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Development of Attendance Management System using Biometrics.

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ABSTRACT

In this paper, the development of an attendance management system using biometrics is proposed. Managing student attendance during lecture periods has become a difficult challenge. The ability to compute the attendance percentage becomes a major task as manual computation produces errors, and also wastes a lot of time. For the stated reason, an efficient attendance management system using biometrics is designed. This system takes attendance electronically with the help of a finger print device and the records of the attendance are stored in a database. Attendance is marked after student identification.

For student identification, a biometric (fingerprint) identification based system is used. This process however, eliminates the need for stationary materials and personnel for the keeping of records. Eighty candidates were used to test the system and success rate of 94% was recorded. The manual attendance system average execution time for eighty students was 17.83 seconds while it was 3.79 seconds for the automatic attendance management system using biometrics. The results showed improved performance over manual attendance management system. Attendance is marked after student identification.

(Keywords: fingerprints, attendance, enrollment, authentication, identification)

INTRODUCTION

In many institutions, and academic organizations, attendance is a very important criteria which is used for various purposes. These purposes include record keeping, assessment of students, and promotion of optimal and consistent

attendance in class. In developing countries, a minimum percentage of class attendance is required in most institutions and this policy has not been adhered to, because of the various challenges the present method of taking attendance presents. This traditional method involves the use of sheets of paper or books in taking student attendance. This method could easily allow for impersonation and the attendance sheet could be stolen or lost. Taking of attendance is time consuming and it is difficult to ascertain the number of students that have made the minimum percentage and thus eligible for exam. Thus, there is a need for a system that would eliminate all of these trouble spots.

An automatic attendance management system using biometrics would provide the needed solution. An attendance management system is a software developed for daily student attendance in schools and institutions. It facilitates access to the attendance of a particular student in a particular class. This system will also help in generating reports and evaluating the attendance eligibility of a student.

Rather than signing an attendance sheet, individuals will pass their thumb over the fingerprint scanner, the finger print is compared against a list of pre-registered users, and once a match is made, the individual will be registered as having attended that lecture.

The paper discusses related works in the problem domain; highlights the general overview of the proposed system; details design considerations of the system, both at the hardware and software level; discusses the operation and how the system was tested in conformity to system design and functional objectives; concludes the observations made; and makes recommendations for future improvement.

RELATED WORKS

A number of related works exist on the application of different methods and principles to effectively monitor the attendance of students. In [1], an embedded computer based lecture attendance management system was proposed. The system provides an improvised electronic card and card reader serially interfaced to the digital computer system.

Authors in [2], used a wireless attendance management system that authenticates using the iris of the individual. The system uses an off-line iris recognition management system that can finish all the process including capturing the image of iris recognition, extracting minutiae, storing and matching.

Attendance Management has also been carried out using attendance software that uses passwords for authentication. The authors in [3] designed and implemented a system that authenticates the user based on passwords, this type of system allows for impersonation since the password can be shared or tampered with. Passwords could also be forgotten at times thereby preventing the user from accessing the system.

Other attendance solutions are RFID-based student attendance system and GSM-GPRS based student attendance system. These are all device-based solutions. While GSM-GPRS based systems use position of class for attendance marking which is not dynamic and if schedule or location of the class changes, wrong attendance might be marked. Problem with RFID [7] based systems is that students have to carry RFID cards and also the RFID detectors are needed to be installed [6].

This system, however, is a cost effective simplified system that uses fingerprints for identification. The fingerprint is unique to each individual and cannot be shared. It allows students to register for lectures with ease and eliminate errors that are associated with attendance reports because the system generates reports at the end of the semester.

SYSTEM OVERVIEW

The proposed system provides solution to lecture attendance problems through the use of

attendance management software that is interfaced to a fingerprint device. The student bio-data (Matriculation number, Name, Gender and Date of Birth) and the fingerprint is enrolled first into the database. The fingerprint is captured using a fingerprint device.

For attendance, the student places his/ her finger over the fingerprint device and the student's matriculation number is sent to the database as having attended that particular lecture. At the end of the semester, reports are generated to specify the students that are eligible for exams and percentage of times the student attended lecture. A simple architecture is shown below.

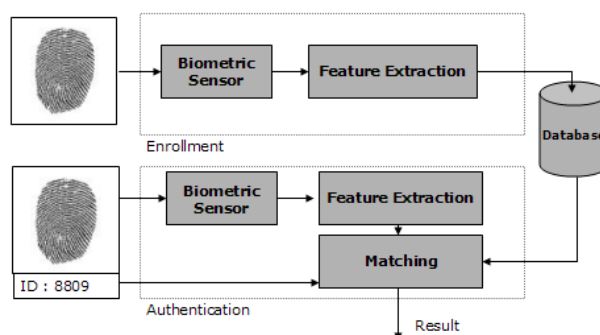


Figure 1: General Architecture of a Biometric System.

SYSTEM DESIGN

An Automated Fingerprint Attendance System (AFAS) is a highly specialized system that records students' attendance by comparing a single fingerprint image with the fingerprint images previously stored in a database. The Automated Fingerprint Identification system (AFIS) is the principle behind the AFAS.

The major factors in designing a fingerprint attendance system include: choosing the hardware and software components and integrating both to work together, defining the system working mode (verification or identification), dealing with poor quality images and other programming language exception, and defining administration and optimization policy [5],[9].

Student attendance system framework is divided into three parts: Hardware design, Software design, Attendance Management Approach and Report Generation. Each of these is explained below.

Hardware Architecture

The hardware to be used can be divided into two categories – fingerprint scanner 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 GrFinger Software Development Kit (SDK) toolbox provided by the Griaule (will explain the detail) can be used as an interface between the fingerprint reader and the attendance software.



Figure 2: Fingerprint Device.

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 SQLServer database. However, this can be migrated to any other relational database of choice. SQLServer is fast and easy, it can store a very large record and requires little configuration.

Application Program: The application program is developed with Microsoft C# programming language using Microsoft Visual Studio framework and it provides a user interface for the Attendance Management 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

Methodology and Flowchart

This proposed attendance management system uses fingerprint identification. In identification, the system recognizes an individual by comparing his/her biometrics with every record in the database. In general, biometric identification consist of two stages:

- i. Enrolment and
- ii. Authentication

During enrolment, the biometrics of the user is captured (using a fingerprint reader, which are likely to be an optical, solid state or an ultrasound sensor or other suitable device) and the unique features are extracted and stored in a database as a template for the subject along with the student ID.

The objective of the enrolment module is to admit a student using his/her ID and fingerprints into a database after feature extraction. These features form a template that is used to determine the identity of the student, formulating the process of authentication. The enrolment process is carried out by an administrator in the attendance system.

During authentication, the biometrics of the user is captured again and the extracted features are compared (using a matching algorithm) with the ones already existing in the database to determine a match. The identification accuracy of a biometric system [8] is measured with the false (impostor) acceptance rate (FAR) and the false (genuine individual) reject rate (FRR). The FAR/FRR ratios depend, among other factors, on the type of difficulty of the algorithms used in the fingerprint extraction. Usually, algorithms with high-medium complexity lead to acceptable low FRR/FAR.

However, as it becomes more complex the computational cost increases which leads to undesirable high processing times. Thus, the overall performance of the identification system should be evaluated in terms of FAR/FRR, computational cost and other factors such as security, size and cost. A brief flowchart is shown in Figure 3.

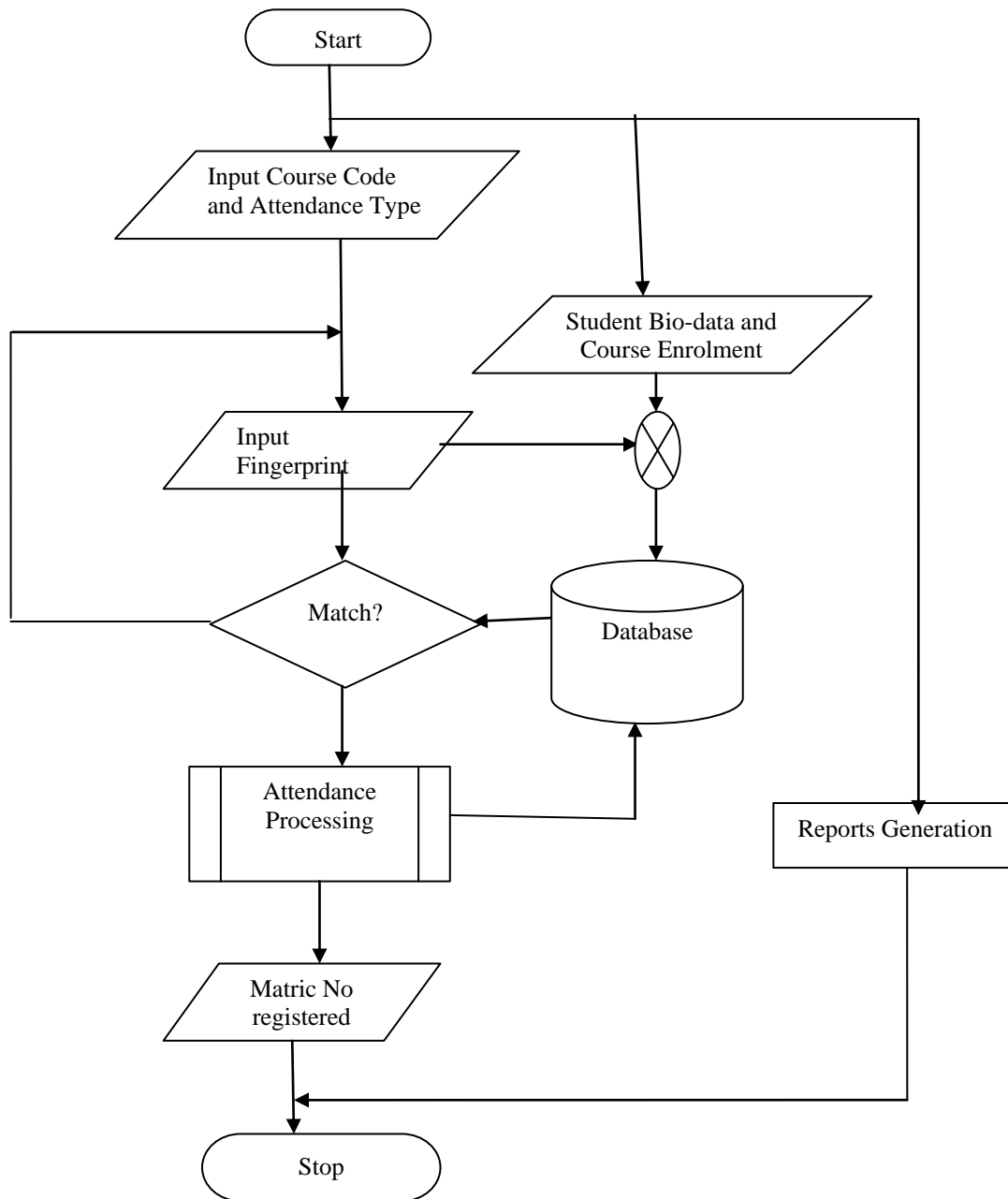


Figure 3: Flowchart of Attendance System Using Biometrics (Fingerprint).

SYSTEM OPERATION, TESTING AND DISCUSSION

The enrolment and registration phase is an administrative phase in which the administrator needs to log in. The user fingerprint as well as the other bio-data is stored for the first time into the database for student registration. The courses,

lecturers and exams are also registered at this phase. All data and information required for the proper recording of attendance are enrolled.

The lecturer selects the course code and the attendance type, then the student places his/her fingerprint on the fingerprint reader; the finger recognition unit compares the fingerprint features

with those stored in the database. The possible cases are:

- **Match (of Fingerprint):** captured user fingerprint features are matched with stored fingerprint templates. The user is automatically recorded for that lecture/mid-semester test/semester exam. A message box pops up for a short interval to show that the user has been recorded for the attendance. Figure 4 shows a snapshot of the program.



Figure 4: Attendance Form (Match of fingerprint)

- **Non-match (of fingerprint):** the user is not accepted for attendance and a message is shown in the textbox that fingerprint is not found. The interface is shown in Figure 5.



Figure 5: Attendance form (Non-match of fingerprint).

Reports are generated for each course and the total number of students for each attendance is listed and their corresponding status. An example is shown in Figure 6.

coursecode	matricno	count	percentage	status
ECE 212	050210004	1	33	Not Qualified
ECE 212	050210004	1	33	Not Qualified
ECE 212	050210013	2	66	Not Qualified
ECE 212	050210061	2	66	Not Qualified
ECE 212	050210101	3	100	Qualified
ECE 212	067282882	1	33	Not Qualified
ECE 212	070210077	1	33	Not Qualified
ECE 212	090210002	3	100	Qualified
ECE 212	090210003	1	33	Not Qualified
ECE 212	090210004	3	100	Qualified

Figure 6: Reports Form for Attendance System.

The test results shows that the system is effective and it has a fast response. There was no false identification of students, few cases of false reject which was later accepted and only pre-registered students were authenticated. The matrix of the identified students were enrolled for attendance automatically.

The system was tested using the bio-data and fingerprints collected from eighty (80) students of the department of Electronics and Computer Engineering, Lagos State University, Epe, Lagos State, Nigeria. In the test, there was no false acceptance i.e. a person that was not pre-registered was not falsely enrolled for attendance. There were a few false rejections during the test in which the system failed to identify some pre-registered users. The false rejects could be attributed to improper placement of the finger on the scanner and fingers that have been slightly scarred due to injuries.

The 80 candidates are divided into 8 groups of 10 students and a success rate of over 94% was obtained from the tests carried out. The results of the test are shown below in the chart (Table 1).

Table 1: Comparison of Success and Failure Rate.

Groups	1	2	3	4	5	6	7	8
Success (%)	100	90	100	100	80	100	90	100
Failure (%)	0	10	0	0	20	0	10	0

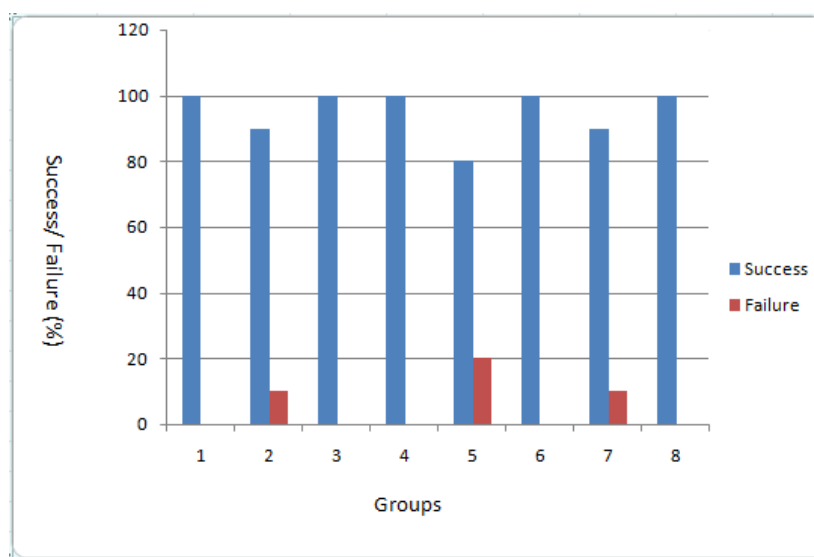


Figure 7: Comparison of Success and Failure Rate.

COMPARISON WITH MANUAL ATTENDANCE

The manual attendance system average execution time for eighty (80) students is approximately 17.83 seconds as against 3.79 seconds for the this automatic attendance management system using fingerprint identification. Reports generation for the attendance system takes approximately 30s. The table is a 25 student sample out of the 80 tests conducted. It can be shown in the graph below and thus, it can be seen that the automatic attendance management system using fingerprint authentication is better and faster than the use sheets of paper.

CONCLUSION

The system successfully took the attendance both at lectures and examinations. The prototype successfully captured new fingerprints to be stored in the database; scanned fingerprints placed on the device sensor and compared them against those stored in the database successfully. The performance of the system was acceptable and would be considered for full implementation especially because of its short execution time and reports generation. Everyone who tested the system was pleased and interested in the product being developed for use in schools.

Table 2: Comparison of the Execution time of Manual Attendance and Attendance System Using Biometrics.

STUDENT	MANUAL ATTENDANCE	ATTENDANCE SYSTEM
1	22.78	3.81
2	12.82	3.43
3	19.65	4.12
4	11.38	3.63
5	12.65	2.53
6	16.24	2..49
7	14.66	2.72
8	15.23	3.35
9	15.03	4.01
10	16.31	4.21
11	14.97	4.31
12	15.16	3.85
13	15.18	4.32
14	16.54	4.78
15	16.59	4.23
16	16.92	3.55
17	16.95	4.34
18	17.61	5.11
19	17.72	3.36
20	17.78	4.57
21	18.01	3.12
22	18.25	3.31
23	18.62	3.1
24	19.19	2.92
25	19.34	2.83

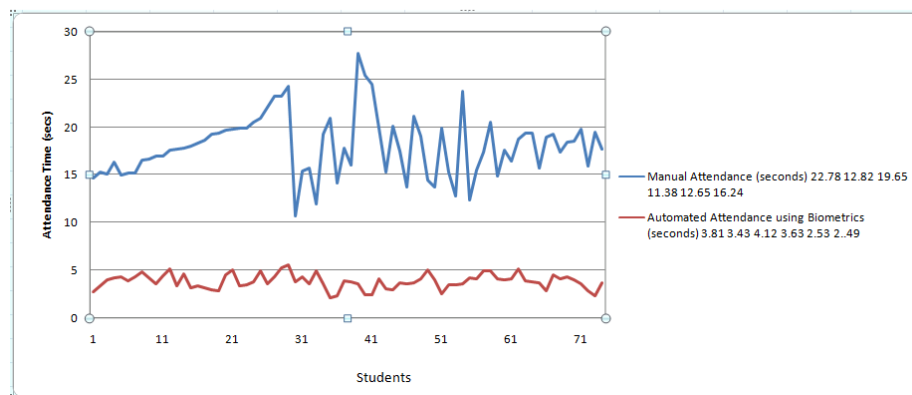


Figure 8: Comparison of Manual Attendance with Attendance Management System.

RECOMMENDATIONS

The following suggestions should be considered in carrying out further work on this study:

- The system can be linked with the school's central database so that the student registration phase can be eliminated and the bio-data can be directly from the database.
- The university should acquire the fingerprints of all students at admission.
- The components could be chosen and assembled in a commercialized manner: instead of a stand-alone fingerprint scanner and a laptop, the unit could have the fingerprint scanner, a small LCD screen and a keypad all attached to the wall of each classroom.
- The system could be modified into a web based system so that reports could be generated anywhere
- The system could be adapted for human resource use i.e. attendance, pension, payroll processing, etc.

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