Development of an Electronic Attendance Biometric Registration System

Falohun A.S.[1], Oke A.O [2]., Gbadamosi O.A.[3]

[1]Ph.D , [2]Ph.D , department of Computer Science and Engineering,
Ladoke Akintola University of Technology, Ogbomoso , Nigeria.
[3]M.Sc., mathematical Sciences Department,
Ondo State University of Science and Technology, Okitipupa, Nigeria.

ABSTRACT

To answer the cravings of parents or guardians quest for update on their children or ward's class attendance activities, the fingerprint-based electronic attendance registration system was developed with Microsoft's C# on the .NET framework and Microsoft's Structured Query Language (SQL) Server 2005 as the backend. The technology consists of two processes namely; enrolment and authentication. During enrolment, the fingerprint of the user is captured and its unique features extracted and stored in a database along with the users identity as a template for the subject. The unique features called minutiae points were extracted using the Crossing Number (CN) method which extracts the ridge endings and bifurcations from the skeleton image by examining the local neighbourhoods of each ridge pixel using a 3 x 3 window. During authentication, the fingerprint of the user is captured again and the extracted features compared with the template in the database to determine a match before attendance is made after which an e-mail will be sent to the parent or guardian.

Keywords: *Authentiction , Biometric, Verification, E-mail , Minutiae.*

1. INTRODUCTION

Biometric technology that involves the identification and verification of individuals by analysing the human body characteristics such as the finger prints, palm vein, iris and the likes has been widely used in various aspect of life for different purposes, most importantly as regards the issue of student's attendance. In recent time, there has been high level of impersonation experienced on a daily basis in both private and public sectors, the ghost worker syndrome which has become a menace across all tiers of government in underdeveloped and developing countries, employers concerns over the levels of employee absence in their workforce and the difficulty in managing student attendance during lecture periods. Despite the numerous advantages of the biometric system and its impact to various work sectors across the globe, most biometric technology users face the issue of defining the right and accurate biometric technology system that will be cost effective in solving particular problems in specific environment. Fingerprints are a form of biometric identification which is unique and does not change in one's entire lifetime; this is being applied in an electronic attendance registration system in a university environment to monitor the attendance using fingerprint recognition of students which also includes e-mailing reporting for the parent or guardian.

The most common means of tracking students attendance in the classroom is by enforcing the students to manually sign the attendance sheet, which is normally passed around the classroom while the lecturer is conducting the lecture. There are numerous disadvantages of using such system. The attendance sheet is passed around the class; some students may accidentally or purposely sign another student's name. Another issue of having the attendance record in a hardcopy form is that a lecturer may lose the attendance sheet. As a consequence, lecturer can no longer trace the students overall attendance record throughout the particular semester. And most of all, parents oblivious of their children's absence from the class.

To overcome the disadvantages of traditional attendance system, a design method of a biometric system based on GSM technology E-mail reporting is proposed. In this system students report their attendance via a biometric system and parents can receive SMS and E-mail notification of attendance.

The authentication elements, biometric recognition system is a common and reliable way to authenticate the identity of a living person based on physiological or behavioral characteristics. The biometric system has to take a binary decision of accepting or rejecting an individual, based on the information extracted from the considered biometric trait. Biometrics authentication uses information specific to a person, such as a fingerprint, face, palm or iris pattern. Therefore, it is more convenient and secure.

Biometric recognition refers to the process of matching an input biometric to stored biometric information. In particular, biometric verification refers to matching the live biometric input from an individual to the stored biometric template about that individual. Examples of biometrics include face images, fingerprint images, iris images, retinal scans, etc. The human

characteristics of interest include visual images, speech, and indeed anything which might help to uniquely identify the individual.[1]

2   A Brief History of Biometrics

In the context of information systems, a general definition of a biometric system is that of, "a pattern recognition system that recognizes a person by determining the authenticity of a specific physiological and/or behavioral characteristic possessed by that person", [2], [3]. The earliest documented use of systematic biometric methods as a means to distinguish one individual from another can be traced back to 14th century China. Chinese merchants were known to stamp children's inked palm and footprints on paper in order to tell them apart,. In western culture, the earliest documented distinction made of a biometric property was that done by the English botanist Nehemiah Grew, who in 1684, published a paper reporting t   he distinct characteristics of ridge, furrow and pore structures in human fingerprints, (Ibid).

In the intervening years the development of formal scientific method, lead to the first significant application of biometrics by Alphonse Bertillon, a 19th century anthropologist and police clerk. The system, known as **Bertillonage**, purported to uniquely identify criminals via head and body measurement and other characteristics, such as scars or tattoos. Although flawed, Bertillonage helped to establish biometrics as a valid area of scientific enquiry and subsequent pioneers, such as Sir Francis Galton and Edward Henry further advanced the understanding of fingerprint morphology.[2]. Galton identified the minutiae features for fingerprint matching and the Henry system of fingerprint classification meant that by the early 20th century fingerprint recognition had become a standard process in forensics for personal identification.

2.1 Finger Print Technology

A fingerprint is an impression of the friction ridges of all or any part of the finger. A friction ridge is a raised portion of the on the palmar (palm) or digits (fingers and toes) or plantar (sole) skin, consisting of one or more connected ridge units of friction ridge skin. These ridges are sometimes known as "dermal ridges" or "dermal ".

Figure1. Fingerprint Bitmap. (Source: [4,5])

2.2 Review of Related Works

Many related works regarding attendance management in schools, colleges and industries exists.

[10] developed a finger based student attendance system using GSM, a finger print device is used and the attendance of the students are stored in the memory chip. If the matched attendance is marked, the ID number of that student is displayed on the LCD screen and a SMS will be sent to the parent mobile through GSM Modem.

[11] designed an efficient module that comprises of a finger print sensor to manage the attendance records of students, the presence is stored in the database through Wi-Fi and also making use of Arduino UNO as an interface to all devices such as Wi-Fi shield, GSM shield, Raspberry Pi, Keypad, LCD Display and the server in which the database is being maintained.

[12] designed a human identification based on finger print and faces biometric using LBP and GWN Descriptors, where they discovered that fusion done at match score level with weighted sum method was found an excellent method giving higher performance.

[9] utilized iris data signature for personal authentication for access control.

[7] proposed a multimodal biometric system using Iris and Finger print and combining ridge based matching for finger print and Eigen face.

3   System Design

The biometric attendance system was designed using classes that perform specific functions. The classes are; 'class Attendance View', which presents the date, time and status of the user; class Admin, which presents the list of all registered users and the attendance record; class 'Reg Page' which deals with the taking in of the fingerprint and other bio-data; class 'Display Form', class 'Attend Form' displays the scanned fingerprint; class 'Form Default' is the default form displaying module, and class 'Data Access Layer' manages the data flow between all the classes. Electronic attendance system framework is divided into three parts: Hardware design, Software design and Networking.

3.1   Hardware Architecture

The hardware to be used can be divided into two categories – fingerprint and which captures the image and a personal computer which: houses the database, runs the comparison algorithm and simulates the application function. The fingerprint scanner is connected to the computer via its USB interface. Basically this work does not involve the development

of hardware. Using the Secugen Fingerprint Reader, the Griaule Software Development Kit (SDK) toolbox provided by the Griaule was used as an interface between the fingerprint and the attendance software.

3.2 Software Architecture

The software architecture consists of the database and the application program.

Database: The database consists of tables that stores records implemented in Microsoft SQL Server database. However, this can be migrated to any other relational database of choice. SQL Server is fast and easy, it can store a very large record and requires little   configuration.
Application Program: The application program was developed with Microsoft C# programming language using Microsoft Visual Studio framework and it provided a user interface for the Electronic Attendance System. The advantages of Microsoft C# programming language are its robustness, easy to program, has an excellent database connectivity, runs on the two most common operating system platforms (Windows and Unix) and it has a larger user community that provides online support.

3.3 Networking

The server was deployed on the personal computer using Wi-Fi as the wide Area network also, periodic SMS was sent to the student's parents once the electronic attendance system verify that the student is attending or leaving the registered course, this feature was enabled by connecting the system to an SMS gateway.

3.4 Finger Print Identification System

3.4.1 Fingerprint Acquisition

The fingerprint was acquired such that the print of the texture of the first finger (that is the pointing finger) was obtained twice and analyzed for processing. The fingerprint samples were stored in a Microsoft SQL Server database with the aid of an interfaced fingerprint reader. The fingerprints were then saved inside the database to cater for subsequent need for the various fingerprint analysis.

3.4.2 Minutiae Extraction

Most of the proposed methods require the fingerprint gray-scale image to be converted into a binary image. The binary images obtained by the binarization process are submitted to a thinning stage which allows for the ridge line thickness to be reduced to one pixel. Finally, a simple image scan allows the detection of pixels that correspond to minutiae through the pixel-wise computation of crossing number.

The figure 2 shown below is the fingerprint identification system flowchart. Fingerprint images scanned are not of optimum quality therefore noises are removed to enhance their quality. Features extracted like minutiae and others for matching, if the set of minutiae are matched with those in the database, it is called an identified fingerprint. After matching post-matching steps is performed which include showing details of identified student, marking attendances, email reporting and SMS reporting.

Figure2.   Flowchart of Electronic Attendance System Using Finger Print Technology

3.4.3 Pore Extraction Technique

Skeleton post processing technique was involved in pore extraction [8] since the method used to extract the pores as fingerprint features is critical to the matching routine. The pore's position, size and shape are features which make it distinct from other objects in an image. Techniques used for the fingerprint data capture can be used to enhance the pore information. For example, high resolution scanning and manipulation of the gain and contrast camera controls can highlight the pores. The position of the pore is determined by processing the grey scale fingerprint image and transforming it to a skeleton representation. By applying models and processing routines to the skeleton of the fingerprint image, the pore location was extracted.

4. Implementation Environment

The implementation of this work was done using Microsoft Visual Studio 2012 integrated development environment (IDE). Visual Studio .NET is Microsoft's integrated development environment (IDE) for creating, documenting, running and debugging programs written in a variety of .NET programming languages. Visual Studio .NET also offers editing tools for manipulating several types of files .NET is the Microsoft Web services strategy to connect information, people, systems, and devices through software.

4.1 Installation of the Biometric based Attendance Software

The Biometric based Attendance software was successfully installed on a laptop with the configuration below:

- 500 Gigabytes Hard disk
- 4 Gigabytes RAM (Random Access Memory)
- 4 Gigahertz Processor Speed (Intel Pentium Dual Core)
- A 32-bit Operating System (Windows 7)

4.2 Component Interaction

The major modules in this Biometric based software project work are: home module, admin module (users' details, users' attendance and admin login), attendance module, students'/workers' registration module and the help module. Each module was coded on separate forms (pages). The home page is the starting point for the use of the Biometric based Attendance application software.

Some of the modules involved are reveled below.

**Figure 4.1 Biometric Attendance Registration Page**

Figure 4.2 The Initialization Page

**Figure 4.3 Window Showing Successful Registration (Enrolment)**
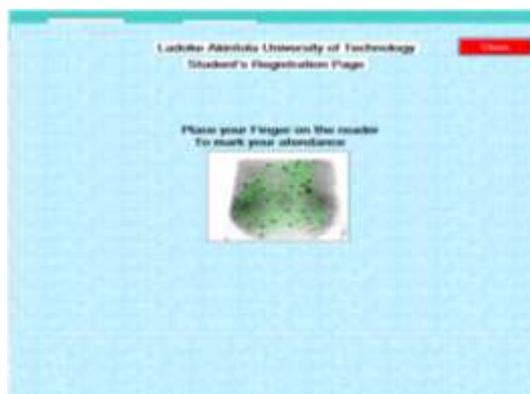
Figure 4.4 Window Showing the Screen when the Thumb is on the Scanner for Attendance

Figure 4.5 Window Showing Successful Attendance
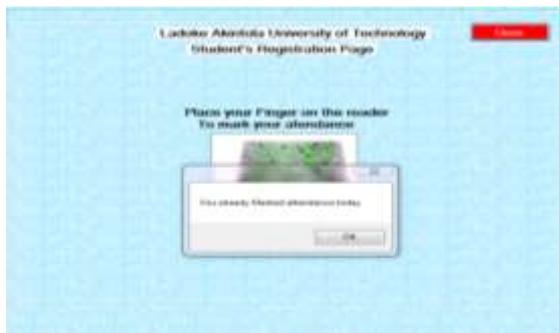
Figure 4.6 Page Showing Denial of Double Attendance
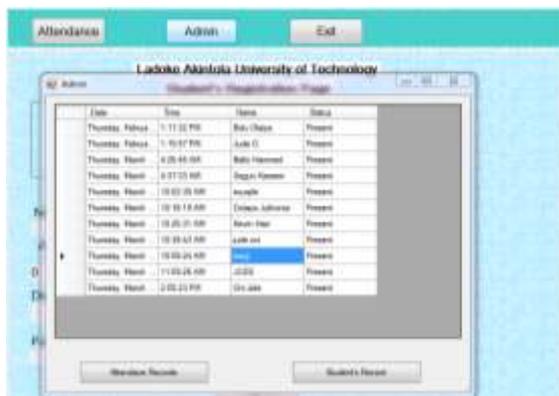
Figure 4.7 Admin Window Showing the Attendance List
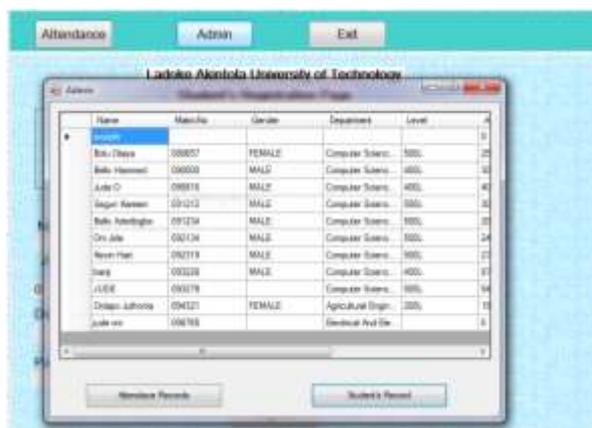
Figure 4.8 Admin Page Showing Students' Details

5.   Conclusion

This project work presents the implementation of Biometric based Attendance software for Ladoke Akintola University of Technology as a case study. The project work answers the cravings of most employers who complain over the issue of employee lateness and even absolute absence in their workforce. It has been seen in present time as a matter of urgency for a solution to be engineered to reduce and eventually stop this ugly menace. A unique feature is needed to avoid impersonation when attendance is being taken; biometrics features provide such an amazing uniqueness. The successful completion of this project work complements the incremental growth in biometrics attendance and punctuality registration as a viable improvement over the paper attendance and registration method. Its relevance spreads across both Academic institutions and other formal settings where attendance and punctuality registration is key.

6.   Recommendation

Future work should consider implementing this with a multimodal biometric scheme.

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