Design of a Face Recognition System for Security Control

Ambrose A. Azeta, Nicholas A. Omoregbe, Adewole Adewumi, Dolapo Oguntade
Department of Computer and Information Sciences,
Covenant University,
Ota, Ogun-State, Nigeria
ambrose.azeta@covenantuniversity.edu.ng, nicholas.omoregbe@covenantuniversity.edu.ng
wole.adewumi@covenantuniversity.edu.ng, dooguntade@gmail.com

Abstract **- Although the recognition of human beings is something quite easy for humans, the ability for machines to recognise people is still a challenging problem; hence it has been receiving significant attention in recent years. Face recognition is one of those challenging issues. Given the fact that human recognition of faces is critical for humans in their everyday life, automating the process of facial recognition is very useful in a wide range of applications ranging from human-machine interfaces and automatic access control systems used for security and criminal identification. To the best of our knowledge, there is no form of facial recognition for identifying criminals in the Nigerian Police Force. The method of criminal record keeping in the country is still manual. Citizens go through manual filling of forms and writing of statements. This is slow and inefficient and sometimes lead to breach of protocols in some crime cases particularly by an insider, or even someone from the outside. The objective of this paper is to design a face recognition system for security control in Nigeria. When fully implemented, we believe the system will go a long way in assisting the security personnel in performing a productive and efficient delivery of better services to citizens. The system will also help in the keeping of criminal records and crime cases by detecting the faces of the perpetrators and masterminds of such crimes, thereby ensuring they are caught and dealt with according to the laws of the country.**

Index Terms – Biometrics, Crime, Face, Recognition and Security

I. INTRODUCTION

Online Biometric security system is one of the tools that Information Technology (IT) is trying to maximise to full potential [1]. Today, security is one of the most important challenges we face in the day-to-day activities of life; there are several security systems, most of which are either electronic or manual. However, the most significant security check systems are those that use biometrics - which is unique to each individual. Iris, fingerprints, palm checks, face recognition are all examples of biometric tools [2] [3].

Face recognition is a popular type of biometric system [4]. Such systems are essentially pattern recognition systems that operate by fetching an individual's biometric data, extracting a feature set from the acquired data (in this case the face), and comparing this feature against the template set in the database. Depending on the application context, a biometric system may operate either in verification mode or identification mode [5]. Face detection has gained significant importance in recent times. Law Enforcement Agencies, security organizations, personal identification systems and mass surveillance applications all use this technology. Human face detection has traditionally been a challenging task due to a number of factors like face size, image size, type and other conditions involved [6]. The pictures containing faces may have different poses and angles; also, there is a lot of difference in pictures and images with respect to resolution, lightning and contrast. Images have different properties and digital structure in case of grey scale and coloured.

Some of the problems faced by the Nigerian Security personnel include: lack of technical know-how; bad record keeping and maintenance; Breach of malicious insiders concerning records; low level of education and the inadequate level of government intervention concerning the state of affairs. To the best of our knowledge, there is currently no known form of secured face recognition system for management and identification of criminals in Nigeria on a national scale.

The aim of this work is to model an appropriate facial recognition system for the Nigerian Security personnel in order to increase the level of efficiency, effectiveness and overall productivity of the security personnel. The rest of this paper is organised thus: Section 2 examines relevant literature. Section 3 discusses the methodology adopted in the research. In Section 4, system design and modelling are presented and discussed. Conclusion is contained in section 5.

II. LITERATURE REVIEW

The intuitive way for face recognition is to look at the main features of a captured face and compare them to features on other faces that have been stored in the database [7]. The first attempt at face recognition began in the 1960's with a semi-automated system. At that time, marks were made on the photographs to locate the main features [8]. It

used features such as mouths, ears, noses and eyes. Then, the distances and ratios were computed from these marks to a common reference point and compared to reference data. In the early 70's, Goldstein, Harmon and Lesk created a system that had 21 subjective markers such as thickness of the lip and hair colour [9]. This proved harder to automate given the subjective nature of many of the measurements made completely by hand. Fisher and Elschlagerb soon introduced an approach that reduced the subjectivity of the previous process [10]. This new approach measured the features above using templates of features of different pieces of the face and then mapped them all onto a global template. After continued research, it was discovered that those features did not contain enough data to represent an adult face.

Another approach is the connectionist approach [11]. This approach searches to classify the human face using a combination of both range of gestures and a set of identifying markers. This is usually implemented using 2-dimensional pattern recognition. Most of the time, this approach requires a huge number of training faces to achieve decent accuracy; for this reason, it is yet to be implemented on a large scale. Kirby and Sirovich initiated the Eigen-faces approach in 1998 at Brown University [12]. Since then many researchers have built and expanded on the basic ideas described in their original paper. The idea for this approach came from a paper by Turk and Pentland based on a research similar to that conducted at MIT [13].

In addition to the aforementioned approaches, algorithms also form part of the components of face recognition systems. The popular ones include: Principle Component Analysis (PCA) that treats face recognition as a two-dimensional recognition problem [11]; Linear Discriminant Analysis (LDA), which distinguishes between the differences within an individual and those among individuals [14] [15]; Independent Component Analysis (ICA), which strives to exploit "higher-order" relationships among pixels compared to PCA [16]; Elastic Bunch Graph Matching (EBGM), which relies on the concept that real face images have many nonlinear characteristics that are not addressed by PCA and LDA—such as variations in illumination, pose, and expression [17].

Face recognition has caught an increased interest from the scientific community in recent times because of its discrete nature. It holds several advantages over other biometric techniques especially for being natural, non-intrusive and relatively easy to use in varied scenarios.

III. METHODOLOGY

In order to realise the model, we employed the Unified Modelling Language (UML). It uses diagrams to document an object-based decomposition of systems showing the interaction between these objects and the dynamics of these objects. UML aims to provide a common vocabulary of object-based terms and diagramming techniques that is rich enough to model any system development project from analysis to design. For our model, we make use of use case diagram, activity diagram and class diagram.

Use case diagrams give a user point of view of a system. Activity diagram are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. Class diagrams depict the relationship among the different classes in a system. Development of the system involves various tools from the graphical aspect of designing to the command aspect of writing codes. This model can be implemented using a Java programming language, Open Source Computer Vision (OpenCV) and Neurotic biometrics.

III. SYSTEM DESIGN AND MODELLING

Fig. 1 shows the use case diagram of the proposed face recognition system with two actors – the administrator as well as the security personnel. The administrator of the system has full access to all the system features and will often be in an office setting while the security personnel will mostly be on the field and so has access to just the crucial functions required on the field. These includes ability to enrol and capture a new face; view existing records and try to match a face with existing records.

Fig. 2 is an activity diagram for verification, identification and matching of new faces to existing ones. Fig. 3 is the class diagram showing the relationship between the various classes in the face recognition system.

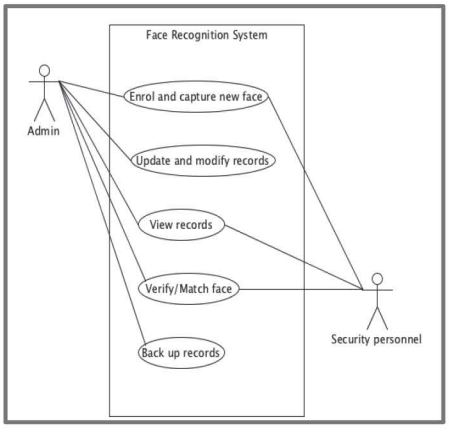

Fig. 1. The Use Case Diagram for the Face Recognition System

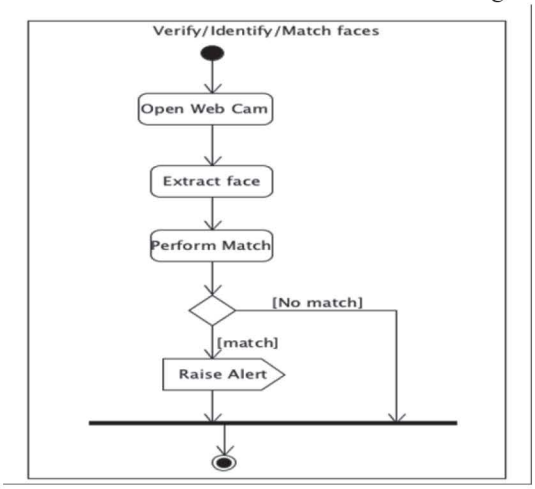

Fig. 2. Activity Diagram for the Verify/Identify/Match Faces

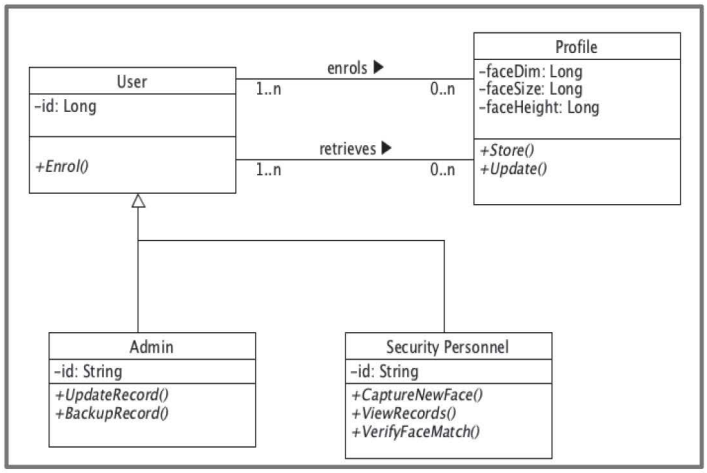

Fig. 3. The Class Diagram of the Face Recognition System

CONCLUSION

Face recognition has great potential in helping security operatives to better carry out their duties especially in developing nations where this technology is not currently widely used. This system therefore when fully implemented will be both a web and mobile-based application that aids security operatives in recording and keeping track of faces of crime suspects from crime scenes. Its full implementation will ensure that criminals do not go unpunished, as is often the case. Nigerians are also assured of a face recognition system which will improve productivity, quality of service, data integrity and protection thus helping to reduce time and cost of sending papers and reports of crime cases to the different zones of the country. It will also go a long way in ensuring that innocent people are not wrongly arrested based on previous crimes that have been committed by other people due to similar names

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