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Research

Automated Students' attendance System Based on Fingerprint Recognition using Minutia

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The increase in students' population in most institution of learning has made the use of manual attendance sheets unmanageable and difficult. The Traditional methods of attendance waste time and make standing-in for each other easy for students. The use of biometric authentication in managing attendance is therefore gaining popularity as it eradicates these problems and avoids impersonation. In this research, Minutia based fingerprint recognition algorithm was used to develop students' attendance Monitoring System. Minutia algorithm was used to locate minutiae points and map their relative positions on the finger for recognition. As the fingerprint is recognized, attendance is marked in the database corresponding to the matched fingerprint. If an unknown fingerprint is detected, the result shows no match found. The system was implemented using C++, PHP and MySql. As Minutia method may not recognize low quality image, future work can hybridize other fingerprint recognition algorithms with Minutia method for better performance.

Keywords:fingerprint recognition, feature extraction, Minutia algorithm

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INTRODUCTION

Keeping accurate records of students' attendance in higher Institutions of learning is of paramount importance as fulfillment of a minimum lecture attendance is a prerequisite for being eligible to sit for examinations (Ikuomola, 2015). Research has shown that there is a significant correlation between students' attendances and their academic performances as students who have poor attendance records are generally linked to poor retention (Patel and Swaminarayan, 2014). The traditional method of keeping attendance is known to be energy and time consuming. Where there are large numbers of students, writing attendance on sheets waste a lot of time and in some cases, these sheets may be lost. A student might decide to write attendance for another student or answer for another student if the lecturer decided to call students' matriculation number for attendance. Furthermore, it is not always convenient to track students' attendance with the traditional methods. Biometrics authentication is unequaled in systems where unique identification is important. To completely exterminate the problems of these traditional methods of keeping students' attendance, there is the need to use biometric method of taking students' attendance. Although several biometric methods are available, fingerprint is said to be one of the most desirable biometric for person identification as it is the most reliable, efficient and commonly accepted biometric (Awotunde, Fatai, Akanbi, Abdulkadir & Idepefo, 2014).

FINGERPRINT FEATURES

Fingerprint comprises of raised parallel lines called ridges with spaces called valley (furrows) in between the ridges. In a typical fingerprint image, the ridges appear dark while the valleys appear bright (Akanbi**,** Abdulrahman, Saka & Olojeola, 2019).The ridges and valleys tend to end and discontinue at some point forming a small or precise details of terminations or ridge endings called Minutia (Yusuf, Akanbi, Bolaji- Adetoro & Jimoh, 2018). In most Minutia fingerprint recognition, only ridge endings (where a ridge ends or terminate) and bifurcations (Branching or decomposition of a ridge into two) are used for recognition. The Minutiae Points (plural Minutia) constitute the local features of fingerprint while the shape or pattern the fingerprint ridges make forms its global features. Different types of fingerprint pattern can be identified as follows: The arch, the whorl and the loop.

ADVANTAGES OF ATTENDANCE MONITORING SYSTEMS

1. The proposed system will make the attendance management system more efficient.
2. The attendance monitoring system is portable, easy to use and not time consuming.
3. The system will eradicate high level of impersonation experienced while taking attendance by preventing a student from writing attendance for another student.
4. The system will give no room for fraudulent manipulation of students' attendance.
5. It minimizes cost by eradicating the use of stationary materials in taking attendance.

RELATED WORKS

Garg, Goswami, Kharat, and Chorage (2018) developed a Fingerprint Based Attendance Monitoring System Using Android Application. They proposed attendance monitoring and record system based on finger print technology and a smart phone with android application.

Ikuomola (2015) worked on Fingerprint-Based Authentication System for Time and Attendance Management. The students of University of Agriculture Abeokuta, Nigeria fingerprint attendance were captured during the 2012 academic session. The system was implemented using C# and Microsoft SQL Server 2008, and was tested using electronic fingerprint scanner which was interfaced to the digital computer system for verifying students' identity.

Soe, Win, and Thoung (2018) implemented a Fingerprint based Student Attendance System with Notification by GSM Module. The fingerprint based attendance system was designed with notification to guardian at certain interval. The system was developed using Arduino IDE, Eclipse and MySQL Server.

Chandramohan, Nagarajan, Ashok kumar, Dineshkumar, Kannan, and Prakash (2017) proposed an Attendance Monitoring System of Students Based on Biometric and GPS Tracking System. The researchers developed a fingerprint recognition system based on minutiae based fingerprint algorithms. The study also provides the design method of fingerprint based student attendance with help of GSM.

Rahman, Rahman and Rahman (2018) proposed an Automated Student Attendance System using Fingerprint Recognition. The minutiae algorithm was used to develop the identification system which is faster in implementation than any other available today in the market.

Oyebola, Olabisi, Adewale (2018) developed a System for Students Attendance Information Management. An automated approach was implemented through biometric technology embedded with a window application which is fully explained in their work. The research presented the design and construction of fingerprint student attendance management system.

METHODOLOGY

FINGERPRINT RECOGNITION STAGES

- **Fingerprint Acquisition**: A sample fingerprint is acquired through a fingerprint scanner or optical sensor. This device is used to capture a digital image of the fingerprint.
- **Pre-Processing Stage:** The quality of the fingerprint captured is improved through enhancement, segmentation and binarization. Unwanted data in the fingerprint grayscale image (such as noise and reflection) are removed at this stage to increase the clarity of the ridge structure through image enhancement. Binarization is a process used to transform fingerprint image from 256 levels to two levels (0,1) where 0 and 1refers to (black and white) respectively. The image produced is known as binary image. The main aim of the pre-processing stage is to remove false minutiae from the image.
- **Feature extraction Stage:** The binarized image is then thinned. Thinning is the process of reducing the width or thickness of each ridge to one pixel. A feature extraction program is applied in order to locate measure and encode the image features. In this research, the Minutia method is proposed. In this method, details of minutiae points are extracted from a fingerprint, stored as a template in the database and matched with a live scan to measure the similarity between them.
- **Fingerprint Matching:** In this phase, the features extracted from the live scan or query image is aligned and matched with the Stored Templates in the database.

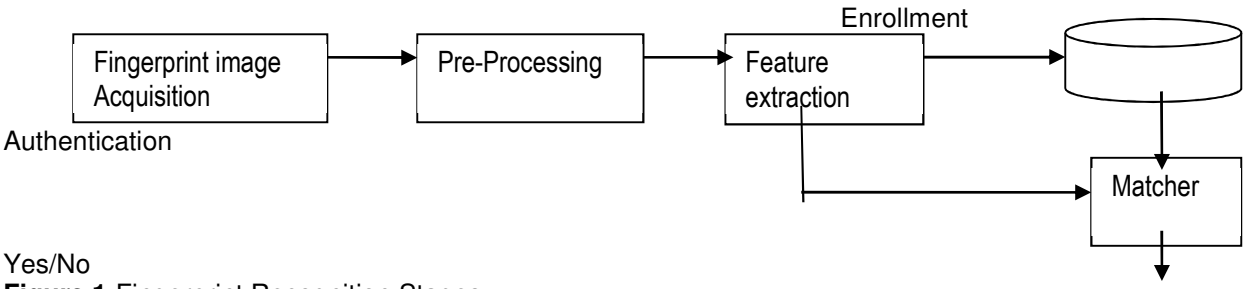


Figure 1: Fingerprint Recognition Stages

MINUTIA ALGORITHM

1. Acquire the fingerprint image
2. Perform pre-processing steps on the acquired fingerprint image
3. Extract the Minutiae points using the crossing number equations
4. Estimate the Orientation angle and the coordinates (x, y, θ) of the extracted minutiae points.

If the minutia points extracted is for the enrollment stage, Goto step 6
Else

Goto step 5

5. Perform fingerprint Matching

5.1 Fetch the fingerprint template from the database for matching

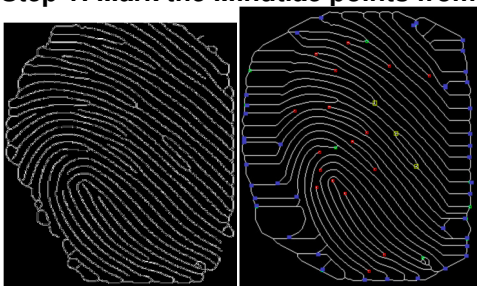
5.2 Compare the query fingerprint with the stored template using Minutia matching score

5.3 Reply match found if the matching score = 1 and No match found if the matching score =0

6. Store the fingerprint image as template in the database

STEPS INVOLVED IN MINUTIA EXTRACTION

Step 1: Mark the Minutiae points from the thinned fingerprint Image.



(a) Thinned image (b) Minutiae points

Figure 2: Thinned Image for Feature extraction

After the pre- processing stage, the image is thinned for Feature Extraction. From the image above, the terminations which lie at the outer boundaries marked with blue colour are not considered as parts of the minutiae points. Other points marked in red and yellow are the Minutia to be used in feature extraction.

Step 2: Get the location and Orientation of the minutia.

A minutia can be characterized by its location and orientation using these parameters
x, y, θ,
where **x** is the x coordinate of the minutia (Termination and bifurcation)
y is the y coordinate of the minutia (Termination and bifurcation) and
θ is the orientation angle (Termination angle and bifurcation angle)

A Termination Angle is the angle between the direction of the ridge and the horizontal while a Bifurcation Angle is the angle between the direction of the valley ending between the bifurcations and the horizontal.

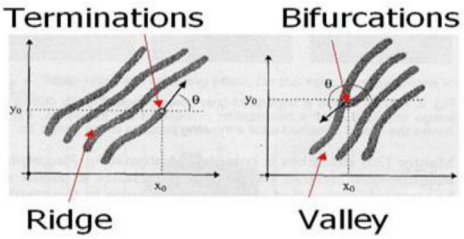


Figure 3: Terminations, Bifurcation and their Orientation Angles. (Source: Mali & Bhattacharya,2014).

Step 3: Determine the Minutiae Type

The crossing number (CN) method is used to mark and extract minutiae type from the fingerprint image by examining the local neighborhood of each ridge pixel using a 3x3 window to determine the minutiae type. The crossing number value is defined as half the sum of the differences between pairs of adjacent or neighboring pixels in the 3x3 block.

$CN=0.5\sum_{i=1}^{8} \mathbf{P}_i\mathbf{P}_{i-1}$

Where P9=P1.
If CN= 1, then minutiae points are classified as termination.
If CN= 2, then minutiae points are classified as normal ridge and
If CN= 3 or greater than 3 then minutiae points are classified as bifurcation.

Step 4: Extract Minutia data

The extracted data (x,y, θ, and the minutiae type) are stored in the matrix format. The data matrix is as follows:
Number of rows = Number of minutiae points;
Number of columns = 4.
Column 1: Row index of each minutia point (x coordinate)
Column 2: Column index of each minutia point. (y coordinate)
Column 3: Orientation angle of each minutia point. (Minutiae angle of the particular minutia point to be paired i.e input image and template image).
Column 4: Type minutiae. (CN=1 is classified as termination, and CN=3 is classified as Bifurcation.)

Step 5: Matching and Recognition

During the matching process, each input(Query) minutiae points are compared with template minutiae points considering the above properties i.e Q(x, y, θ, and the Minutiae type) of input or query image would be aligned with the same T(x, y, θ and the minutiae type) of registered template and the matching score will be calculated.
The extracted features from the template and query fingerprints image must be aligned, or registered before matching. The result of Fingerprint Matching measures the Percentage of similarity between the input or query data and the template data. When minutiae of two fingerprint images are aligned in the minutiae method, an elastic match algorithm is performed by counting the matched minutia pairs which have a nearly position and direction with the template and finally the matching score is calculated using:

$$\textbf{MATCHING SCORE} = \frac{\textbf{MATCHED MINUTIAE}}{\textbf{MIN (M1, M2)}}$$

Where M1, M2 are the number of extracted Minutia in the Input image and Template image respectively.
If the Matching Score =1 then the data matches and access is granted to the student
if the Matching Score = 0 then the data is mismatched and access is denied.

RESULTS

During enrolment, the students' bio-data (Surname, Other names, Gender, Matriculation Number, Faculty, Department, Level, email, Phone number), passport photographs and their fingerprints are captured and stored into the database using MySQL.

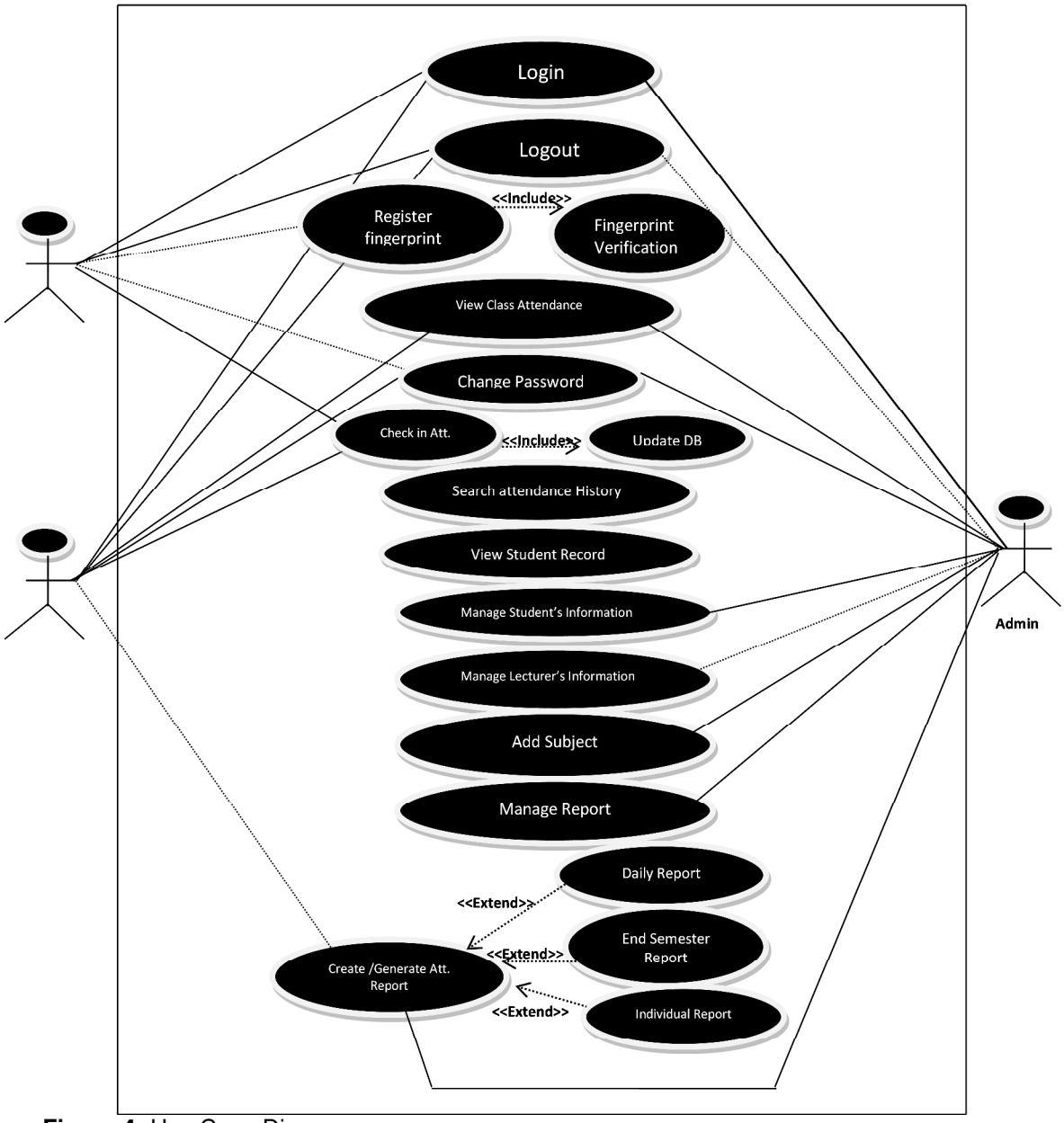


Figure 4: Use Case Diagram

The fingerprint was captured using a fingerprint scanning device where a student presents his/her finger to the fingerprint sensor and a fingerprint image is acquired by the sensor module. Minutia features of the acquired fingerprint image are extracted, and further adapted or transformed to generate template data for the purpose of comparison in the verification stage.

During authentication, the fingerprint biometrics of the students are captured again and the extracted features are compared with the ones already existing in the database to determine a correct match.. The feature representations of the query fingerprint image captured go through the same process as in the enrollment stage, so as to obtain the query data (Yang et.al, 2019). The query data are then compared with the template data so that a matching outcome is attained and the student is marked present or absent depending on the result of the matching score. If the fingerprint matched, attendance is marked in the database corresponding to the matched fingerprint of the student. If an unknown fingerprint is detected, the result shows “no match found”. At the end of the semester, reports are generated for the number of times the student attended lectures.

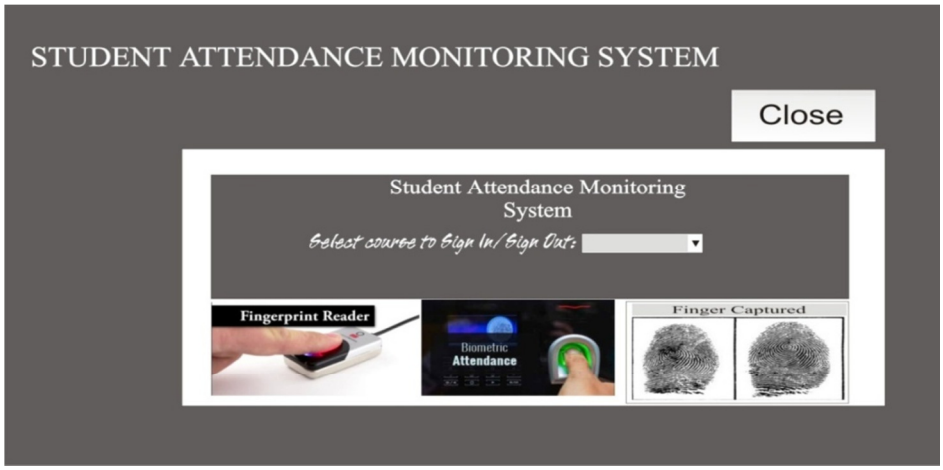


Figure 5: Select Course to Sign in / Sign Out

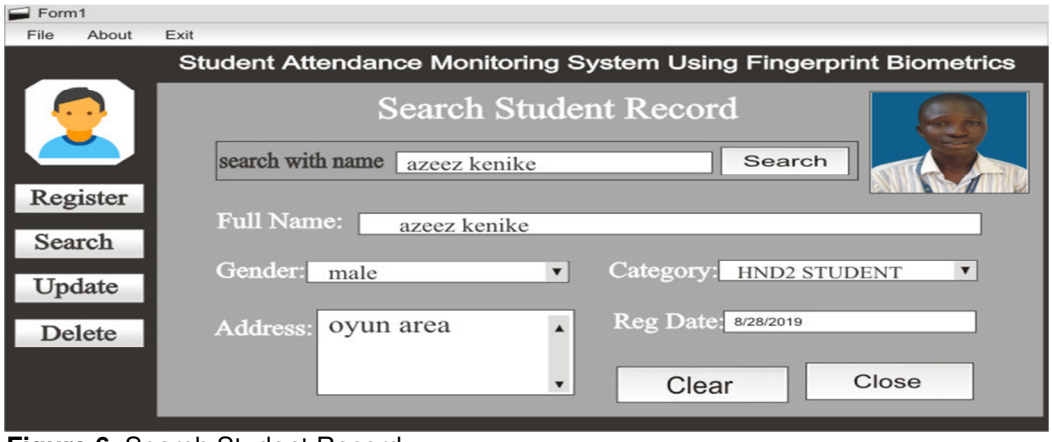
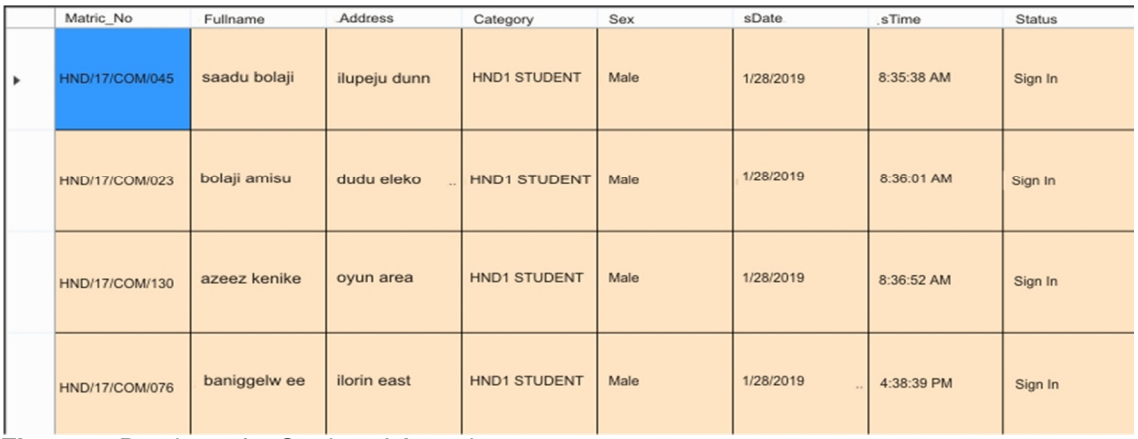


Figure 6: Search Student Record

The admin can search for students’ record. The admin is also the only person that can delete or update students ‘records.



Matric_No	Fullname	Address	Category	Sex	sDate	sTime	Status
HND/17/COM/045	saadu bolaji	ilupeju dunn	HND1 STUDENT	Male	1/28/2019	8:35:38 AM	Sign In
HND/17/COM/023	bolaji amisu	dudu eleko	HND1 STUDENT	Male	1/28/2019	8:36:01 AM	Sign In
HND/17/COM/130	azeez kenike	oyun area	HND1 STUDENT	Male	1/28/2019	8:36:52 AM	Sign In
HND/17/COM/076	baniggelw ee	ilorin east	HND1 STUDENT	Male	1/28/2019	4:38:39 PM	Sign In

Figure 7: Database for Students' Attendance.

The system successfully recognized 14 students out of the 15 template samples in the database and was able to reject 5 unauthorized students from gaining access. Results show that (students' query fingerprints are compared with the stored ones during attendance taking) attendance are marked successfully when a match is found. However, any query fingerprint that does not match fingerprints in the templates kept in the database is rejected.

CONCLUSION

Biometric attendance monitoring system can be used to take students attendance since it can solve the problems of traditional attendance system. Although, there are many biometric methods of authentication, fingerprint biometric is said to be the most efficient and widely used. This research proposes an Automated Fingerprint Attendance Monitoring System Using Minutia Method. The system can be used to take students' attendance based on individual fingerprint. The Proposed Students' Fingerprint Attendance Monitoring System will make taking attendance in lecture rooms easy and user friendly. The system will give no room for impersonation. The proposed system will also make the attendance management system more efficient, portable, less time and energy consuming. Since Minutia cannot detect fingerprint images of low or poor quality, its accuracy can be affected when the images are bad. An hybridized algorithm can be used for better accuracy and performance.

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