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E-PAYCHEQUE FRAMEWORK WITH CONTACT ELECTRONIC CARD AND FINGERPRINT BIOMETRIC FOR CASHLESS SMART CAMPUSES

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ABSTRACT

Identity theft in financial transactions is a very rampant problem among students in most institutions of learning. Currently, in order to minimize financial theft, most schools dole out paper based "paycheques" to students, which usually contain the name, personal identification number (PIN) and the value of money deposited by the students to the cashier. However, anybody bearing the PIN of another student can conveniently assume the identity and defraud the legitimate owner. This often generates a lot of rancor among students and it is a major concern for management especially in the high schools. In this work, we developed an ***e-Paycheque*** framework for secured cashless campuses. To be recognized on the web application within the framework, each student must possess a Smart ID card that is preconfigured with their unique fingerprint template and the value of deposited cash for transaction purposes. Since no two humans have the same fingerprint, financial transactions will only be possible for the legitimate owners of cards on the platform. This will in no small measure curb identity theft with respect to financial transactions on the campuses and also fast track the pace of achievement of the cashless policy in Nigeria.

Keyword: AET 65, biometric, e-Paycheque, fingerprint, PIN.

1. INTRODUCTION

The current surge in the adoption of Information and Communications Technology (ICT) in the global financial sector has created seamless opportunities for borderless and secured transactions. Although, hackers also take advantage of the technological evolution and computer hardware/software is manipulated to impersonate humans in financial transactions. The merits of the electronic "flat" world far outweigh the demerits. Shoppers can log in to an e-commerce site armed with their smart cards at any time of the day/night and purchase any good from any part of the world just at the click of the mouse with guaranteed security. It is however alarming that despite these cashless technological boom, most schools still utilize paper based "paycheque" to curb financial theft in dormitories and within the entire college campus. This manual approach has resulted into identity theft in which students bearing PINs from someone else can illegitimately utilize their "paycheque". Other problems with the paper-based approach include weak security in transactions, slow verification process, littering of environment with used papers and ultimately, a surge in greenhouse effect. These mirage challenges have therefore made it expedient to create secured electronic financial platform that grants access only to authentic users during transactions. Research has proven that no two human beings have the same fingerprint and fingerprint patterns for individuals do not change throughout his/her life [1,2]. Therefore, fingerprint has become one of the most secured and reliable approaches for financial transactions.

Fingerprint biometric was first used for identification purposes in 1858 when Sir, James Herchel from Jungipoor in India started using it to seal local contracts [2]. Although a superstitious way of ensuring persons comply with the terms of contracts, as time progressed, the correlation between persons and their fingerprints became evident. Hence, fingerprint for identification purpose has since been adopted in differs domains. Younhee et. al.[3] developed a Match-on-Card system in which instead of a centralized database, the storage of fingerprint data is decentralized on the individual smart card. Fingerprint verification and storage take place in the smart card to achieve maximum security in the system. Clancy [4] developed an application which focused on how a secure authentication scheme using *Fingerprint vault* (fingerprint on the smart card) and a private key stored on the smart card can be used for authentication in a networked environment. This is based on the assumption that attackers can launch an offline attack against a stolen smart card.

This paper reports the development of a framework tagged ***e-Paycheque***. The aim of the project is to replace the paper-based "paycheques" on college campuses and the associated accessories with Smart ID cards, electronic hardware module and web application. The hardware module of the platform is called AET65 [5] and it incorporates fingerprint and contact smart-card reader in the same module. The web application is a software we developed so that only authentic Smart ID card bearers can carry out cashless transactions for good and services within the college campus. This work ultimately brings to light the infrastructural requirements and feasibility of the biometric cashless economy being advocated by the Nigerian government.

2. SYSTEM DESIGN AND MODELING

The system is designed to eradicate any form of cash based transactions for good and services by students within a college campus. There are four different user groups which are the *administrator*, *cashier*, *attendant* and *students*. All users are registered by the administrator and he can either edit or delete user profile as required from time to time. The cashier loads money to the student's account on the Smart ID card which is also backed up on the database. The cashier also has the privilege to check current balance in the students account and offer necessary advice to the students. Students make transactions as their account statements accommodate and their identities are confirmed by presenting the Smart ID card and swiping their fingerprint for authentication. The attendant enters details of transactions made by the students and balances their account appropriately. The flowchart in Fig.1 illustrates the student's authentication process within the platform.

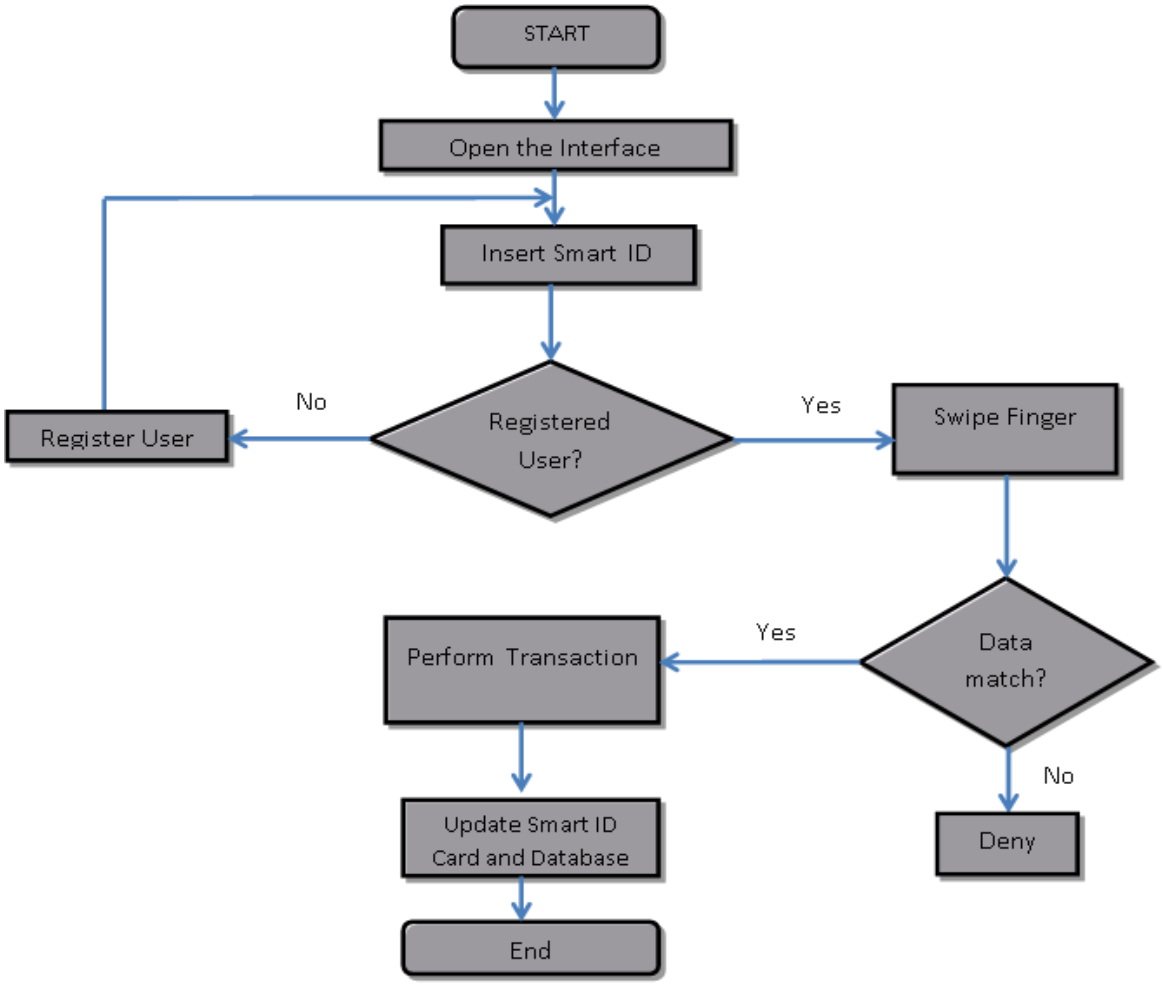


Figure 1: Students' Authentication Process for Transactions

2.1 The AET 65 Hardware Module

The AET 65 hardware module by Advanced Card System (ACS) combines a fingerprint reader with smart card reader using a USB chip controller. The smart card module is based on the ACR38-SAM core and uses the PC/SC API while the fingerprint works based on UPEK's BSAPI (Biometric Services API) and BSGUI. BSAPI dynamic link libraries (DLL) handle implementation of application logic, error handling, memory management and interactive operations while BSGUI DLLs provides GUI implementation callback and loads the graphic content used for the development of windows-based interface[5]. Fig.2 shows the block diagram of the AET 65 hardware components and computer system interconnections.

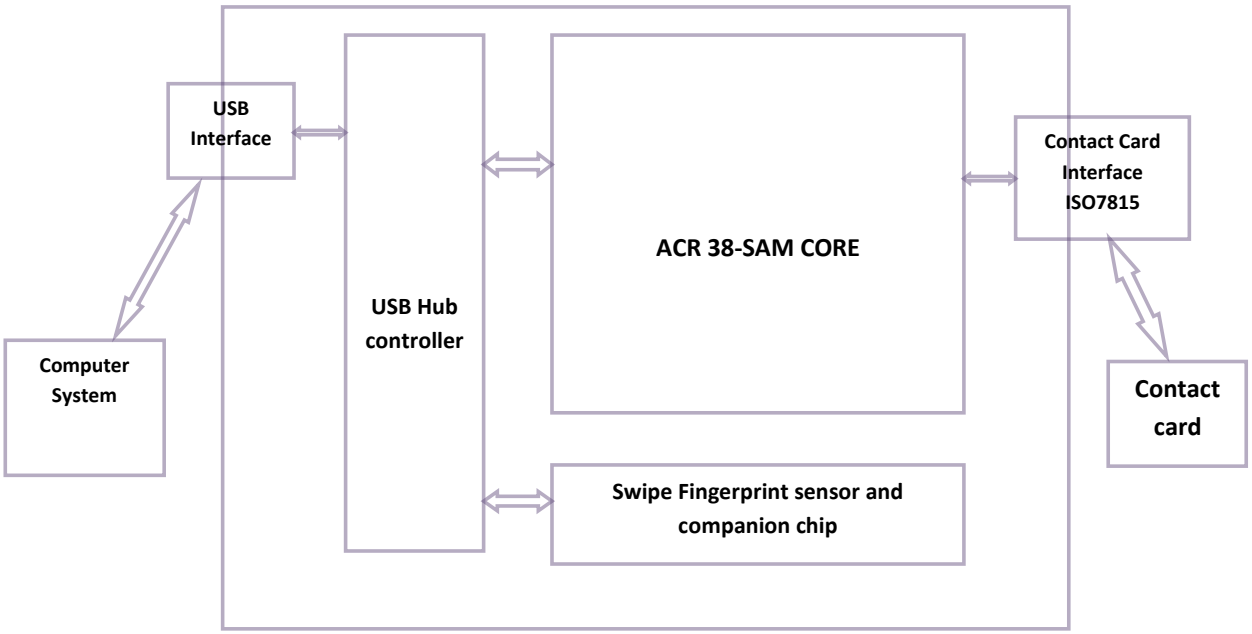


Figure 2: Block Diagram of Interconnections between the components of AET 65 Module and the Computer System

2.2 Web Application Design and Modeling

In order to achieve the goal of this project, some functional requirements were established for the web application. Different users log in to the application based on the assigned privileges to carry out tasks that are unique to them. The administrator registers students and their fingerprint template on the Smart ID card and database through the application. Also, the administrator adds new items to the stock database, view existing items and manage the different stakeholders on the platform by adding, deleting or blocking as appropriate. The cashier is the only user group that can load money on students' smart cards. The attendant checks the available items in the stock database and allows purchase of items by students based on the balance on their Smart ID cards. The various user groups are referred to as actors in the parlance of Unified Modeling Language (UML), which is the tool we adopted for modeling the web application.

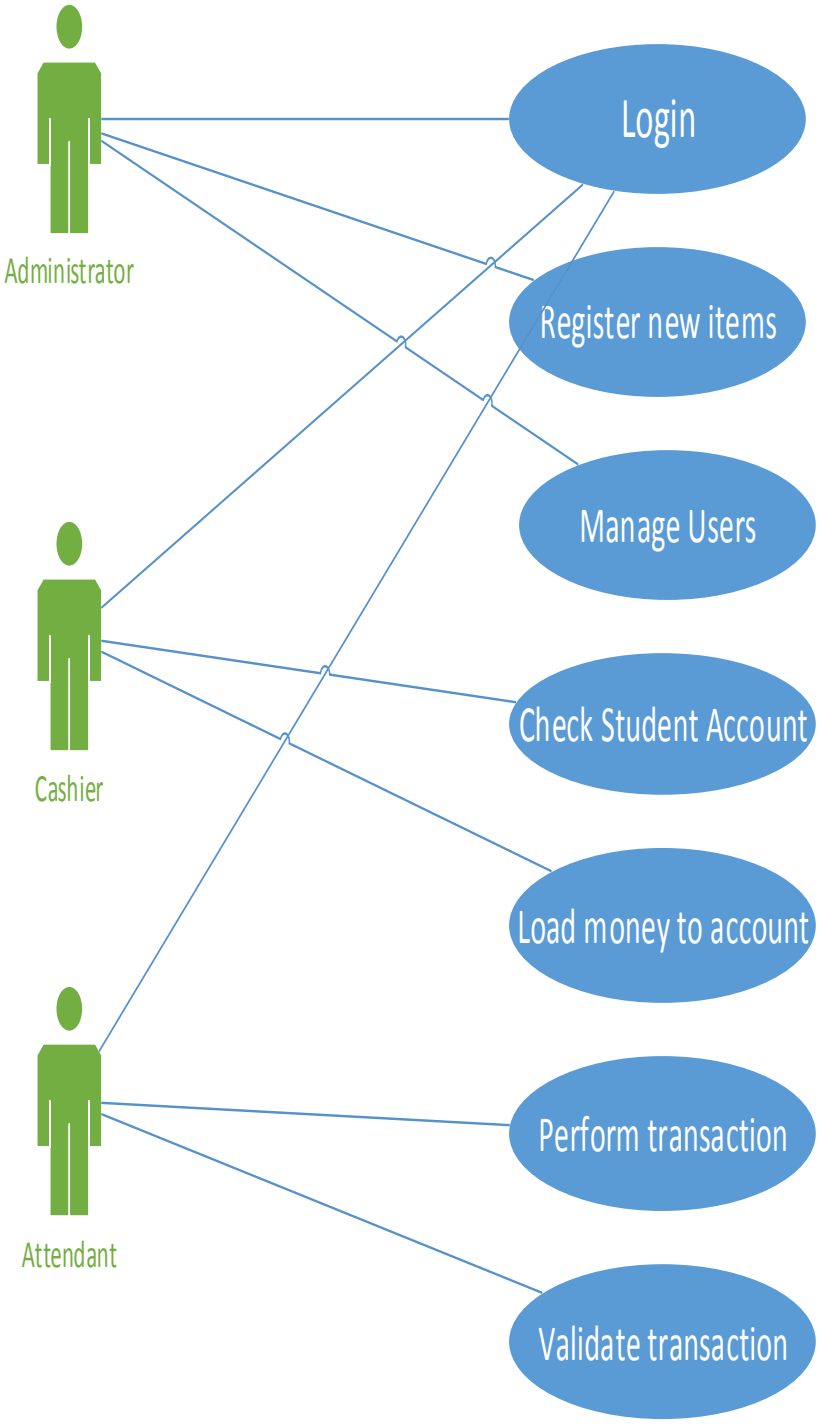


Figure 3: Use Case Diagram for the Actors in the Web Application

The modeled interactions of these actors within the web applications are illustrated in Fig.3 while the detailed activities of the administrator is modeled using UML activity diagram as shown in Fig. 4. The functional tasks carried out by other actors in the web application are also modeled with UML activity diagrams.

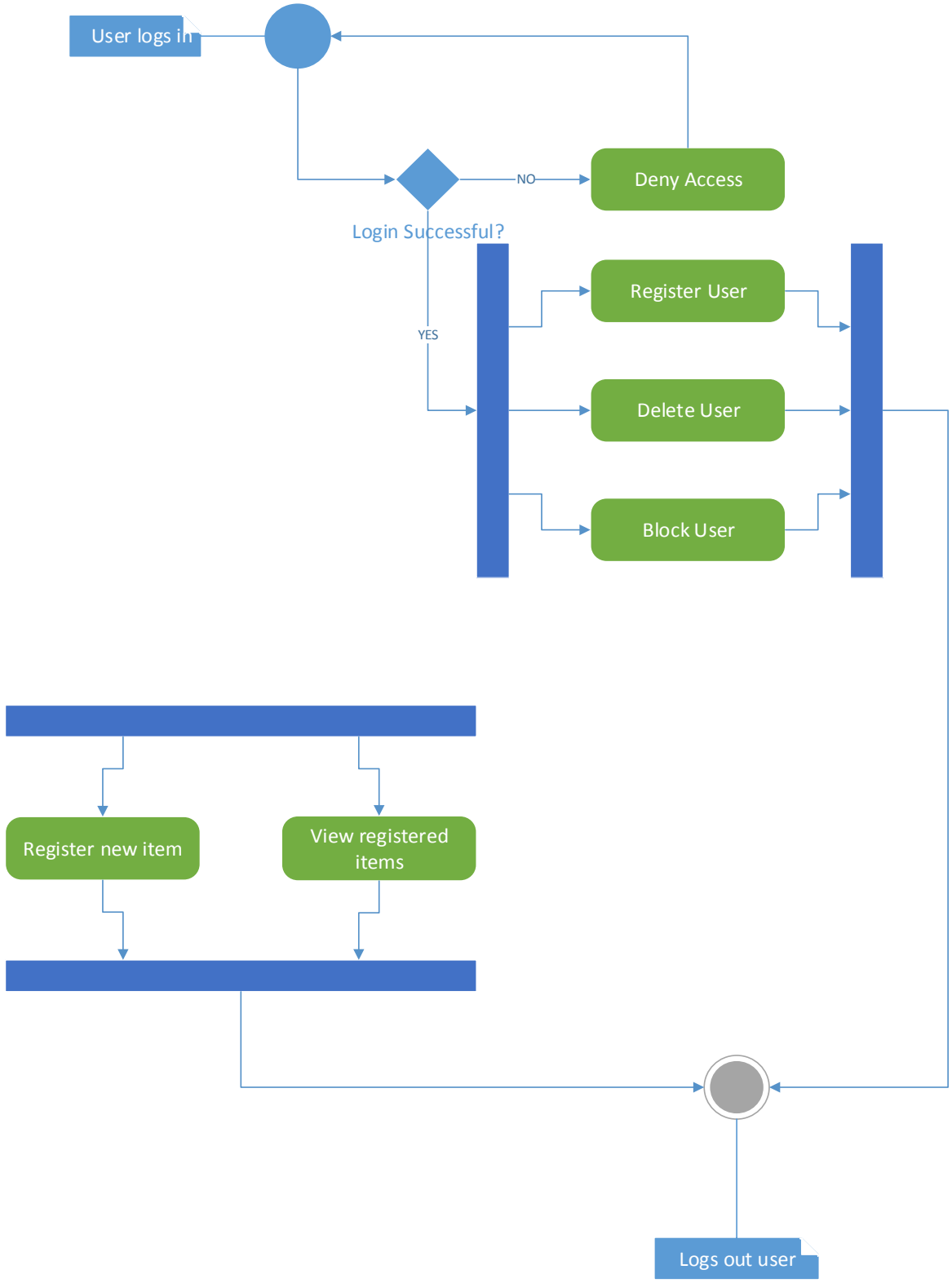


Figure 4: UML Activity Diagram of the Administrator

Apart from UML diagrams and notations which are object-oriented design and modeling tools, a Sitemap is an effective planning model that helps in clarifying and organizing the content of any web site[6]. In order to graphically illustrate the entire content of the web application in this project, we developed a sitemap which is a model of the different pages and their interconnections, this map is as shown in Fig 5.

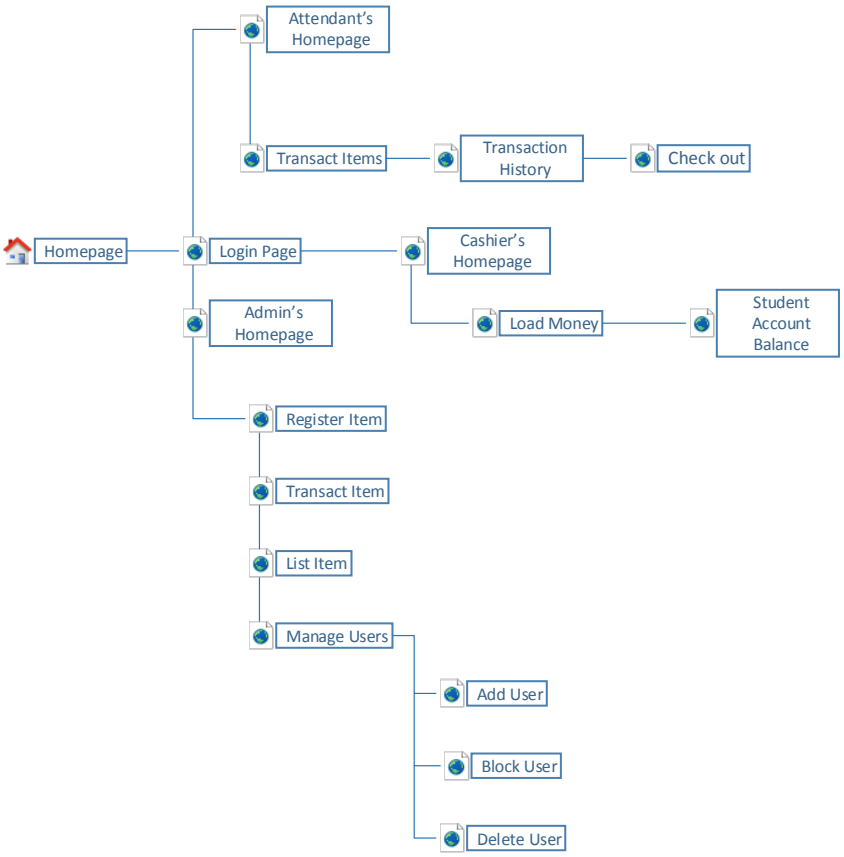


Figure 5: The Sitemap for the Web Application

3. SYSTEM IMPLEMENTATION AND TESTING

To successfully implement and test the designed web application, we utilized Visual Studio 2012, IIS Express web server, Mozilla Firefox or Google Chrome browser and Microsoft Access database all running on Windows 7 operating system. The implementation was carried out on an HP Laptop with Intel core i5 processor and 2GB RAM. The software for the enrollment and verification of the students' fingerprint template on the Smart ID card is a standalone utility which can be installed on any system on which the web application is to be used. All other features specified in the design are incorporated in the web application. The test setup for the framework is shown in Fig. 6. Some students were enrolled using the AET 65 software utility and the test result of the verification for one of the students was obtained. Fig 7.0(a) shows the enrollment output and Fig 7.0(b) shows the verification output in which a match was reported for the tested student. Fig. 8 shows some pages within the web application that the system administrator can use to carry out his/her tasks.

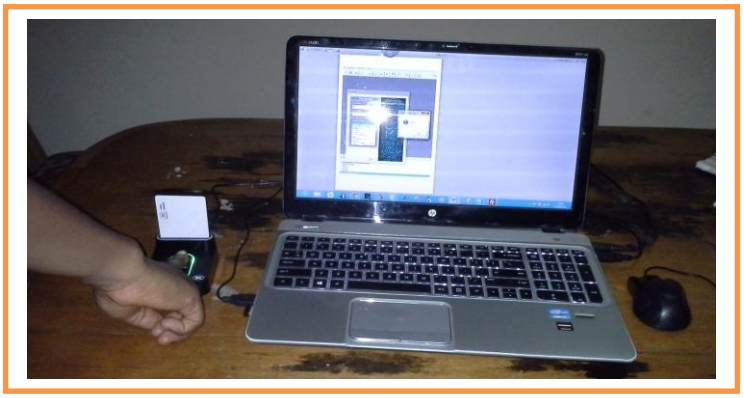
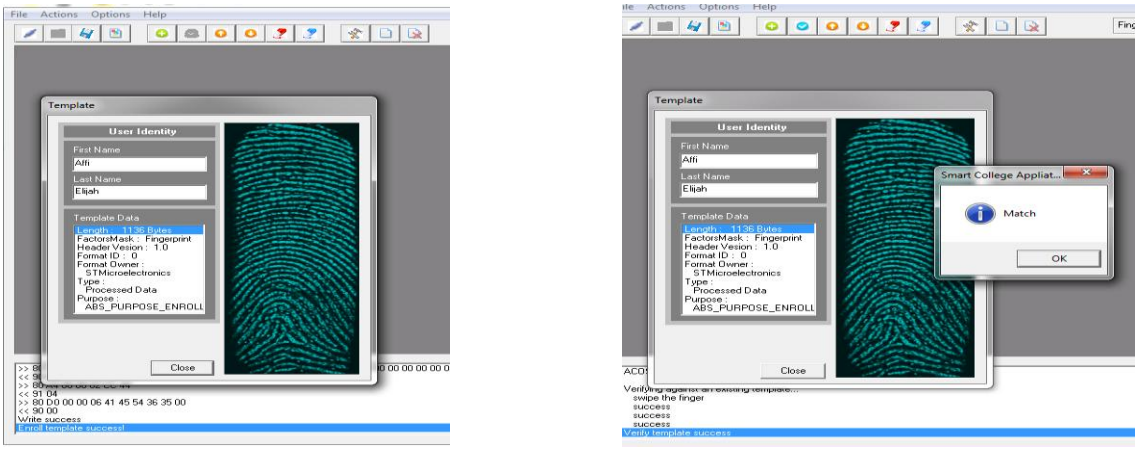


Figure 6: Test Setup for th e e-Paycheque Platform



(a) Enrollment *(b) Verification*

Figure 7: Enrollment and Verification Outputs

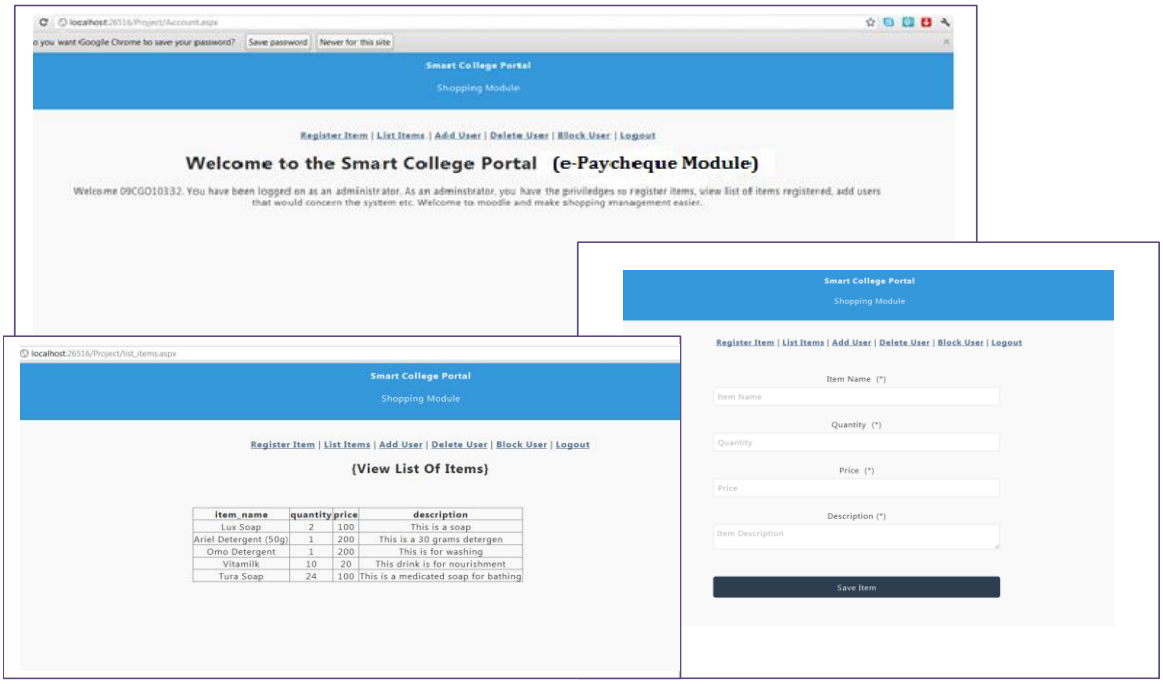


Figure 8: Some Administrator's Pages within the Web Application

4. DISCUSSION AND CONCLUSION

The successful implementation of this work has been illustrated with the positive results we obtained. In addition to all the numerous benefits earlier itemized, adoption of the platform also holds the prospect of reducing over-head costs and enhancing security in schools. The Smart ID cards to be given to all students for them to have access to the platform will replace their regular ID cards. This will help to curb intrusion by undesirable persons into the school premises and eliminate the costly production of paper based "paycheques". The next phase of this work is the pilot deployment of the platform in some selected secondary schools within Ota community in Ogun State. Also in the future, we hope to develop similar frameworks for other aspects of school administration, such as smart card based absenteeism control and library management.

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DR. EMMANUEL ADETIBA'S BIOGRAPHY

Dr. Emmanuel ADETIBA bagged a B.Eng. (Hons) degree in Electrical Engineering at the University of Ilorin in May 2002. After his NYSC, he proceeded to Covenant University to commence an academic career and he is currently a Lecturer 1 at the Electrical and Information Engineering Department. He obtained a masters degree (M.Eng., Electrical and Information Engineering) in July 2007 and a Ph.D (Information and Communication Engineering) in January 2014 both at Covenant University, Ota, Nigeria. 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 and IEEE Engineering in Medicine and Biology Society (IEEE EMBS). He is a registered engineer (R.Engr.) with the Council for the Regulation of Engineering in Nigeria (COREN). He has received several national and international grants such as the Rollar Cecilee Communications (RCC) Research Grant (2014), NCC Research Grant (2013), IEEE EMBS Travel Grant (2012), Rockefeller/SAHIA Grant (2010), IMIA/HELINA Grant (2009) and others with which he has carried out ground beaking applied researches and that have also taken him outside the shore of Nigeria for academic conferences, seminars and workshops. His research interests include Biomedical Informatics, Computational Intelligence, Genomics Signal Processing (GSP), Wireless Communications and e-Learning. He is proficient in several computational tools and programming languages such as MATLAB, PHP, VHDL, QBASIC, VB.NET and C/C#. As a Principal Investigator (PI), he recently completed and hosted an e-learning portal for SIWES administration at Covenant University and the URL for the portal is: esiwes.covenantuniversity.edu.ng. He was also a co-PI for the RFID-based e-Attendance System that is currently being used at Covenant University for electronic attendance. He can be reached through phone: +2347033397788 or e-mail: emmanuel.adetiba@covenantuniversity.edu.ng

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