

OBCAMS: An Online Biometrics-based Class Attendance Management System

E. Adetiba & O. Iortim

Department of Electrical & Information Engineering
Covenant University
Canaanland, Ota, Ogun State, Nigeria.
emmanuel.adetiba@covenantuniversity.edu.ng, lord2dean@gmail.com

A.T. Olajide

Department of Computer Science
Kwara State Polytechnics
Ilorin, Kwara State, Nigeria
linkanthonyolajide@gmail.com

R. Awoseyin

Rollar Cecilee Communications
Ibrahim Taiwo Road
Ilorin, Kwara State, Nigeria
rawoseyin@yahoo.com

ABSTRACT

The importance of attendance taking and processing in educational institutions and corporate organizations cannot be over emphasized. Up till date, most institutions engage in the use of paper and pen in taking and processing of class attendance and this has proven to be very stressful, time consuming, unreliable, inaccurate and inefficient. However, it has been empirically proven over the years that no two human beings have the same fingerprint. Therefore, we adopted fingerprint biometrics in this work to develop an object-oriented web based software application named OBCAMS (Online Biometrics-based Class Attendance Management System) for processing and management of class attendance. The developed system is not only robust but trial tests conducted using 60 sample students in Covenant University, Ota, Nigeria, achieved an average of 89.33% accuracy for first signing attempt.

Keywords: Attendance, Biometrics, Fingerprint & OBCAMS

African Journal of Computing & ICT Reference Format:

E. Adetiba, O.Iortim, A.T. Olajide & R. Awoseyin (2013). OBCAMS: An Online Biometrics-based Class Attendance Management System. Afr J. of Comp & ICTs. Vol 6, No. 3. pp 25-38.

1. INTRODUCTION

The need for an effective and reliable attendance system in any organization (such as schools, banks, factories, hospitals and etc) has become of paramount importance as this can help determine the timeliness of any staff or student. In tertiary institutions in Nigeria for instance, it is mandatory for all students to make 70% attendance before they are eligible to write the exams in a given course. Hence, there has to be reliability and accuracy when taking this attendance. Apart from paper and pens used in taking attendance, a lot of researchers and designers have come up with various other methods in taking attendance. Some of these methods include: Web-Based, Smart Board, Mobile devices, RFID chips and Biometric based attendance systems.

In biometric based systems, bio-features of each student such as their fingerprints, voice, face, palmprint and iris can be used to verify student's presence in class. Biometric methods are much more reliable, help to save the cost of producing smart (RFID) identity cards, easy to use and quite affordable. They have proven to be very handy in curbing the problems related to forgotten pins, lost cards, and the potential for misuse due to bullying. Instead of basing identity authentication on what someone possesses or what someone knows, biometric identification is based on what one is, or how one behaves. This approach to identification is made possible by technology developments that enable precise measurement coupled with computational power that allows measurements to be transformed into mathematical representations that can be rapidly compared [1].

Fingerprint biometrics is one of the most common biometric methods and it has been used for more than one hundred years as a proof of individual identification for forensic and law enforcement purposes. These days with advancement in technology, fingerprints of individuals are acquired by electronic or optical sensors that turn patterns once only defined as whorls and arches into mathematical representations called biometric templates. A lot of research works have adopted fingerprint biometrics to develop electronic attendance system with remarkable benefits and some inherent shortcomings.

Chitresh Saraswat [2] developed an Automatic Attendance System using Fingerprint Verification Technique. This work did not only focus on attendance management, but also on the specification of accuracy of the minutiae during enrolment and verification process. A high degree of accuracy in the enrolment and verification process was reported by the author, however, the attendance management software is a desktop application; hence it can only be used on standalone PCs where the application is installed. Rufai et. al. [3] developed a Biometric Model for Examination Screening and Attendance Monitoring. The model was developed to ensure that impersonation does not take place during examinations. The authors reported that the use of biometric devices helped to reduce impersonation since one student cannot misuse, forge or steal another student's biometric identity.

However, it was reported that fingerprint scanners used tend not to read fingerprints properly and this lead to denial of some students from taking their examinations. Mohd Zamzury Bin [4] built an attendance management system using fingerprint scanner to monitor the students in lectures and tutorials in a more efficient way as compared to the traditional means of paper and pen. Meanwhile, the system is a windows desktop application which inherently imposed a constraint on prompt generation of students' attendance report.

Most fingerprint biometrics-based attendance systems developed so far are prone to the same shortcomings reported by the reviewed works in this paper, some of which include; low sensitivity of fingerprint scanner and stand-alone desktop based architecture. However, OBCAMS is developed to overcome most of these shortcomings. It is a web-based platform which can be deployed on a server within a campus wide intranet. With this kind of architecture, processing of attendance data that are captured from different classrooms are centralized on the server and reports can be generated, viewed and printed by any host(s) on the same network as the server. Also, SecuGen fingerprint scanner is adopted for capturing of students' fingerprints. SecuGen Hamster Plus, the model utilized for OBCAMS is based on minutiae, the feature points around the core of each individual fingerprint. A portion of the minutiae is sampled from a captured fingerprint, processed using extraction algorithm and converted to a template which can be used for enrollment or matching [5]. The subsequent sections contain the design, implementation and performance evaluation details of OBCAMS.

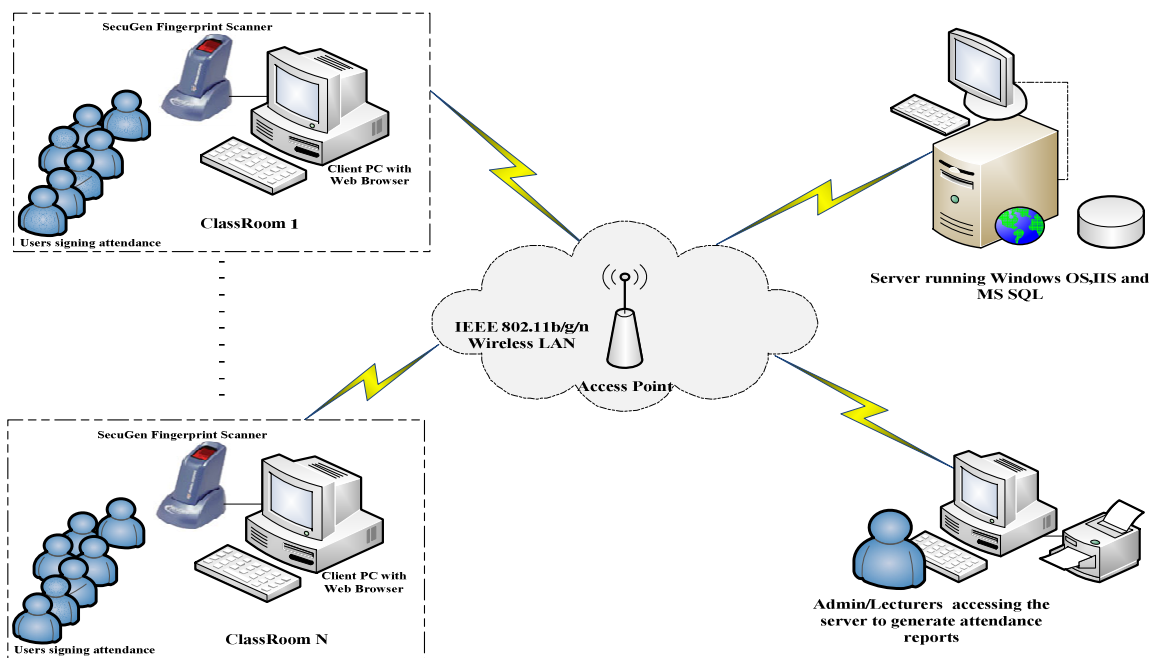


Figure 1. System Architecture

2. SYSTEM ARCHITECTURE

The system architecture is comprised of both hardware and software components as shown in Figure 1. As illustrated in the diagram, the hardware components comprises of SecuGen Hamster Plus fingerprint scanner, Personal

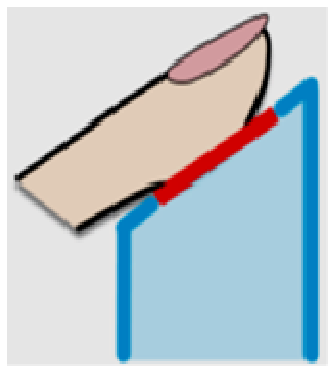
Computer (PC), IEEE 802.11b/g/n access point, Server computer and Printer. The SecuGen fingerprint sensor contains optic module, board with CPU, memory and embedded algorithms. The technical details are shown in Table 1.

Table 1: Technical Specification of SecuGen Fingerprint Scanner [6]

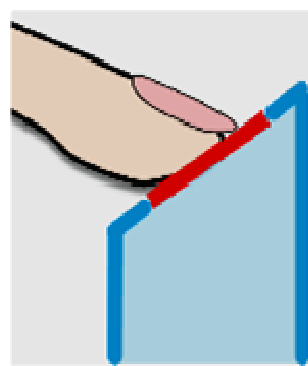
S/N	Description	Specification
1	Image Resolution / Size	500 DPI / 260 x 300 pixels
2	Sensing Area / Platen Size	13.2 x 15.2 mm / 16.1 x 18.2 mm
3	Fingerprint Capture Time	0.2 ~ 0.5 second with Smart Capture
4	Light Source / Typical Lifetime	LED / 60,000 hours
5	CPU / Flash Memory	400 MHz ARM / 32 MB
6	Storage Capacity	3,000 Users (1:1 or 1:N)
7	Minutiae Extraction Time	< 0.4 second
8	Matching Time (1:1)	< 0.1 second
9	Matching Time (1:N)	< 0.2 second
10	Fingerprint Template	SecuGen, INCITS 378, ISO 19794-2
11	Communication Speed (max)	460,800 bps (RS 232, CMOS Serial)
12	External Interface	RS232 Serial, Wiegand, GPIO
13	Dimensions / Weight	59 x 43 x 8 mm / 16 g
14	Supply Voltage	3.3 V DC
15	Current Consumption	120 mA (idle), 320 mA (operating)
16	Operating Temperature	-20o ~ 65o C
17	Operating Humidity	90% or less RH, noncondensing

To achieve optimum result, the proper positioning of the finger on the scanner is essential. The pad of the finger (which is the fleshy part located near the middle of the first segment of the finger) should be placed at the center of the SecuGen scanner [5,6]. This is illustrated in Figure 2. The minimum configurations for the Server computer are; 4 Gigabyte RAM, 160 Gigabyte Hard Disk Drive (HDD), Intel Core 2 Duo Processor with a 22' Monitor. For the Client PCs, the minimum configurations are; 1 Gigabyte RAM, 40

Gigabyte HDD, Intel Dual Core Processor and 15' Monitor. The software components of the Server include Microsoft Operating System (Windows 7) on which Internet Information Server (IIS) is enabled. IIS is the web-server for hosting the OBCAMS web application. MS SQL is also installed on the server computer to serve as the database system for the platform. On the client system, Windows 7 Operating System which contains the



Correct Finger Positioning



Incorrect Finger Positioning

Figure 2. Positioning of Fingers on the SecuGen Fingerprint Scanner [5]

Internet Explorer web browser is installed. The driver for SecuGen fingerprint scanner is also installed on the

client system for communication between the fingerprint hardware and the client PC.

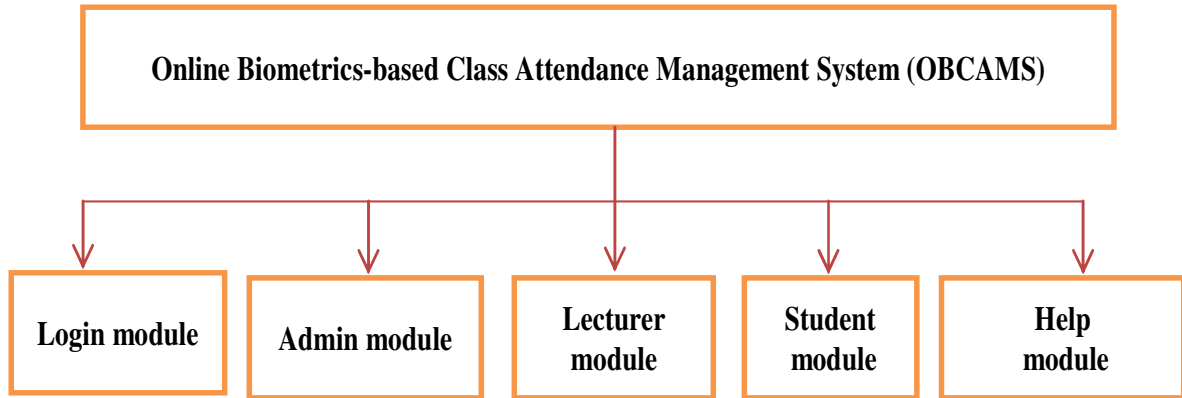


Figure 3. The Block Diagram of OBCAMS

3. LOGICAL DESIGN AND MODELING

OBCAMS is a web application that was thoroughly designed, modeled and implemented with standard tools of software engineering. Software system design is a creative activity in which software components and their relationships, based on customer's requirements are identified. It is the process of defining the modules, interfaces and the architecture of the system to satisfy the user requirements [7]. Figure 3 shows the block diagram of the different modules in OBCAMS.

We carried out various requirement analyses in this work in order to make the system very robust. A requirement states the attributes and characteristics that a system is expected to possess so as to meet the need of a user. In the object oriented analysis and design, Unified Modeling Language (UML) is used to model functional and behavioral attributes of software components and modules. The UML diagrams used here are Use Case, Class, Sequence and Activity diagrams [8]. These diagrams capture the functional requirements, structure and behavioral dynamics of OBCAMS.

3.1 Use Case Diagram

The Use Case model of the UML is used here to specify the functionality of the system from the users' point of view and show the way the system and the users interact to achieve its stated functions and perform its goal. Figure 4 shows the Use Case diagram for OBCAMS.

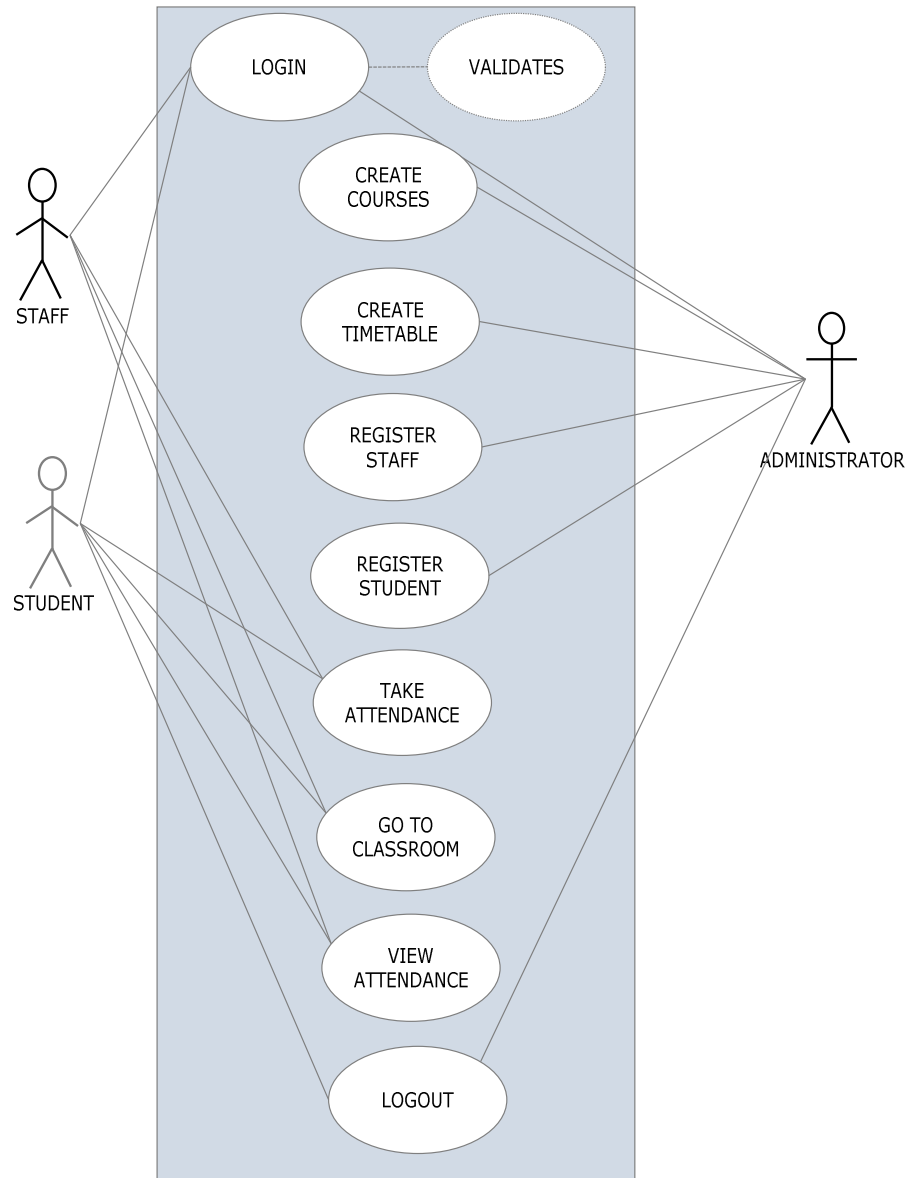


Figure 4. Use Case model of OBCAMS

The Use Case diagram in Figure 4 is explained as follows:

Actor: *Student*

Description: login to the application, go to virtual classroom, take attendance, view attendance status and logout

Pre-Condition: the student must have his or her matriculation number and password created by the administrator.

Flow of Events (Actor’s description):

- i. The student logs into the online attendance management system,
- ii. The student goes to the classroom,
- iii. The student proceeds to sign his or her class attendance.
- iv. The student inputs his or her fingerprint on the scanner to verify his/her identity.
- v. The student then logs out.
- vi. Use case ends.

Actor: Lecturer

Description: To view students that have signed, take attendance and view the attendance status of the students taking a particular course at a particular time.

Pre Condition: This actor must be a staff of the University with a valid staff ID and password as created by the administrator.

Flow of Events (Actor’s description):

- i. The lecturer logs into the system.
- ii. The Lecturer goes to the classroom.
- iii. Lecturer views the list of students signed in to his class at the moment and can take his own attendance.
- iv. Lecturer then views the students’ attendance status for the day, week, month and semester.
- v. The lecturer signs out.
- vi. Use case ends.

Actor: Administrator

Description: To create accounts for all user groups, create courses, timetables, map out lecturers, student and their respective courses.

Pre Condition: This actor must be conversant with how this system works as well as the pro’s and con’s of the system and has technical expertise.

Flow of Events (Actor’s description):

- i. The administrator logs in with his username and password.
- ii. The administrator creates the course and their respective course codes.
- iii. The administrator registers lecturers and students.
- iv. The Administrator creates a timetable as specified by the school management.
- v. The administrator the maps students and their respective lecturers.
- vi. Administrator logs out.
- vii. Use case ends.

3.2 Class Diagram

Class diagrams are the most popular UML diagrams used by the object oriented community. It describes the objects in a system and their relationships. Class diagram consists of attributes and functions. A single class diagram describes a specific aspect of the system and the collection of class diagrams represents the whole system. Basically the class diagram represents the static view of a system [8]. The class diagram for the online attendance management system is shown in Figure 5.

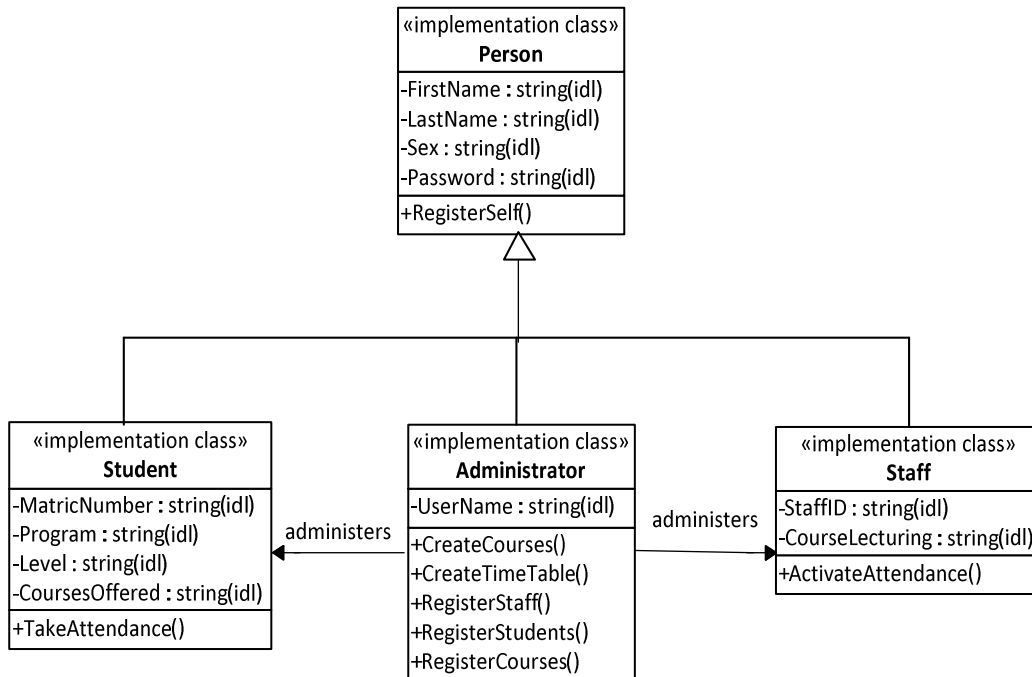


Figure 5. Class diagram of OBCAMS

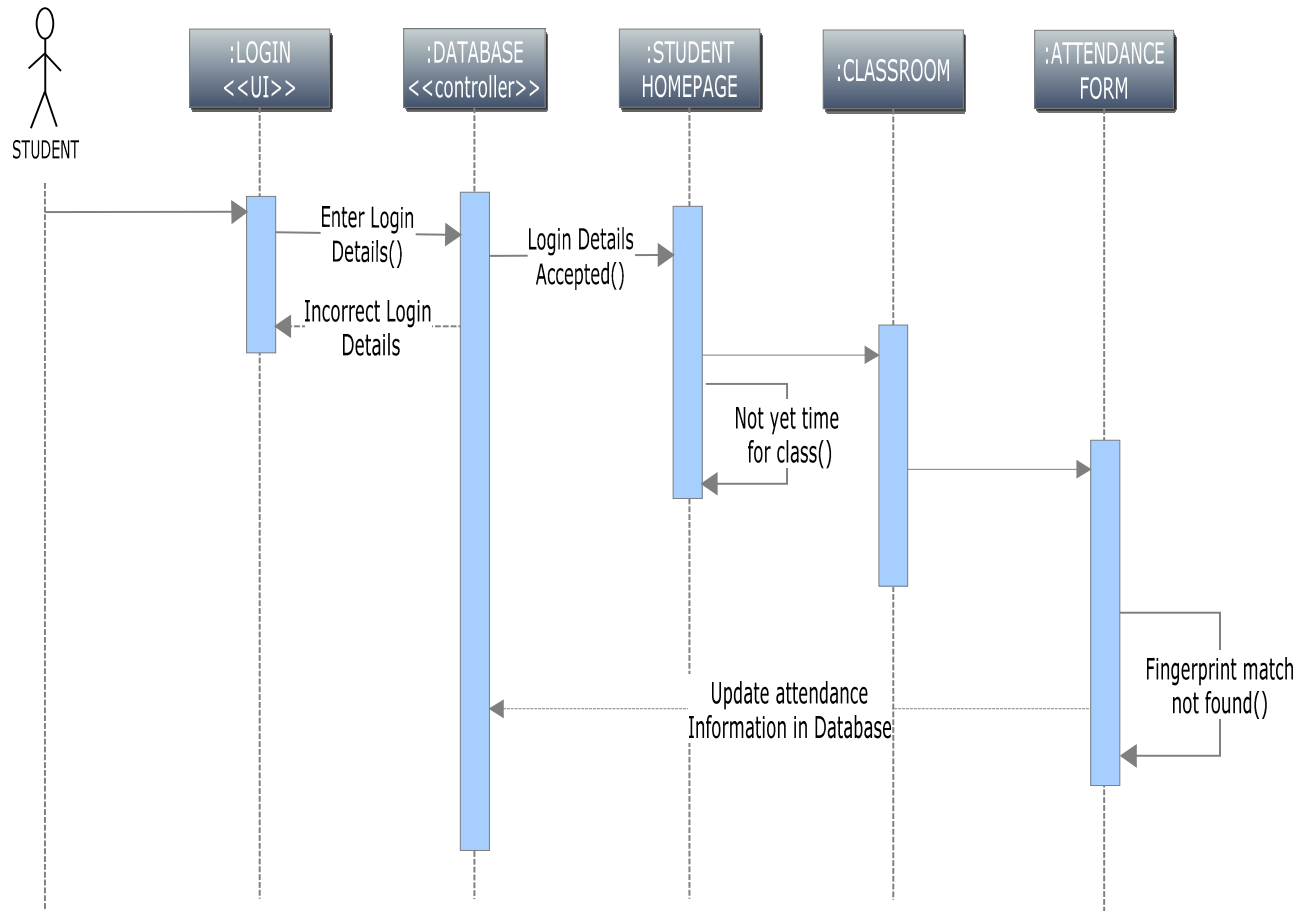


Figure 6. Sequence diagram for student

3.3 Sequence Diagram

Sequence diagrams show the relationships between the objects participating in a given use case. They help to identify interaction between objects, describe the flow of messages, events and actions between objects; Figure 6 shows the sequence diagram of the student (a use case actor), OBCAMS and the database. A use case is a collection of interactions between external actors and a system.

3.4 Activity Diagram

Activity diagram is another important diagram in UML used to describe the dynamic aspects of a software system. Activity diagram is basically a flow chart of an object-oriented system used to represent the flow from one activity to another. The activity can be described as an operation of the system. So the control flow is drawn from one operation to another. This flow can be sequential, branched or concurrent. The modeled activity diagrams for OBCAMS are as shown in Figures 7,8 and 9

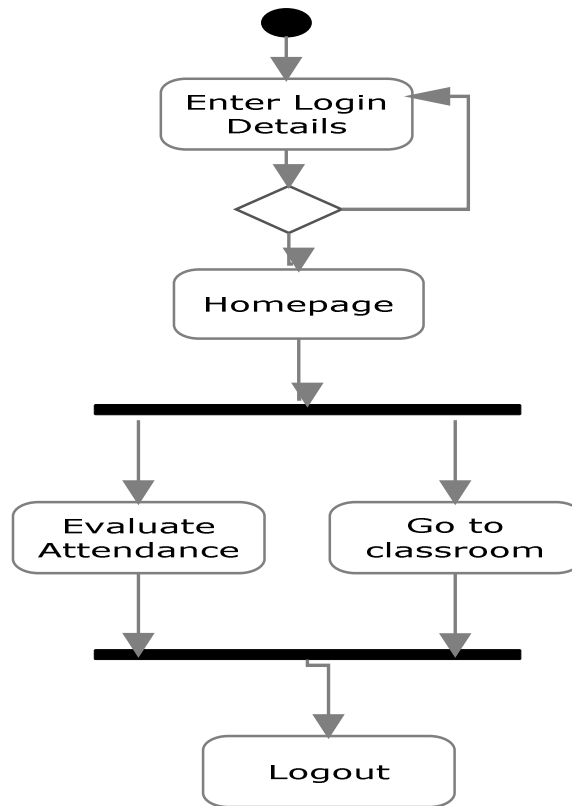


Figure 7. Activity Diagram for Lecturer

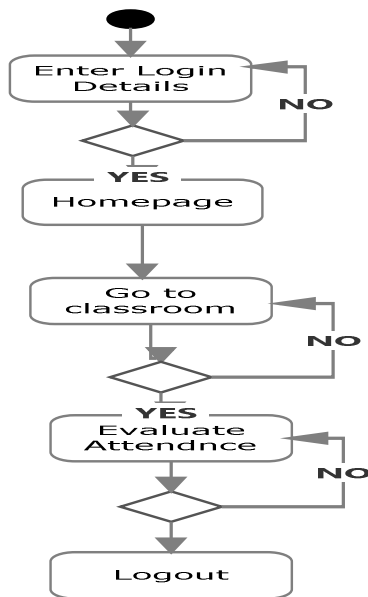


Figure 8. Activity Diagram for Students

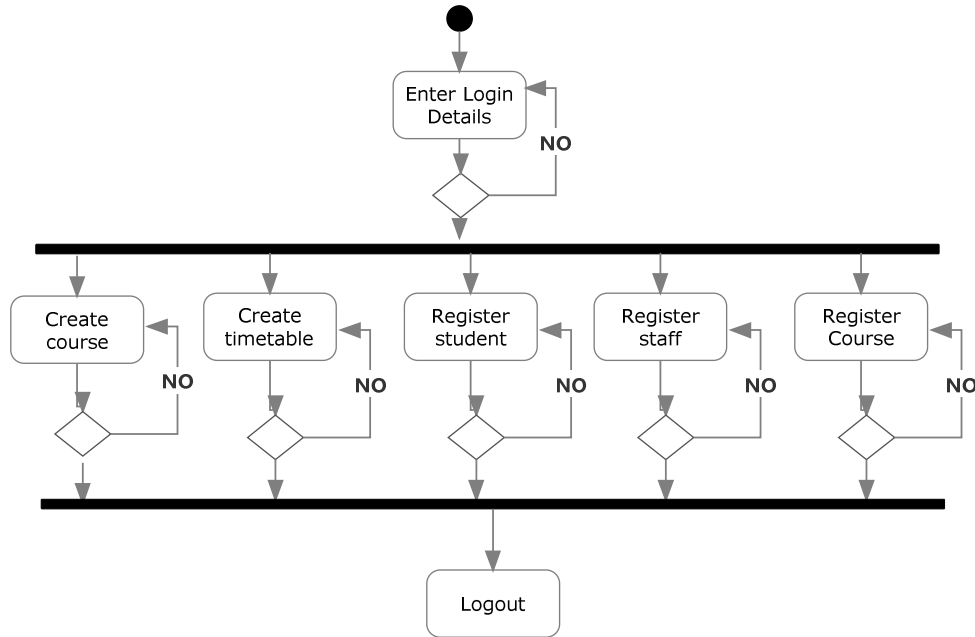


Figure 9. Activity Diagram of Administrator

4. WEB INTERFACE AND DATABASE DESIGN

In dynamic web development, three main tiers are required which include; web server, server-side codes (using an appropriate server side programming language) and a database. Dynamic means that the user interacts more with the web site beyond just reading pages, and the web site responds accordingly. The function of the web server which in this case is the Internet Information Server (IIS) is to deliver web pages via an assigned IP address or a domain name [9, 10].

OBCAMS, which is a web-based system contains about a total of seventeen (17) web pages (both static and dynamic) which range from the index page, student page, lecturer page, administrator page, lecturer login page, student login page, admin login page and so on. The web pages were designed using a text editor known as Notepad++ and Microsoft Visual Studio 2010 which provides ASP.NET (the server side coding platform), HTML and CSS capabilities. The interconnection of the various web pages is illustrated in Figure 10

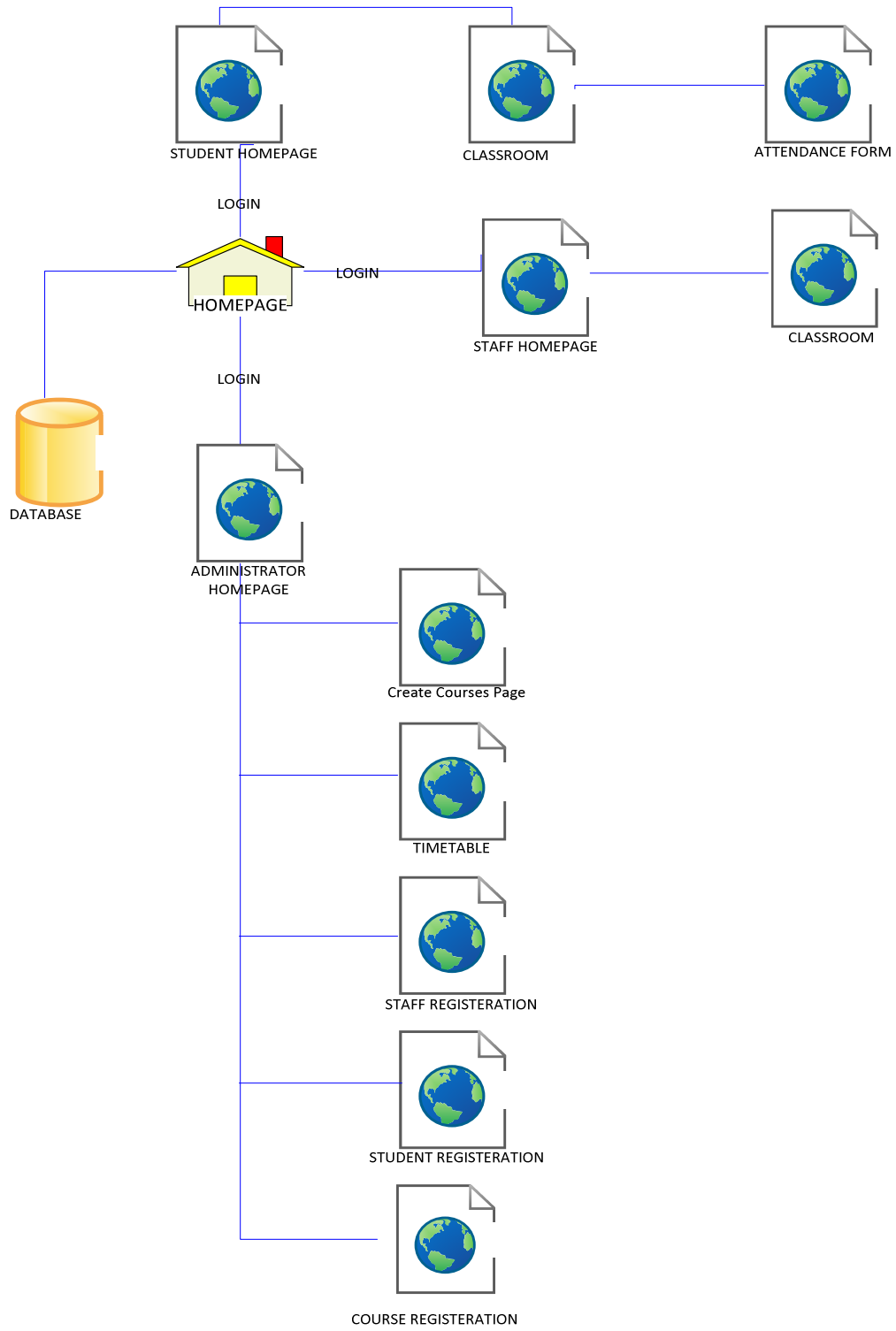


Figure 10. User Interface Interconnection

When the user enters the IP address of the server, a general homepage comes up. Depending on the login details of the user, the system redirects the user either to the student homepage, staff homepage or the administrator's homepage. If the user is a student he has the ability to redirect to the classroom page where he can take his/ her attendance. In the case where it is a lecturer, the lecturer can either view the compiled attendance list and percentage or go to the classroom page where he can view the students as they take their attendance. If the user is an administrator, he can navigate to create course, create timetable, register staff, register student and also register a course. All the users and activities details are stored or called from the database.

Databases are central to all web applications. A database can hold almost any collection of information you may want to search and update. The database that was adopted for this work is MSSQL which is a relational database. It is accessed using the graphical user interface provided by the Microsoft SQL server 2008 Management Studio tool. The tool allows the database to be administered through the desktop application after installation. The database created for OBCAMS is titled 'TimeAttAspDb' and it comprises of 10 tables. A table is a database object used to keep data. It is a set of defined, ordered columns (fields), which can contain any number of rows (records). A field is a single piece of information defined by type, length, and other attributes. A row or a record is a line of data specific to something or someone within a table. Some of the implemented web interfaces in OCAMS are shown in Figure 11.

5. TESTING AND PERFORMANCE EVALUATION

The following tests were carried out in the course of and after the full implementation of OBCAMS.

- i. *Unit Testing*: The system is made up of several static and dynamic web pages. Tests were carried out on each web page to ensure that they work perfectly and independent of each other.
- ii. *Integration Testing*: Integration testing involves tests carried out on the individual web pages as they connect and link up with one another.
- iii. *System Testing*: System testing involves integrating all the system components to create a version of the system and then test the system as a whole. The focus here is testing the interactions between components.

It checks that the components are compatible, interact correctly and transfer the right data at the right time across the interfaces.

- iv. *Portability Testing*: This involves a process of testing the ease with which the software application can be moved from one system or environment to another. In this project, the web application was initially tested using the Google Chrome browser as the default browser; it was then tested on the Internet Explorer browser. We ensured that the application's behavior across the different browsers is seamless.

Performance evaluation was carried out to test the accuracy of the system to identify each of the students that was pre-enrolled in the database. We carried out 5 experiments using 60 final year students at the Electrical and Information Engineering Department, Covenant University, Ota, Nigeria. Each student was given an opportunity of 4 signing trials and the results for each trial was documented. Figure 12 shows the plot of the experimental results.

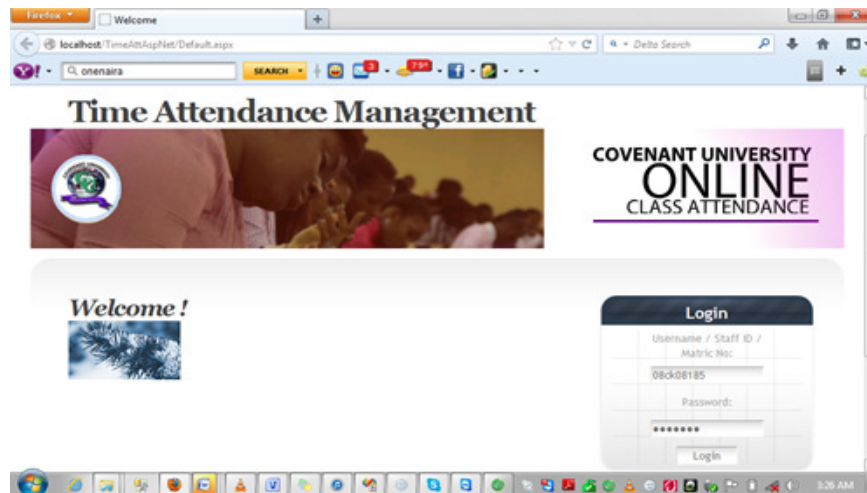


Figure 11. Sample Web Pages in OBCAMS (a)

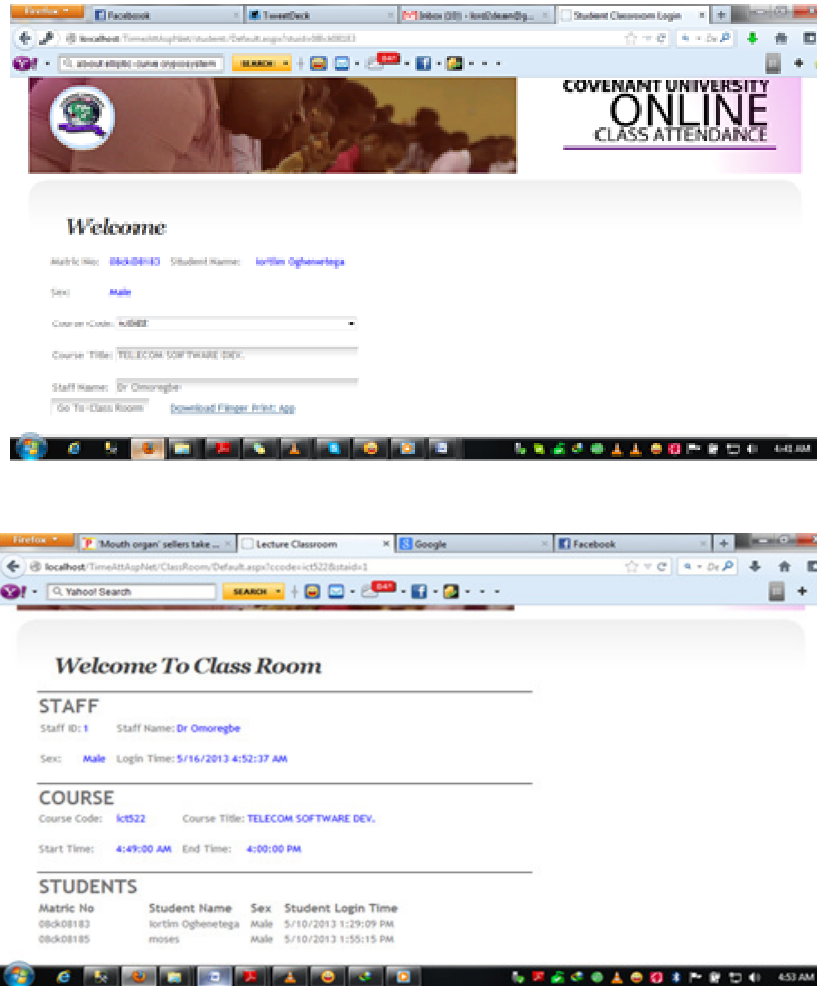


Figure 11. Sample Web Pages in OBCAMS (b& c)

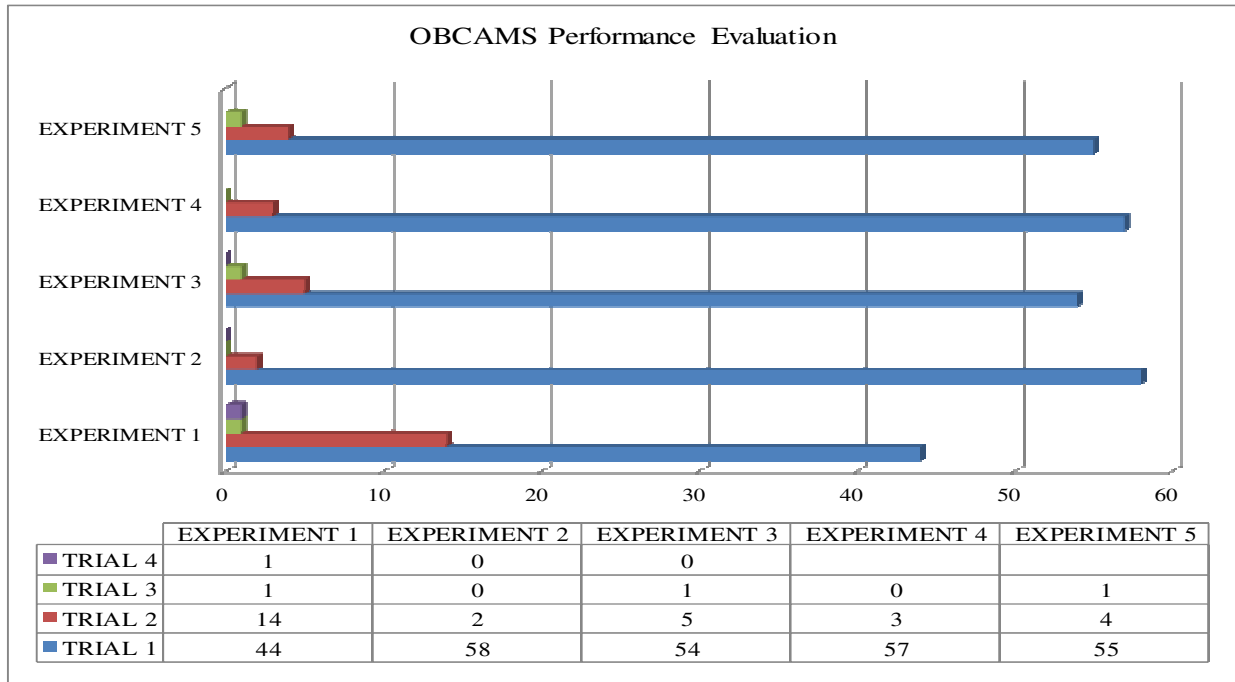


Figure 12. Performance Bar Chart for Students’ Attendance Signing in OBCAMS

Table 2: Performance Results for Students Attendance Signing with OBCAMS

S/N	Trial ID	Average Acceptance/ Successful Signing	Percentage of Successful Signing
1	Trial 1	53.6	89.33%
2	Trial 2	5.6	9.33%
3	Trial 3	0.6	1.00%
4	Trial 4	0.2	0.33%
5	TOTAL	≈60	99.99%

As illustrated in the performance bar chart in Figure 12 and Table 2, for the first signing trial, 89.33% of the students were able to sign successfully, 9.33% needed to go for a second signing attempt, 1.00% needed a third signing attempt and only 0.33% of the students needed a fourth signing attempt using OBCAMS. This result is a very promising one since almost all the students (99.99%) can take their attendance within four trials.

The Secugen fingerprint scanner utilized for this work is a very sensitive and fast device; hence, almost all the students have the privilege of signing electronically with very high acceptance rate using a biometric approach that out-rightly eliminates impersonation.

6. CONCLUSION

The Online Biometrics-based Class Attendance Management System (OBCAMS) developed in this study is a robust platform that has the prospect of enhancing class attendance management in educational institutions. Our experimental results which produced 89.33% of first successful signing attempt are highly encouraging. However, in order to enhance the speed and efficiency of the platform, we hope to fine tune it both in hardware and software so as to achieve first signing attempt of 100% by all users. Also, in future upgrade of OBCAMS, we will incorporate Artificial Neural Networks and other computational intelligence strategies to further enhance the identification capability of the platform.

REFERENCES

- [1] Biometrics Background, Accessed from <http://www.ibia.org/biometrics/>
- [2] Chitresh Saraswat, Amit Kumar, "An efficient automatic attendance system using fingerprint verification technique", International Journal on Computer Science and Engineering, vol. 02, No. 02, pp. 264-269, 2010.
- [3] M.M Rufai, J. O Adigun, N. A. Yekini, "A biometric model of for examination screening and attendance monitoring in Yaba College of Technology", World of Computer Science and Information Technology Journal (WCSIT) ISSN: 2221 - 0741 Vol. 2, No. 4, 120 – 124, 2012.
- [4] Mohd Zamzury Bin Abdullah Sanni, "Attendance Management System Using Fingerprint Scanner", B.Eng. Degree Report, Faculty of Electronic and Computer Engineering, Universiti Teknikal Malaysia, Melaka, April 2008.
- [5] SecuGen® USB Fingerprint Reader User Guide; Installation, Usage, Diagnostic Tools and Troubleshooting, 1998-2013, SecuGen Corporation, Accessed from www.secugen.com/download/SecuGenFingerprintReaderGuide.pdf
- [6] Fingerprint Sensor OEM Modules, Accessed from <http://www.secugen.com/products/sensor.htm>
- [7] Barbara Kitchenham, Roland Carn, Research and Practice: Software Design Methods and Tools, Psychology of Programming, Academic Press Limited, ISBN 0-12-350772-3, pp. 276-281, 1990.
- [8] J. A. Hoffer, J. F. George, J. S. Valacich, Object-Oriented Analysis and Design, Modern Systems Analysis and Design Third Edition, 2002, Prentice-Hall, Inc., pp. 20.1- 20.34.
- [9] Miles Tracy, Wayne Jansen, Karen Scarfone, Theodore Winograd, Guidelines on Securing Public Web Servers, Computer Security Division, Information Technology Laboratory, National Institute of Standards and Technology, Gaithersburg, MD 20899-8930, September 2007.
- [10] Available Web Server (IIS) Role Services in IIS 7.5, Microsoft, 2013, Accessed from: <http://technet.microsoft.com/en-us/library/cc753473.aspx>



Emmanuel Adetiba bagged his first degree (B.Eng.) in Electrical Engineering at University of Ilorin in May 2002. After his NYSC, he proceeded to Covenant University to commence an academic career and obtained a masters degree (M.Eng.) in

Electrical and Information Engineering in July 2007. He is a member of several professional bodies such as the

Nigerian Society of Engineers (NSE), Institute of Electrical and Electronics Engineers (IEEE), IEEE Communications Society, IEEE Computational Intelligence Society, IEEE Computer Society, IEEE Engineering in Medicine and Biology Society. Also, he is a registered engineer (R.Engr.) with the Council for the Regulation of Engineering in Nigeria (COREN). He has received several international grants such as the IEEE EMBS Travel Grant (2012), Rockefeller/SAHIA Grant (2010), IMIA/HELINA Grant (2009) and others that have taken him outside the shore of Nigeria for academic conferences and workshops. His research interests include Biomedical Informatics, Applied Computational Intelligence, Genomics Signal Processing and e-Learning. He is about to complete his Ph.D degree in Electrical and Information Engineering at Covenant University, Ota, Nigeria. He can be reached through phone(+2347033397788) or e-mail; emmanuel.adetiba@covenantuniversity.edu.ng

Oghenetega Iortim obtained his first degree B.Eng.(Hons) in Information and Communications Engineering (ICE) at Covenant University in June 2013. He has designed and developed several Web Applications and serves as a consultant to a number of Web hosting companies within and outside Nigeria. His research interests include e-Learning and Web Applications development. He can be contacted via e-mail; lord2dean@gmail.com

Anthony T. Olajide is a graduate of Computer Science from the Federal University of Technology, Minna, Niger State. He is currently a Lecturer in Kwara State Polytechnics at the Computer Science department. His research interests include e-Learning and Data Mining. linkanthonyolajide@gmail.com

Richard Awoseyin graduated with a B. Sc degree in Electrical/Electronics Engineering from Obafemi Awolowo University, Ile-Ife, Nigeria. As a result of his depth of knowledge in Information and Communications Technology, He founded Rollar Cecillee Communications; a highly profitable ICT venture as an Undergraduate. Currently, He is a consultant to Kwara State government in Nigeria on e-Government. He is also a managing partner of Danite Nig.Ltd and Danite USA. His research interests include e-Learning and e-Government. He can be reached via e-mail; rawoseyin@yahoo.com.