } 100$$

$$\text{FAR} = 0.2\%$$

C. False Rejection Rate (FRR)

The false recognition rate is to measure the likelihood that this system will incorrectly reject an access attempt by an authorized user. It is the ratio of the number of false recognitions divided by the number of indentification attempts. For the purpose of this study, five hundred facial images were registered and verified, in which fifteen of the registered image were rejected. Hence,

$$FRR = \frac{\text{Number of false rejected image}}{\text{Number of registered image}} X\ 100 \quad (2)$$

$$FRR = \frac{15}{500} X\ 100$$
$$FRR = 0.03\ X\ 100$$
$$FRR = 3\%$$

D. Recognition Accuracy

Recognition accuracy of this system is the total percentage of the correct recognitions of the system. Recognition accuracy is defined as follows:

$$RA = (100 - (FAR + FRR))\ \% \quad (3)$$

Recall: FAR = 0.2% while FRR = 3%

$$RA = (100 - (0.2 + 3))\ \%$$
$$RA = (100 - 3.2)\ \%$$
$$RA = 96.8\%$$

E. Equal Error Rate (EER)

Equal error rate (EER) is a biometric security system algorithm metric used to predetermine the threshold values for its false acceptance rate and its false rejection rate. When the rates are equal, the common value is referred to as the "*equal error rate*". *The equal error rate of this* system is calculated to be 0.3% (see figure 2 below).

Figure 2: Equal Error Rate

([K+12]) in their research on Study of Implementing Automated Attendance System Using Face Recognition Technique described a method for Student's Attendance System which is integrated with the face recognition technology using Personal Component Analysis (PCA) algorithm with recognition accuracy of 95%. Also, ([KB15]) described how to take student's attendance using face recognition. The face recognition is implemented with the help of Principal Component Analysis (PCA) algorithm and documented recognition accuracy of 94%. Moreover, ([S+15]) proposed system integrates techniques such as image contrasts, integral images, Ada-Boost, Haar-like features and cascading classifier for feature detection and the system recognition accuracy is 83.2%. Moreover, ([DR16]) introduced face detection method using the Voila and Jones algorithm and recognition using correlation technique with recognition accuracy of 81.88%. Furthermore, ([AP17]) also implemented a facial recognition system using a global-approach to feature extraction based on Histogram-Oriented Gradient. Running the model resulted in over 90% accuracy in matching the input face to the correct person from the gallery. Thus, the results of the experiment of this study indicate that this system is faster and accurate than its contemporaries. And as a result it will be sufficient for any institution to replace this system with the orthodox method of students' attendance management.

5. CONCLUSION

A bimodal biometric system through the amalgamation of two algorithms at the feature extraction and classification stage in a more secure environment has been design and implemented successfully and it is found to overcome the drawback of the traditional students' attendance management. The experimental result of this study indicates that through the combination of multiple algorithms, this system improve the matching performance, the issue of illumination and deter spoofing. The approach considerably reduces the computation time and improves the recognition accuracy. Moreover, this automated attendance system is quite simple requiring few components and is effective and efficient enough to be integrated within academic environment. The experimental results are encouraging and the comparison with some algorithm indicates that this method is comparable to them and the output of this research is satisfactory.

Based on the results of this study, it therefore recommended that future researcher should venture into combination of algorithms so as to take care the issue of posing and illumination as it is one of the major drawbacks in this face recognition system. Also, it is recommended that future researchers should use many facial images as much as possible for the training and testing to attain better authentication of the system.

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REFERENCES

[Asm15] **Asmahan M. A**. - *Face Recognition Techniques - An Evaluation Study*, International Journal of Advanced Networking and Applications Volume: 6 Issue: 4 Pages: 2393-2397, ISSN: 0975-0290, 2015.

[AP17] **Arun G., Peter C.** - *Face Recognition using Machine Learning*. http://noiselab.ucsd.edu/ECE285/FinalProjects/Group7.pdf, 2017, retrieved November 23rd, 2018.

[A+13] **Akinduyite C. O, Adetunmbi A. O, Olabode O. O., Ibidunmoye E. O**. - *Fingerprint-Based Attendance Management System*. Journal of Computer Sciences and Applications, 1(5): 100-105, 2013.

[C+10] **Chang H., Koschan A., Abidi B., Abidi M**. - *Fusing Continuous Spectral Images for Face Recognition under Indoor and Outdoor Illuminants*. Machine Vision and Applications, 21(2): 201–215, February 2010.

[DR16] **Deshpande1 N. T., Ravishankar S.** - *Face Detection and Recognition using Viola-Jones algorithm and fusion of LDA and ANN*. OSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 18, Issue 6, Ver. II (Nov. - Dec. 2016), pp 01-06 www.iosrjournals.org, 2016.

[KB15] **Krishnan M. G., Babu B. S.** - *Implementation of Automated Attendance System using Face Recognition*. International Journal of Scientific and Engineering Research, Volume 6, Issue 3, ISSN 2229-551.8, 2015.

[KP14] **Kanti J., Papola A.** - *Smart Attendance using Face Recognition with Percentage Analyzer*. International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 6.2014.

[KKA10] **Khan B., Khan M. K., Alghathbar K. S.** - *Biometrics and Identity Management for Homeland Security Applications in Saudi Arabia*. African Journal of Business Management, Vol. 4(15), pp. 3296-3306, 2010.

[K+12] **Kar N., Debbarma M. K., Saha A., Pal D. R.** - *Study of Implementing Automated Attendance System Using Face Recognition Technique.* International Journal of Computer and Communication Engineering, 1(2), 2012.

[K+14] **Kumbhar A., Wanjara K., Trivedi D., Khairatkar A., Sharma D.** - *Automated Attendance Monitoring System using Android Platform*. International Journal of Current Engineering and Technology, E-ISSN 2277 – 4106, P-ISSN 2347 – 5161, 2014.

[LL17] **Li S., Lin L.** - *Face Recognition Based on HOG and Fast PCA Algorithm*, Proceedings of the fourth Euro-China Conference on Intelligent Data Analysis and Applications www.springer.com/cda/content/document/cda_downloaddocument/9783319685267-c2.pdf?SGWID=0-0-45-1619846-p181166638 retrieved Nov 2017.

[Oye15] **Oyeniran O. A.** - *Multi-Algorithmic Feature Extraction Technique for Personal Recognition using Iris*, 2015.

[PPG12] **Patel R., Patel N., Gajjar M.** - *Online Students' Attendance Monitoring System in Classroom Using Radio Frequency Identification Technology: A Proposed System Framework.* International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, Volume 2, Issue 2 Pp 61, 2012.

[SO19] **Sotonwa K. A., Oyeniran O. A.** - *Feature Extraction and Classification Technique for Multi-Algorithm Facial Recognition System*, International Journal of Latest Technology in Engineering, Management and Applied Science-IJLTEMAS, 8(2): 06-10 http://www.ijltemas.in/DigitalLibrary/Vol.8Issue2/06-10.pdf, retrieved Feb 2019.

[SD13] **Swati S., Deepak G.** - *Iris Recognition using Gabor*. International Journal of Computer Technology and Application, Vol 4 (1), 2013, 1 – 7 ISSN: 2229-6093.

[S+15] **Shirodkar M., Sinha V., Jain U., Nemade B.** - *Automated Attendance Management System using Face Recognition.* International Journal of Computer Applications (0975 – 8887) International Conference and Workshop on Emerging Trends in Technology, 2015.