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Biometric-Based Human Recognition Systems for Institutions using Exeat Monitoring System

Issa Lukman Oluwadare[1], Ogunsanya Mobolaji Mojisola[2], Ojenomo Paul Ozabereme[2], Makinde Kayode[3], Sunday David[4]

[1]Kwara State Ministry of Power and Energy, Ilorin, Kwara State, Nigeria
[2]Electrical and Computer Engineering Kwara State University, Malete, Kwara State, Nigeria
[3]Department of Electrical Engineering, Federal Polytechnic Bida, Niger State, Nigeria
[4]Agip Building No 40/42 Aguyi Ironsi Street Maitama, Abuja, Nigeria

ABSTRACT

Exeat is a primary term generally used to describe a period of nonattendance from a centre of learning either for the entire day or parts of a day for appointments and interviews in a secured academic environment. The current method of monitoring students' movement is inefficient. It brings difficulty to the University Halls management by checking students into the halls of residence and impersonation during exams. For this reason, a Biometric-Based Human Recognition System for Institutions is needed to use Exeat Monitoring System. The motive of the study is to develop a user-friendly online interface embedded with a fingerprint biometric authentication system through which the school portal can monitor students who exit from school premises or a school campus. Nexus combination techniques were adopted. The results showed that exeat monitoring systems are less prone to forgery since they can prevent impersonation among students, and it's purely digital since it is a GSM-based devices.

KEYWORDS: *Exeat, Fingerprints, Monitoring, Impersonation, GSM, SMS*

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1. INTRODUCTION

The increasing use of technology in all aspects of society makes confident, creative and productive use of Information and Communication Technology (ICT) an essential skill for life. ICT capability encompasses not only the mastery of technical skills and techniques but also facilitates understanding these skills in learning, everyday life and employment. ICT capabilities are fundamental to participation and engagement in modern society. Exeat is most commonly used to describe a period of absence from a learning centre. It is also used at specific colleges to define a required note to take an absence from school for entire days or parts of a day for appointments, interviews, open days and other fixtures (Frischolz, 2000).

Access control is concerned with determining the allowed activities of legitimate users, mediating every attempt by a user to access a resource in the system. Several means and techniques have been adopted to restrict access to various domains of human endeavours (Omidiora, 2009). But not much has been done regarding biometrics exeat monitoring systems in the privately/publicly owned academic domain such as in the Kwara State University Malete. The current paper tally approach to Exeatis inadequate because it can be forged or duplicated and does not provide reliable student monitoring. Biometric identification is any automatically measurable, robust and distinctive physical characteristics or personal traits that can be used to identify an individual or verify the claimed identify of an individual. The trending concern in this modern world is regarding national security, identifying theft, and online terrorism.

Biometric science utilizes the measurements of a person's behavioural characteristics (keyboard strokes, mouse movement) or biological characteristics (fingerprint, iris, nose, eyes, voice pattern, etc.). It is the feature capture that is being transformed digitally into a template. Recognition is the most common biometric method adopted in the identification of a person (Ismail, 2009).

Biometrics is a field of technology that uses automated methods for identifying and verifying a person based on physical and behavioural traits. Because some parts of the human body are used in biometrics, the issue of getting lost is not possible, and the ease for a password to be easily guessed is avoided. Also, utilizing biometrics in most cases can be said to be more efficient when speed is considered and convenient than using password and ID cards method. Using a particular person's fingerprint as a form of authentication is just like using natural physical data as a password. The benefit of using biometric authentication is that it is absolutely distinct for each person. There are no two different individuals with the same fingerprint, and it is impossible for one another to have the same fingerprint, i.e. fingerprints from different people can never be the same. Also, a fingerprint can never be guessed by a criminal, such as a password that an imposter can easily predict using a user's birthday or any other common password. Infiltration is very hard to come by due to the fact that criminals will not be able to snoop around to steal user passwords when using an ATM with a 4-digit passcode.

Fingerprint can be categorized as one of the most mature biometric traits and is accepted in a court of law as legitimate proof of evidence. In Information Technology (IT), biometrics refers to technologies for measuring and analyzing human physiological characteristics such as fingerprints, eye retinas and irises, voice patterns, facial patterns, and hand measurements, especially for authentication purposes. Examples of measurable behavioural characteristics include signature recognition, gait recognition, speaker recognition and typing recognition. Biometrics authentication is by measuring a person's physiological or behavioural features. In the past, the common perception of biometrics was that they were limited to use by government facilities and high-security areas. However, biometrics is becoming more prevalent in day-to-day applications. It is a type of verification that can be used for authentication when using computers for a variety of purposes. These technologies help restrict access to the system, allowing access to only those who own a gate card or id card(level 1), know a specific code(level 2), have a determined physical mark(level 4), or have a combination on of both card keys and have a determined physical mark (level 4 mainly for advance systems (Matyas, 2000).

This research will focus on developing Fingerprint based Biometric Students' Exeat Monitoring System Using Fingerprint Biometric Authentication and Mobile Short Message Service. The fingerprint Biometric is adopted in this research work for the fact that it is one of the most successful applications of biometric technology. The manual exeat method, where students have to queue up to seek Exeat, and the hostel administrator has to give a sheet of paper to students to fill, has proven to be ineffective in that it is prone to data loss, falsification and a host of other errors.

2. MATERIALS AND METHODS

The following approach was adopted so as to achieve the central idea of this work. These are requirement definition and infrastructural modelling.

2.1. Requirement Definition of the Proposed Service Infrastructure

Mobile Students Exeat Monitoring and Management System Requirement This requirement follows from the assumption that in order to automate the exeat management system, the system should provide: a) **Eligibility and Authentication**: The system should be designed in a way that only allows access to authorized personnel. b) **Uniqueness**: A student has only one Exeat, and it cannot be used by another person. c) **Accuracy**: The administrator should be able to compute records and generate exeat reports with lesser errors. d) **Integrity**: students' exeat records can only be modified, updated or deleted by the assigned administrator. e) **Reliability**: The system should work robustly without any loss of records due to good and reliable database and also should be able to notify parents/guardians in lesser time. f) **Flexibility**: More modules expected of exeat operations can be integrated into the system to increase functionality. g) **Convenience**: students should be able to enter/exit the university with minimal sign in/out time (The Don International Journal of ICT and Youth Development, 2012).

Service Provision Requirement: The infrastructure should allow the administrators to monitor registration of staff/supervisors and students, allow supervisors to grant Exeat to students, record time of Exeat granted, check student exeat number, monitor whether a particular student has returned after the exeat duration expired or not etc. 3.2 Infrastructural

Model and Architect i. Overall System Architecture The Students Exeat Monitoring Automated Systems involves two important technologies namely: i) Biometric Fingerprint Technology (Scans the fingerprints of users) ii) SMS technology (automatically sends alert to parents or guardian). The hardware phase integrated into the system is the biometrics fingerprint scanner. The software phase is divided into two sub-phases: i) Front End (application interfaces the users would interact with) ii) Back End (database where the information is stored). In designing the front and back end of the system, some development tools required are: i) Microsoft Visual Studio (.Net Framework): The programming language used is C# which is an elegant and type-safe object-oriented language that enables developers to build a variety of secure and robust applications that run on the .NET Framework. C# can be used to create traditional Windows client applications, XML Web services, distributed components, client-server applications, database applications etc. ii) Microsoft SQL Server 2005: It is a fast, stable and true multi-user, multi-threaded SQL database server; SQL (Structured Query Language). This serves as the database at the back end because it is fast, robust and easy to use. Access to the database will be limited to the administrator in order to prevent unauthorized individual from having access to sensitive information. The designed system is a client-server system that describes a network in which processing is divided between a client program running on a user machine and a network server program. The system architecture of the designed system is shown in figure 1. The system components include fingerprint scanner, exeat management system, the system database and an SMS gateway.

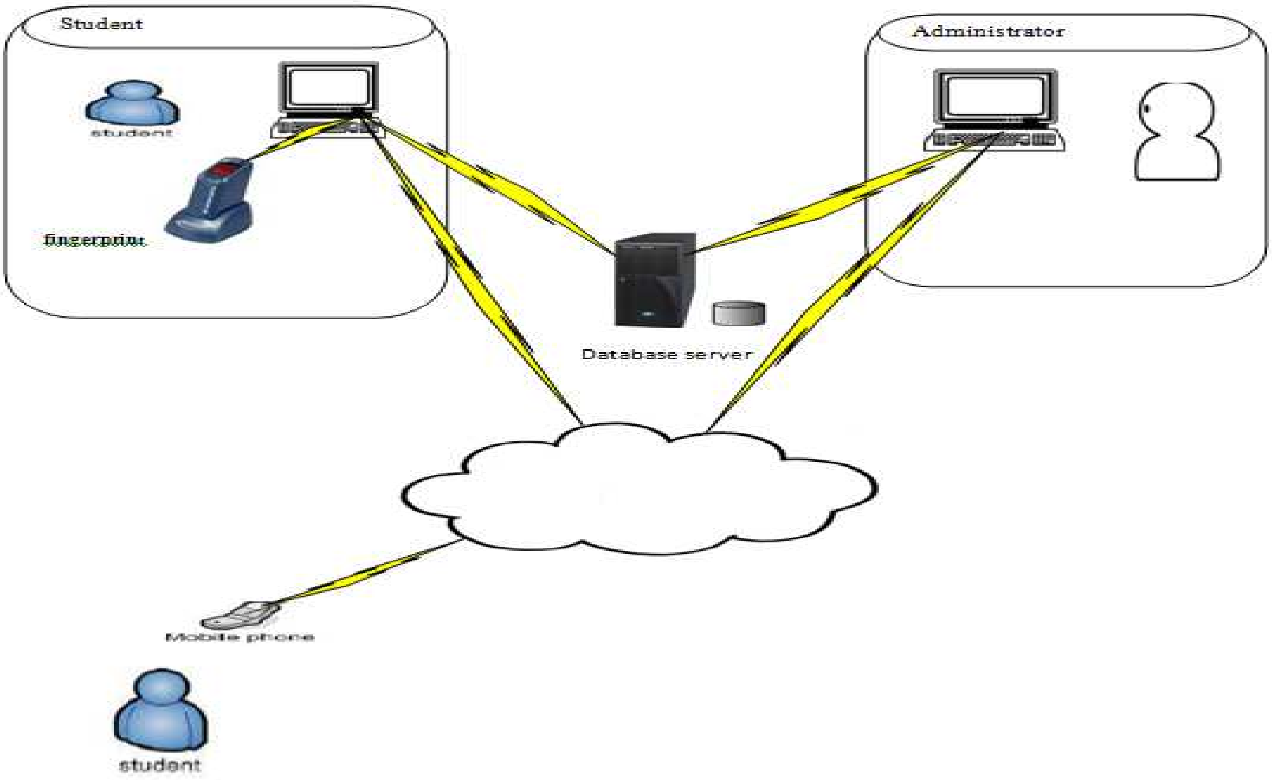


Figure 1: Architecture of the proposed system

2.2. Major System Components

The Fingerprint Scanner

The Fingerprint scanner enrolls and verifies the identity of every person based on the marks on his or hers fingers and these marks have a pattern that cannot be changed or removed. The print is made up of ridges and furrows as well as characteristics that occur at minutiae points. Standard systems are comprised of a sensor for scanning a fingerprint and a processor which stores the fingerprint database and software which compares and matches the fingerprint to the predefined database. Within the database a fingerprint is usually matched to a reference number or Pin number which is then matched to a person's name. In instance of security, the match is generally used to allow or disallow access. (Thorton, 2000).

Database Server:

In other to make comparison possible, the fingerprint representation and students matric number have to reside in a data repository. In this paper, a centralized database was used for storing each Student's data. There will also be a link between the biometric data stored in the database to some information about the Student's identity. When the database is queried, the feedback will not just include the biometric data, it also includes the personal information relating to the corresponding Student and the database was implemented using Microsoft Access 2005.

SMS Gateway

Message Alert format that is used is the Express Bulk SMS, with an SMS account opened. This will enable the Student to get SMS if granted or not granted Exeat the exeat system is implemented as a server system. It enrolls, verifiers by granting Exeat, and for the home exeat it sends an SMS over the internet to a number that has been specified in the database using **sms247.com** gateway.

2.3. Biometric Authentication Framework

Biometric authentication requires comparing a registered or enrolled biometric sample (biometric template or identifier) against a newly captured biometric sample. The biometric authentication system is used in two phases: The Enrolment phase and The Verification phase.

Enrolment Phase Design

In the enrolment phase (figure 2), a sample of the biometric trait is captured, processed by the computer and then stored in the system database for comparison at a later date. During this phase, the biometric characteristic of an individual is first scanned by a biometric reader to produce a raw digital representation of the characteristics. A quality checker is performed in to ensure that the required sample can be reliably compared during the verification stage. In order to facilitate matching, the raw digital representation is usually further processed by a feature extractor to generate a compact but expressive representation called a template. The template is then stored in the central database of the biometric system.

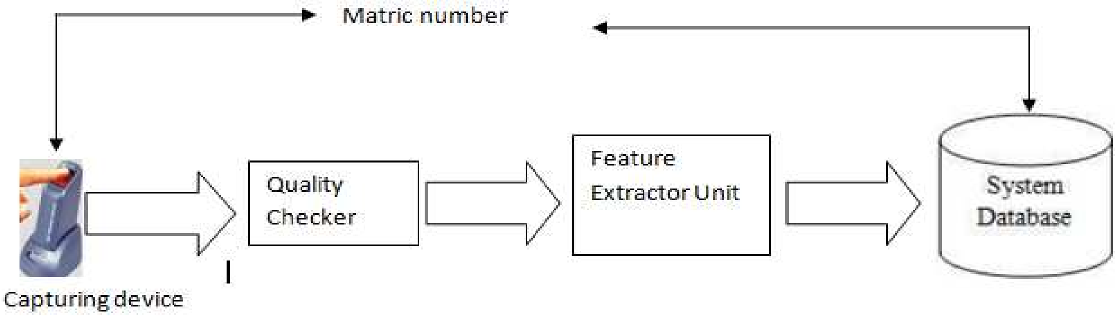


Figure 2: Enrollment phase design

Verification Phase Design

In the verification phase (figure 3), the biometric system authenticates a student's claimed identity from their previously enrolled pattern and this is also called one-to-one matching. The verification task is responsible for verifying individuals at the point of access. During operation the students matric number, room number and the type of Exeat (either day or home exeat) is inputted, at the gate the biometric reader captures the characteristics of the individual to be recognized and converts it to a digital format, which is further processed by feature extractor to produce a compact digital representation. The resulting representation is fed to the feature matcher, which compares it against the template of a single user retrieved from the system database.

In the biometric exeat system, the verification would be done at the gate after the supervisor has collected the student information and inputted it. At the gate a finger is used to authenticate the Student and if there is match, the Student is allowed to leave the school premises.

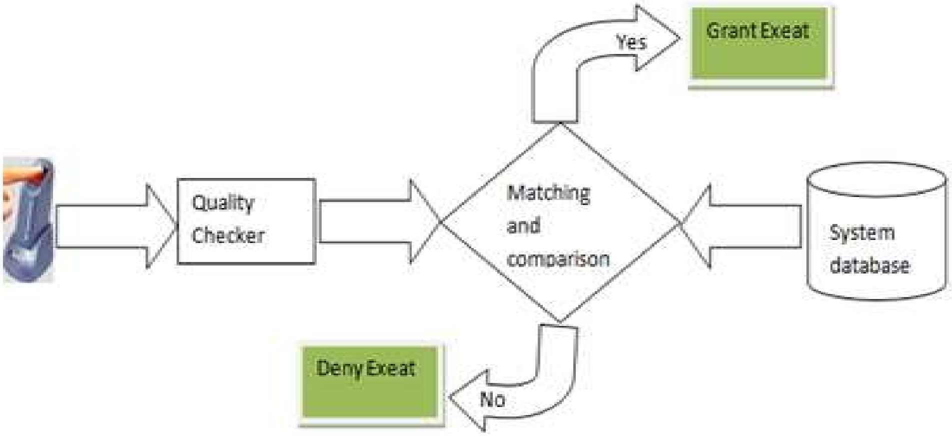


Figure 3: Verification phase Design

2.4. Model Analysis

The structure of the proposed system model can be analyzed using the use-case diagram, class diagrams sequence diagram and flowchart diagram. The use-case scenario of the infrastructure is shown in Figure 4 showing the interactions of the porters, guardians/parents and students on each tier of the model. The use case diagram has three actors. The registered porter login into the desired Mobile Students Exeat Monitoring and Management System Service, identified the Student requesting Exeat in the system, grant exeat to Student. If the Student desired to go home, an SMS alert is automatically sent to the Student by the administrator to notify them. All information here is stored in the database and can be used for future reference. Figure 4 shows case diagram of the Mobile Students Exeat Monitoring Systems Using Fingerprint, Figure 5Class diagram of the Mobile Students Exeat Monitoring Systems Using Fingerprint Biometric Authentication and Figure 6Sequence diagram of the Mobile Students Exeat Monitoring Systems Using Fingerprint Biometric Authentication.

2.5. Use Case

Use case describes the system from the user perspective in a manner they will understand. Use case is an instrument in project development and document of system requirements. It specifies a set of interactions between two users to achieve a particular goal. Use cases are the result of composing the scope of the system functionality into many smaller statements of system Functionality (Whitten, 2004). It is valuable for system developers; it is a tired and effective technique for gathering systems from user point of view. Besides drawing the diagram, it allows you to document the requirements details. It describe the action a user will perform in order to use the system.

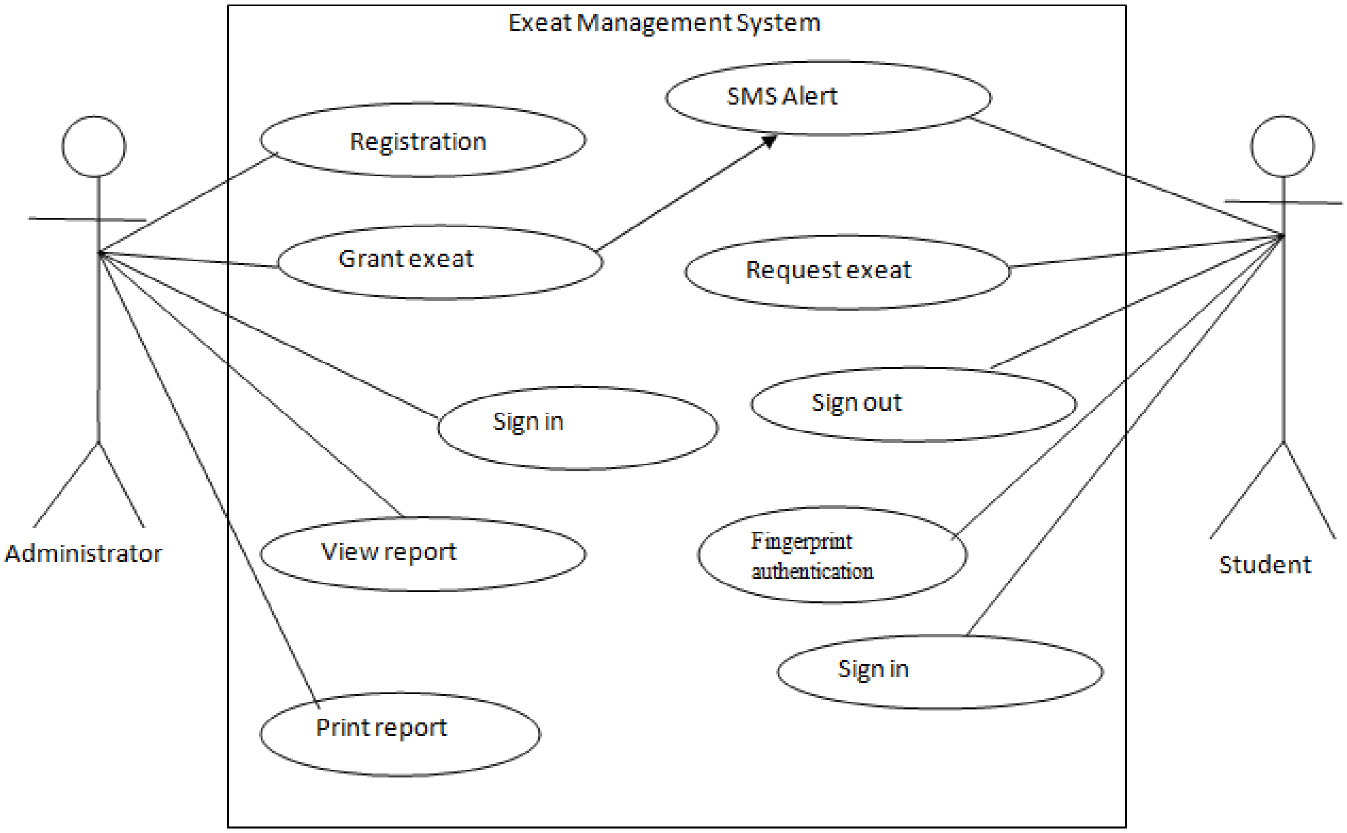


Figure 4: Use case diagram of the Mobile Students Exeat Monitoring Systems Using Fingerprint Biometric Authentication

2.6. User Activities

The most common activities carried out by user are illustrated bellow

1. The Student can sign up/do registration with the system
2. The Student can request for Exeat
3. The registered user can login to the proposed system
4. The registered user can grant Exeat
5. The user can also logout when he/she done with the system

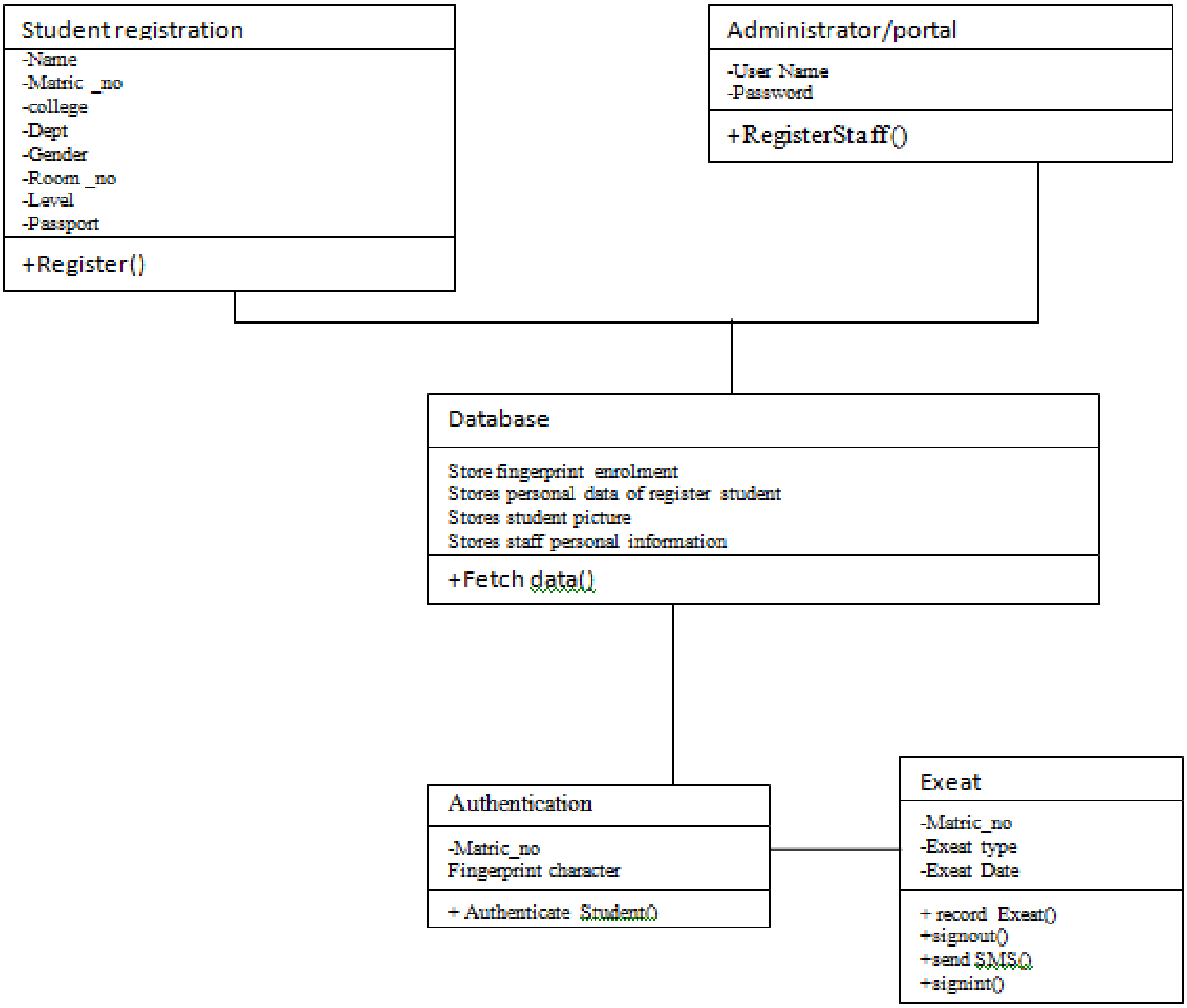


Figure 5: Class diagram of the Mobile Students Exeat Monitoring Systems Using Fingerprint Biometric Authentication

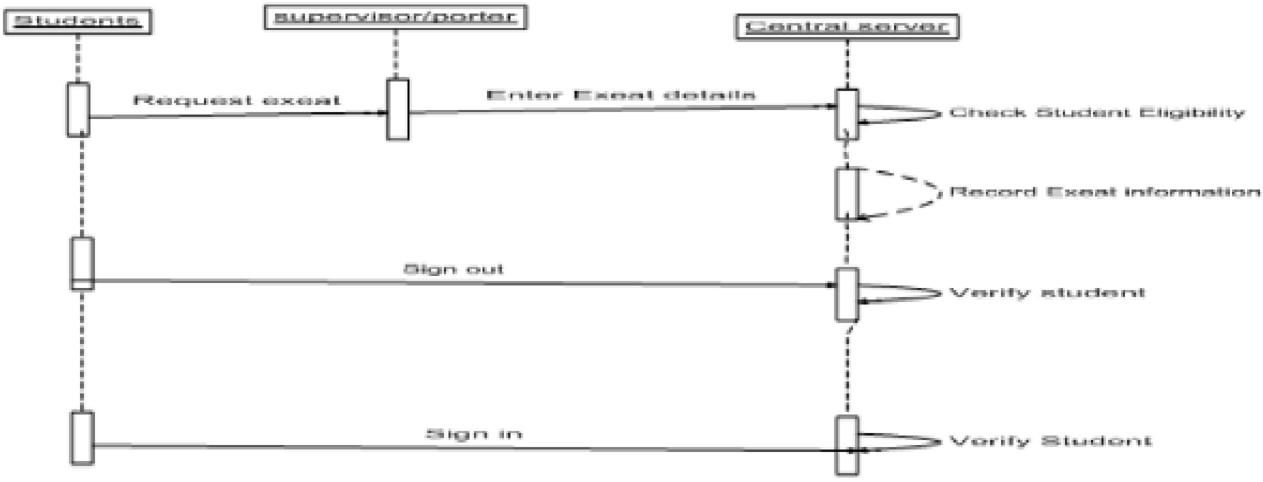


Figure 6: Sequence diagram of the Mobile Students Exeat Monitoring Systems Using Fingerprint Biometric Authentication.

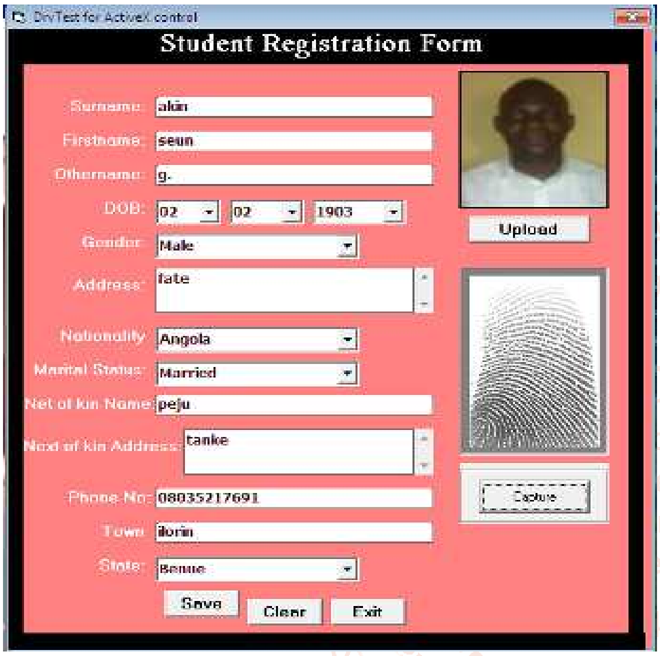
3. IMPLEMENTATION AND TESTING

System design is the phase of software development that follows the system analysis phase. It is the solution mapping out stage, the way or method problem discovered during the system analysis stage is map out arranged planned and designed. The implemented system was tested using actual students' data in a typical university setting. During testing the staff logs in using his or user name and password and is allowed to grant day and home exeat, manage student records, enroll new students and then monitor if the Student has returned at the expectedtime or not. The system grant the day and home exeatand then sends an SMS to the student phone number via the SMS gateway; stating that the Student had been or not granted Exeat and then when that Student returns it verifies that the person has returned. The exeat grant page is in two forms: the home and day exeat. This page is used to manage the type ofExeat that the Student has been granted. It keeps a record of the entire Student and their information. The Student that requires the Exeat is selected from the list and granted the Exeat either day or home, when this is done the status of the Student changes to: "student name" has not signed in.For a successful request granted, in the case of the day and home exeat as shown in figure 12 the system displays the message "Approval sent successfully" as shown in figure 12, once this is done, it shows the message "an SMS has been sent" to confirm the SMS deliver

3.1. Input Requirements

The system is designed to accept input data via the keyboard and the fingerprint device. This gives the detailed specification and format of the input required to generate the output. The web page is basically menu driven and choice is being made based on the option.

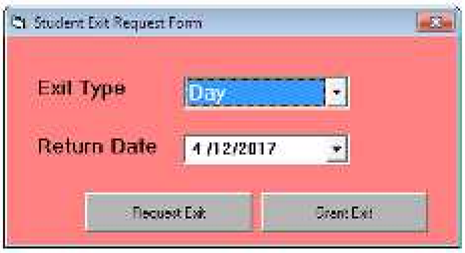
Figure 7shows the screen shot of input required for Student Registration


DrvTest for ActiveX control

Student Registration Form

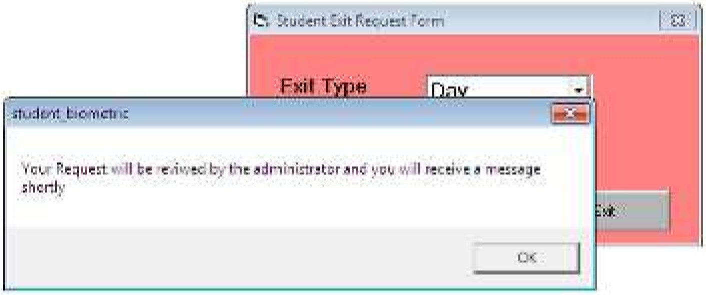
Surname: akin
Firstname: seun
Othername: g.
DOB: 02 02 1903
Gender: Male
Address: fate
Nationality: Angola
Marital Status: Married
Net of kin Name: peju
Next of kin Address: tanke
Phone No: 08035217691
Town: ilorin
State: Benue

Figure 7: Student Registration Form


Student Exit Request Form

Exit Type: Day
Return Date: 4 /12/2017

Figure 8: Student login to request for exeat

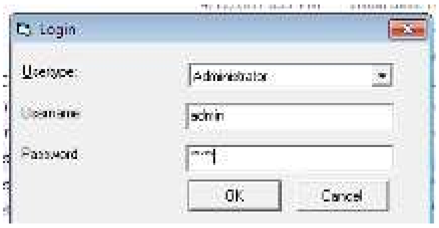

Student Exit Request Form

Exit Type: Day

student_biometric

Your Request will be reviwed by the administrator and you will receive a message shortly

Figure 9: Student Request for Day Exeat


Login

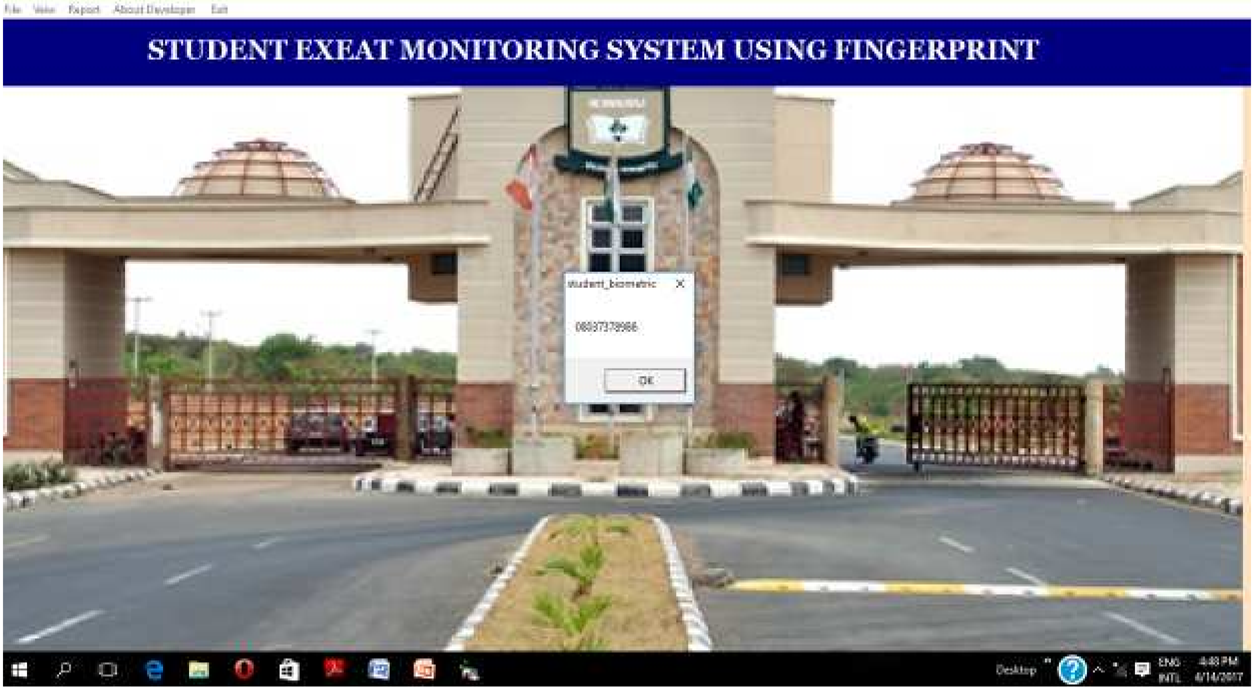
Usertype: Administrator
Username: admin
Password: ***

Figure 10: Admin Login

3.2. New Output Requirement

The most important output device here is the student cell phone. The output of the system will sent as an SMS to the student phone stating either granted or denial an exeat.

Figures11to figure 13 shows output generated by the system (Student Exeat Monitoring Sytem)



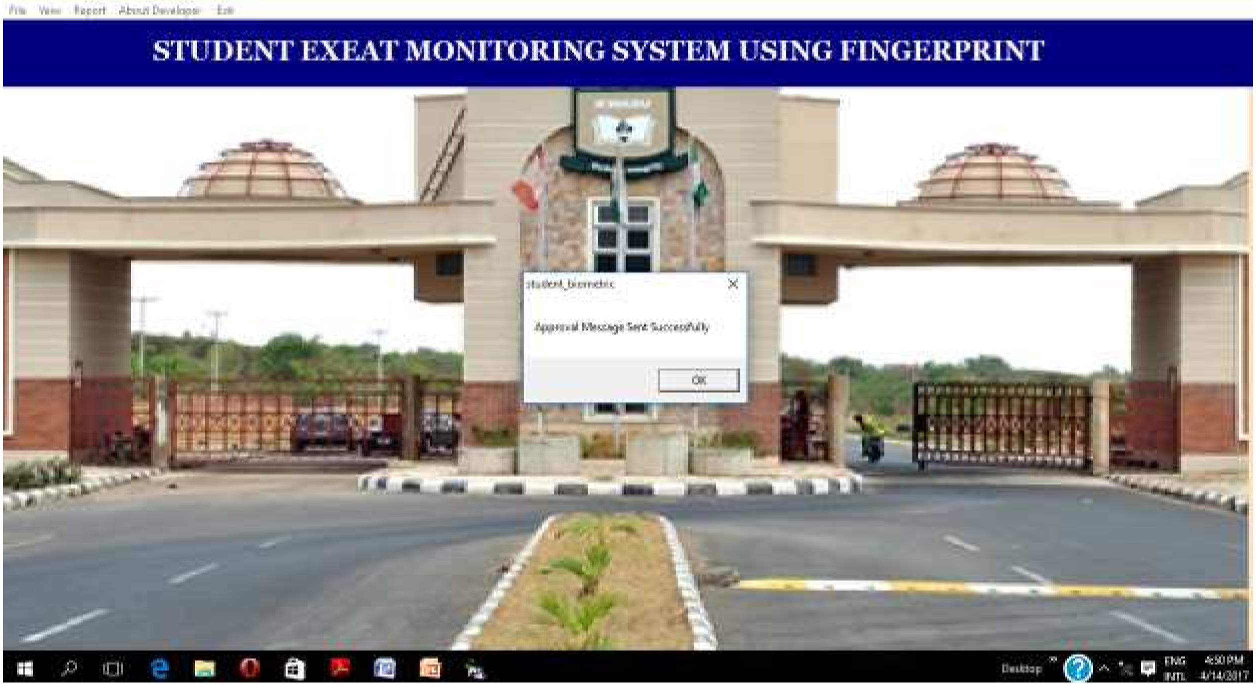
STUDENT EXEAT MONITORING SYSTEM USING FINGERPRINT

student_biometric

08037378986

OK

Figure 11 Home page of Exeat Monitoring System



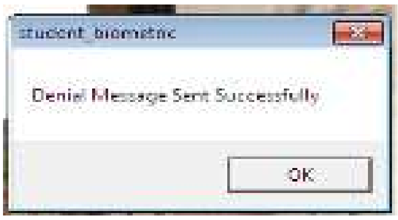
STUDENT EXEAT MONITORING SYSTEM USING FINGERPRINT

student_biometric

Approval Message Sent Successfully

OK

Figure 12 Approval message sent to student



student_biometric

Denial Message Sent Successfully

OK

Figure 13: Denial Message

3.3. Implementation

Implementation is physically converting the old information system to the new or modified one. There are many conversion strategies available to analysts, and also a contingency approach that takes into account several user and organizational variables in deciding which conversion strategy to use. There is no single best way to proceed with conversion. The importance of adequate planning and scheduling of conversion with the strategic involvement of users, file backup, and adequate security cannot be overemphasized. Shelly (2011)

Implementation is the act on making the designed system work as describe in the aims and objective of the project proposed.

The new system is now ready to go to work. The earlier design activities produced, the overall architecture and processing strategy are to be implemented.

3.4. Conversion Strategies

Parallel approach

In this project the approach that will be use in the implementation is parallel approach, in parallel change over, the new system runs simultaneously with the old for a given period of time. of all techniques, this tends to be the most popular, mainly because it carries the lowest risk. If something goes wrong at any point, the entire system can be reverted back to its original state.

3.5. Testing and Evaluation

After coding, I test each program to make sure it functions correctly. The first step is to compile the program using language compiler. This process detects **syntax errors**, which are language grammar errors. I correct the errors until the program executes properly.

Next, I desk-checks the program. **Desk checking** is the process of reviewing the program code to spot **logic errors**, which produce incorrect results.

Testing is done throughout systems development, not just at the end. It is meant to turn up heretofore unknown problems, not to demonstrate the perfection of programs, manuals, or equipment.

Although testing is tedious, it is an essential series of steps that helps ensure the quality ofthe eventual system. It is far less disruptive to test beforehand than to have a poorly tested system fail after installation. Testing is accomplished on subsystems or program modules as work progresses. Testing is done on many different levels at various intervals. Before the system is put into production, all programs are desk checked, checked with test data, and checked to see if the modules work together with one another as planned.

3.6. Testing

Admin, Login

Registration of New Student

Step 1. run the program
Step 2. enter the student data
Step 3. load the passport
Step 4. Enter fingerprint biometric
Step 5. Submit

Modify Student Record

Step 1. run the program
Step 2. edit as desire
Step 3. Submit

Student Login

Request for Exeat

Step 1. Login as Student
Step 2. Enter matric number
Step 3. Request for Exeat
Step 4. exit

3.7. Evaluation

Cohesion and coupling are important technical tools for evaluating the overall design.

A. **Cohesion** measures a module's scope and processing characteristics. A module that performs a single function or task has a high degree of cohesion, which is desirable. Because it focuses on a single task, a cohesive module is much easier to code and reuse Shelly (2011).

B. **Coupling** describes the degree of interdependence among modules. Modules that are independent are **loosely coupled**, which is desirable. Loosely coupled modules are easier to maintain and modify, because the logic in one module does not affect other modules Shelly (2011).

C. **Users Evaluation:**

1. Is the newly design system suitable for Learning Center?
2. Will the newly design system increase the efficient of the Learning Center?
3. Does the newly design system interface look friendly to the users?
4. Did you agree that the newly design system is users friendly?

After proper evaluation the system users accept and agree that the Student Exeat monitoring system will assist in no small way in tackling the issue of impersonation and data lost.

3.8. Change over Techniques

Parallel approach

In this project the approach that will be use in the implementation is parallel approach, in parallel change over, the new system runs simultaneously with the old for a given period of time. of all techniques, this tends to be the most popular, mainly because it carries the lowest risk. If something goes wrong at any point, the entire system can be reverted back to its original state.

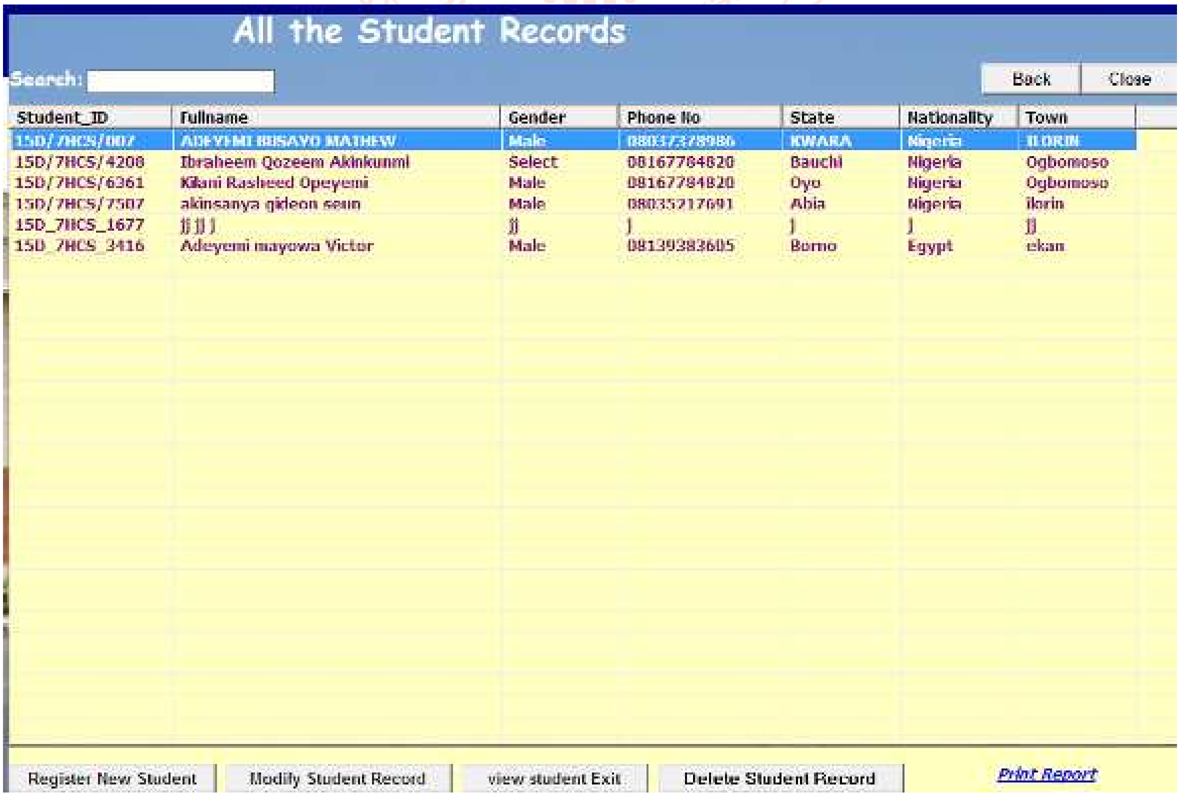
3.9. system documentation and testing

Result after testing of the designed and simulated system shows that exeat monitoring system is less prone to forgery as stakeholders are carried along, capable of preventing impersonation among students, and provide absolute electronic compliance to the policy of issuing Exeat to students in the University Halls of Residence.

4. RESULTS

The implemented system was tested using actual students' data in a typical university setting. During testing the staff logs in using user name and password and it was allowed to grant day and home exeat, manage student records, enroll new students and then monitor if the Student has returned at the expected time or not. The system grant the day exeat by verifying the fingerprint of the Student and then it notifies the supervisor in charge the number of Exeat that has been granted. For the home exeat it grants the Exeat and then sends an SMS to the guardians phone number via the SMS gateway; stating that the Student or ward has left school, and then when that Student returns it verifies that the person has returned. The exeat grant page is in two forms: the home and day exeat. This page is used to manage the type of Exeat that the Student has been granted. It keeps a record of the entire Student and their information. The Student that requires the Exeat was selected from the list and granted the Exeat either day or home, when this is done the status of the Student changes to: "student name" has not signed in. For a successful request granted, in the case of the day exeat as shown in figure 7 to figure 9 the system displays the message "exeat granted" while for home exeat request it grants the system shows the message "now sending SMS" as shown in figure 13, once this is done, it shows the message "an SMS has been sent" to confirm the SMS delivery.

A sample report page is shown in figure 14 and this page displays the student name, matric number, the type of Exeat collected, expected date of return and finally if that Student has returned or not. A returning student status is update once they confirm their return with their fingerprint thus, with this approach there is no problem of uncertainty as to whether a student returned or not as the system can automatically accurately monitor Exeat.



Student_ID	Fullname	Gender	Phone No	State	Nationality	Town
15D/7HCS/007	ADEYEMI BISAYO MATHEW	Male	08037378986	KWARA	Nigeria	ILORIN
15D/7HCS/4208	Ibraheem Qozeem Akinkunmi	Select	08167784820	Bauchi	Nigeria	Ogbomoso
15D/7HCS/6361	Kilani Rasheed Opeyemi	Male	08167784820	Oyo	Nigeria	Ogbomoso
15D/7HCS/7507	akinsanya gideon seun	Male	08035217691	Abia	Nigeria	ilorin
15D_7HCS_1677	jj jj j	jj	j	j	j	jj
15D_7HCS_3416	Adeyemi mayowa Victor	Male	08139383605	Borno	Egypt	ekan

Figure 14: Student Record

5. CONCLUSIONS

This research was developed to solve inaccuracy, insecurity and impersonation challenges of the current paper based exeat system in use in most institution Halls of Residence. With aid of a fingerprint biometric authentication, impersonation of other students is eradicated.

The biometric device authenticates each Student before granting access; ensuring that no student can take more the required number of the Exeat per unit time. The mobile short message service informs the Student that he/she has been granted or not granted Exeat.

This research can be improved by the existing system in the following ways: Provide electronic solution to the existing method of issuing Exeat to Student which is paper based; discourage and prevent impersonation; Allow the school management to know the number of students that are within and outside the campus at a particular time; Eliminates the cost of making several copies of paper exeat and allow the university administrator to have a report of the Student's exeat activities.

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