



## A Wireless Sensor Network for Examination Attendance Management System

I. F. Obayemi<sup>1</sup>, O. T. Arulogun<sup>2\*</sup> and A. S. Falohun<sup>2\*</sup>

<sup>1</sup>Information and Communication Technology Unit, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

<sup>2</sup>Department of Computer Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

### Authors' contributions

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

### Article Information

DOI: 10.9734/BJMCS/2016/24661

*Editor(s):*

(1) Victor Carvalho, Polytechnic Institute of Cávado and Ave, Portuguese Catholic University and Lusiada University, Portugal.

*Reviewers:*

(1) Kexin Zhao, University of Florida, USA.

(2) R. Jaichandran, AVIT-Vinayaka Missions University, India.

Complete Peer review History: <http://sciencedomain.org/review-history/14103>

Original Research Article

Received: 28<sup>th</sup> January 2016

Accepted: 24<sup>th</sup> March 2016

Published: 9<sup>th</sup> April 2016

## Abstract

Every academic institute has special concerns for student's attendance in examination halls. At present, in developing countries attendance is usually taken using paper sheets and the old file system. The effectiveness of this style is low because it is highly labor-intensive, error-prone, susceptible to examination malpractices, time wastage, data manipulation, and impersonation among others. On the other hand, Wireless Sensor Network is concerned with using sensors technology to acquire, store, trace and transfer examination attendance data to the host computer for report generation and data analysis.

The system uses fingerprint recognition as well as Wireless Sensors technique for obtaining student's examination attendance, porter registration of courses and tuition payment clearance. The design was achieved with the system divided into units of operation and each unit is designed as a single entity and later combined into a whole.

The proposed solution is limited to four nodes and a server. The nodes can communicate with the Server via signaling. The transmitter used is connected to a fingerprint interface unit and a database server and can only transmit through a distance of approximately 100metres. The four nodes were arranged using a star topology network.

\*Corresponding authors: E-mail: [asfalohun@lautech.edu.ng](mailto:asfalohun@lautech.edu.ng), [otarulogun@lautech.edu.ng](mailto:otarulogun@lautech.edu.ng);

*Keywords: Transmitter; signaling; node; biometric; sensor.*

## 1 Introduction

Wireless sensor networks have been attracting many research efforts during the past few years. It has inspired tremendous research interest in diverse application domain such as structural health monitoring, underwater marine, life monitoring, military and security surveillance, health-care, smart homes, automotive industry, habitat monitoring, forest fire detection, electronic nose etc. A typical sensor network consists of hundreds to thousands of sensor nodes, each equipped with various kinds of sensors, deployed over a geographical region of interest. A sensor node by itself has several resource constraints in terms of memory, battery power, and computation and communication capabilities. However, a group of sensors collaborating with each other can accomplish a much bigger task efficiently [1].

Although Wireless sensor networks are highly dynamic and prone to faults, mainly because of energy shortages, connectivity interruptions, and environmental obstacles, yet the field of Wireless Sensor Networks (WSN) is developing very rapidly with the main research done in routing, localization, and data fusion. An effective information system needs to support a set of activities. These activities will enable human beings to achieve with effectiveness the objectives of the organization, through computer-based information technology. In the past, the styles adopted in examination attendance management include hand-written signatures, card bell, magnetic card, IC card and RF card attendance machines. In fact, every academic institute has certain criteria for students regarding their attendance in examination halls. That is why keeping the accurate record of attendance is very important. Even at the present, attendance is still being taken using paper sheets and the old file system, particularly in the developing nations and this is long overdue. Development of Wireless sensor network for examination attendance management system offers effectiveness through its functions in capturing data, minimizing time-constraint, and saving effort to write/collect/check attendance slips resulting in an efficient way of administering and managing the attendance procedure.

## 2 General Overview of Wireless Sensor Networks

Wireless sensor networks are emerging applications of pervasive computing, consisting of many small, low power, and intelligent sensor nodes and one or more base stations. Sensor nodes gather information in diverse settings including natural ecosystems, battlefields, and manmade environment. This information is sent to one or more base stations. Sensor nodes work under severe resource constraints such as limited battery power, computing power, memory, wireless bandwidth, and communication capability, while the base station has more computational, energy and communication resources.

Sensor network applications can be categorized according to its operational paradigm: data gathering and event-driven. The data gathering application requires sensor nodes to periodically report their data to the base station. In the event-driven application, nodes only send data when an event of interest occurs [2].

Wireless Sensor Networks, or WSNs, have been used to enable better data collection in scientific studies, create more effective strategic military defenses, pinpoint the origin of a gunshot, and monitor factory machinery [3]. All of these uses depend on the ability to collect data such as light, vibration, moisture, temperature, and more, as well as the ability to communicate with each other. This last ability is what makes a collection of nodes so much more powerful than any node in particular.

### 2.1 Wireless networking

Besides hardware technologies, the development of WSNs also relies on wireless networking technologies. The 802.11 protocol, the RST standard for wireless local area networks (WLANs), was introduced in 1997. It was upgraded to 802.11b with an increased data rate and CSMA/CA mechanisms for medium access

control (MAC). Although designed for wireless LANs that usually consists of laptops and PDAs, the 802.11 protocols are also assumed by many early efforts of WSNs.

## 2.2 Overview of biometric systems

Biometric technologies enable automatic personal recognition based on physiological or behavioral characteristics [4-5] Biometric is defined as the “automated identification or verification of human identity through the measurement of repeatable physiological and behavioral characteristics” (Association of Biometric, 2004). Biometric systems have been widely used for the purpose of recognition. These recognition methods refer to automatic recognition of people based on some specific physiological or behavioral features. There are many biometrics that can be utilized for some specific systems but the key structure of a biometric system is always same [6].

Some of the most commonly used biometric systems are (i) Iris recognition (ii) Facial recognition (iii) Fingerprint identification (iv) Voice identification (v) DNA identification (vi) Hand geometry recognition (vii) Gait recognition (viii) Signature verification [7]. Previously the biometric techniques were used in many areas such as building security, ATM, credit cards, criminal investigations passport control [8].

The proposed system uses fingerprint recognition as well as Wireless Sensors technique for obtaining student’s attendance. Human beings have been using fingerprints for recognition purposes for a very long time [9] because of its simplicity and accuracy.

Although the idea of attendance tracking systems using facial recognition techniques have also been proposed but it requires expensive apparatus and are not getting the required accuracy.

Fingerprints identification usage is based on two factors:

- (i) Persistence: the basic characteristics and features do not change with the time.
- (ii) Individuality: fingerprint of every person in this world is unique [4].

## 2.3 Review of related work

Notable works have been done in the area of wireless sensor network based examination attendance system some of which are reviewed as follows.

[10] describes the integration of mobile device with software for recording examination attendance, a wireless based examination attendance system was developed, implemented **with RFID** (Radio Frequency Identification) chip. The RFID card reader was plugged into the microcontroller via MAX232 since RS232 is not compatible with the present technology. The database containing all the necessary requisites acts as a backbone of the system, Microsoft Access was used as the database backend and VB (Visual Basic) with its three design forms as the frontend. The controller that receives TTL logic from the line driver performs database search for the student’s name, student’s number, Registration number, subject, hour, class name, e-mail id and finally the parent web interface. When the student’s tag is passed near by the reader, the number is displayed on the LCD of the controller and the respective session’s attendance automatically updated to the faculty and the parent interface via internet by the transmitter.

[11] also worked on an RFID based attendance system. To take attendance for students in school, college and university as well as for workers in working places.

[12] designed a wireless fingerprint based class attendance system to record and obtain the attendance data of students. It expressed low cost RFID based attendance system prototype, the system provided several advantages over conventional method of taking attendance in class. The prototype developed was compact

and light weighted. Besides, it can run using power adapter or battery power. Therefore, it is very portable and can be taken to the class attendance.

[13] designed a time management and access monitoring system using microprocessor card to monitor student's and invigilator's attendance with the records that are kept in the database for administrator's reference on campus, office or certain area. All data captured by this system could be accessed by teachers and parents.

A system that was capable to record student's attendance using interactive input generating reports, view students, generate student's time-table and lecturer's profile was proposed by [14]. The system records attendance using barcode scanner and RFID technology that can simultaneously collect large quantities of data with high accuracy, contactless, etc.

[15] implemented a system that takes attendance of student using fingerprint sensor module. When the student enrolls his/her finger on the fingerprint sensor module, his/her fingerprint will match with database to mark the attendance. Every time the student enters the class, his / her images will be capture by the camera placed in the entrance. The images will retrieve the identity of the student and take attendance for that student.

[16] developed an attendance management that used attendance software and passwords for authentication. He 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.

[17] worked on examination attendance system that used Fingerprint scanner, fingerprint of each student will be taken and rolls name of those whose attendance is marked. Computer Software interfaced fingerprint scanner and LCD and was connected to the network. It will input fingerprint, process it and extract features of fingerprint for matching. After matching, it will update database attendance records of the students.

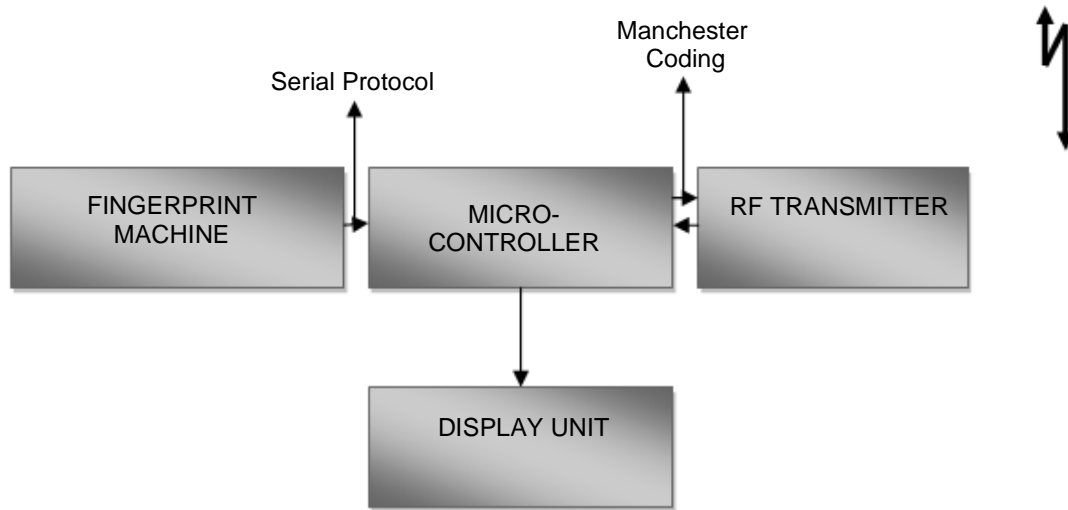
[3] studied a WSN using a radio which consists of a radio transmitter and a radio receiver. Both of these parts must exist for any mote to fully communicate with the other motes. The radio, when transmitting, receives information from the electronic brain and broadcasts the data to other motes according to the network connections. In the other direction, when receiving, the radio receives information from another mote's radio and transmits it to the electronic brain. The radio was connected to the mote base.

### **3 System Design**

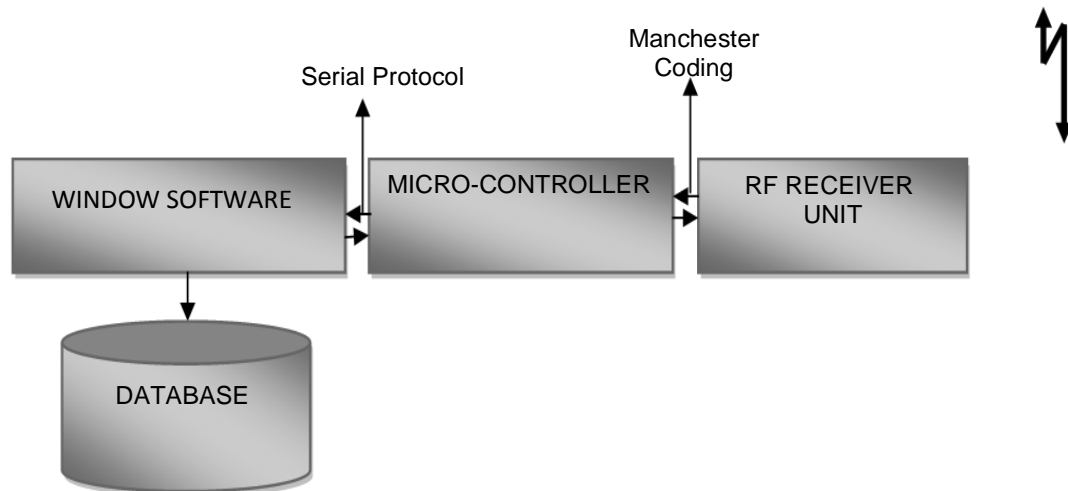
This design of a wireless based examination attendance management was achieved with the system divided into units of operation and each unit designed as a single entity and later joined together as one system. The block diagram of the system is shown in the Figs. 1 and 2. Each node consists of fingerprint machine which serves as an interface between the user and the machine. The user is required to supply nothing but his or her fingerprint template and this template will be transmitted to the microcontroller using a serial protocol. The microcontroller then act on the template based on the series of programs written on it. The microcontroller then sends the result of its processing to the server through the transmitter and the server after processing will also send the response out to the node to which either the registration or verification is required. The result will then be displayed on the display unit attached to the node.

#### **3.1 Flow of enroll, verify and identify process**

The flow of enroll verify and identify process show the sequence in which the fingerprint template supplied by the user is processed either for enrolment otherwise called registration process or verification and identification process simply called verification process. These are shown in Figs. 3 and 4 where FP as used on the flowcharts means fingerprints.



**Fig. 1. Block diagram of a node**



**Fig. 2. Block diagram of the server end**

### 3.2 Match threshold levels

The Match Threshold is a number that represents the degree to which verification is performed to ensure that the user is whom he claimed to be. The Match Threshold Levels establishes a balance between False Acceptance Rate (FAR) and False Rejection Rate (FRR). This has been catered for by the manufacturer and the threshold level value needs only be specified in the code. To set up the threshold of fingerprint identification engine, integer of 1 – 5 can be selected, one is the lowest identification level and five is the highest identification level, default is three.

### 3.3 User ID numbers

Each fingerprint was assigned a user number. This number is used to call up the fingerprint template each time the verification is requested. User identification numbers can also be called up via the serial port.

### 3.4 Authority (status) levels

The fingerprint system has four authority or status levels:

- Users are people whose identity must be verified, to have access to the hall.
- Enrollers are users who are authorized to enroll new users or delete from the system.
- Administrator can perform other operations, except set advance option and enroll administrator authority.
- Supervisors are users who have access to all functions and can modify all the settings in the system.

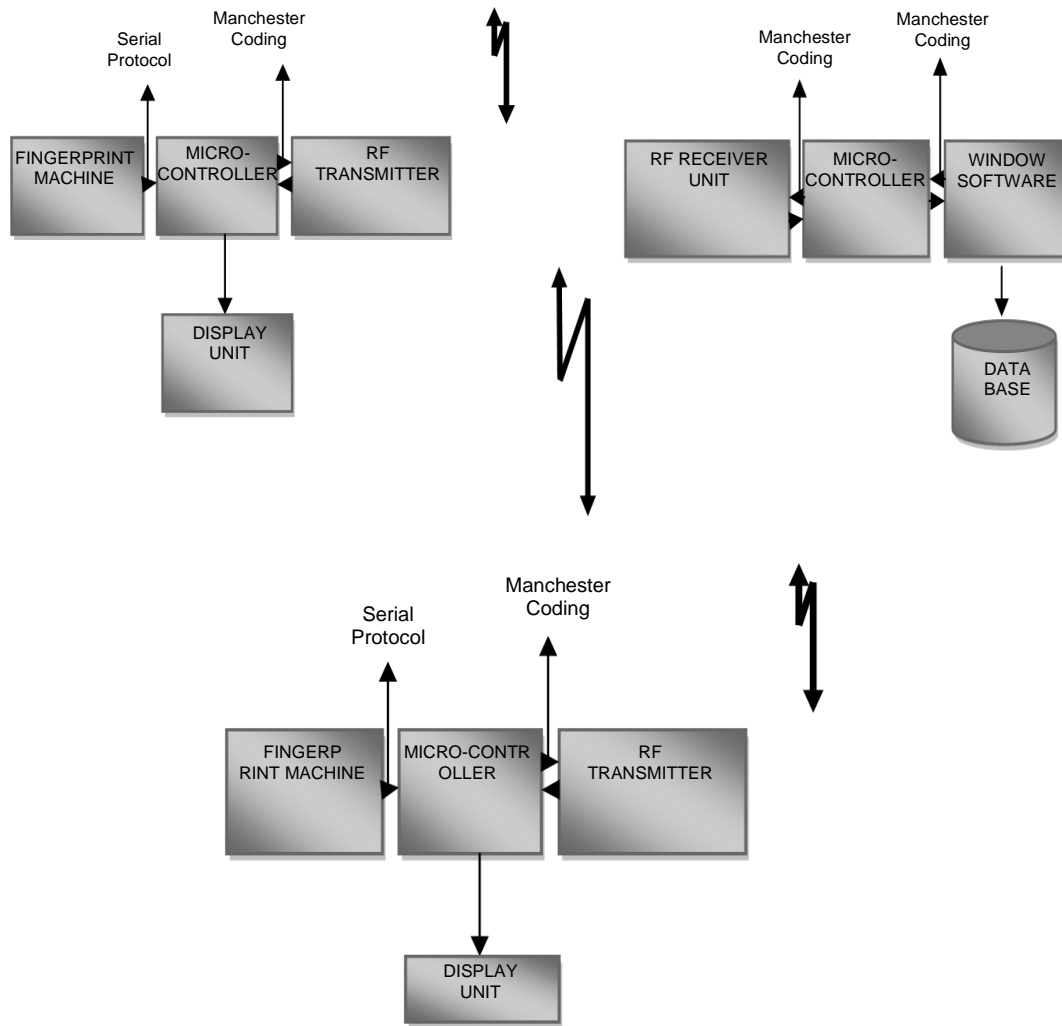
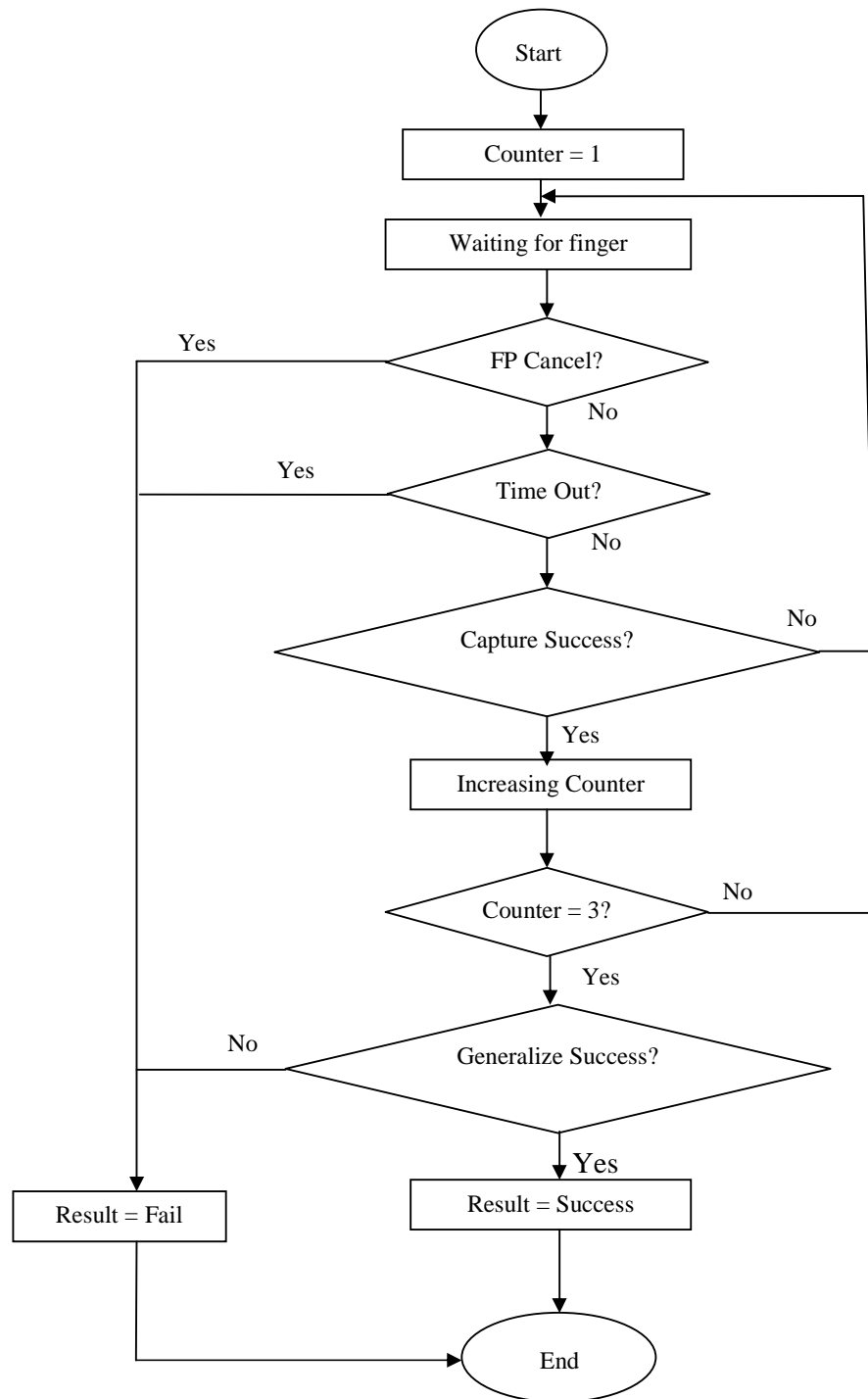
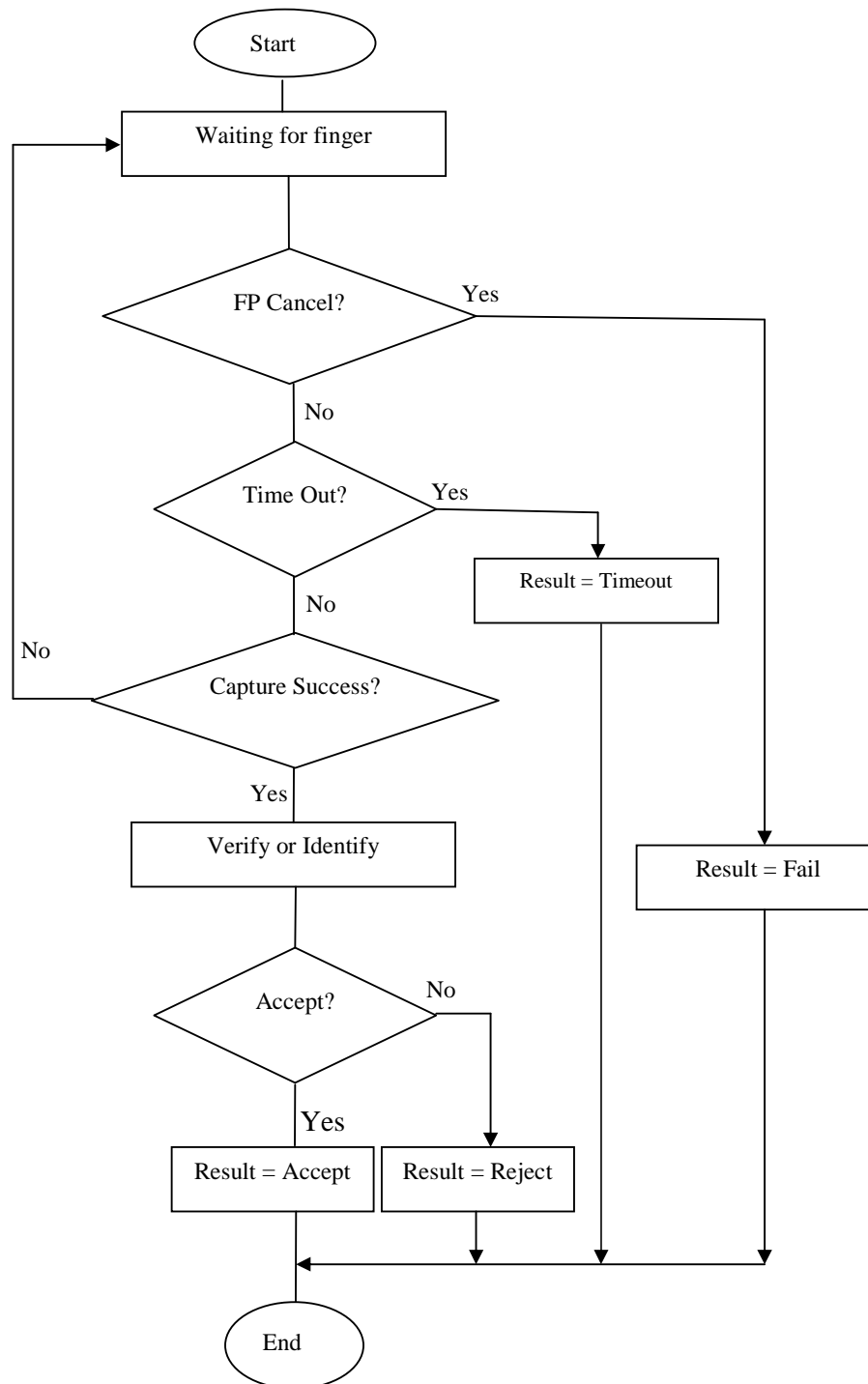


Fig. 3. Overall design of the implementation



**Fig. 4. Enroll process**



**Fig. 5. Verify and identity**



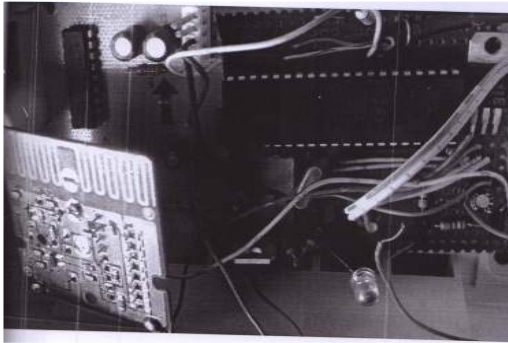
### 3.5 Material gathering

The first stage of the design is the material gathering, most of the materials used were locally source while some were bought from far distance especially the sensor and the fingerprint module with UART (CAMA SM-12) which were brought in from China. Some of materials locally sourced were soldering iron, Lead, Ferro – board, Programmable IC, AC adaptors, Cutters, plastic for the casing, LCD screen.

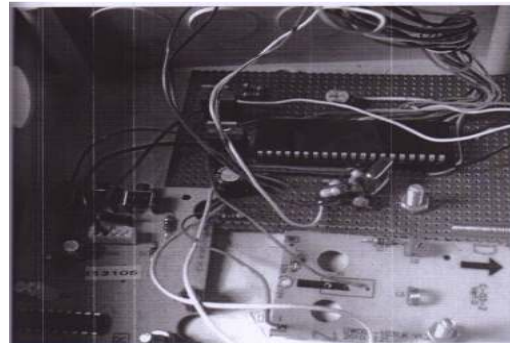
### 3.6 Hardware assemblage

The circuit components were locally sourced from the local shops around the vicinity, after getting all the components needed for the project, the project was assembled and soldered on a Ferro board according to the specifications of the circuit diagram. This was done on three different Ferro boards as the system has two nodes and one server. The Plates 1 and 2 shows the picture of the assemblage for the three parts.

The circuit diagrams used for the fabrications of the Nodes and the Server Units are shown in Plates 1and 2.



**Plate 1. Server node circuit assembly**



**Plate 2. Node assembly**

## 4 Testing

Development of wireless sensor network for examination attendance management is a process consisting of two major sections namely;

- Registration Section
- Verification Section

For registration section, the student will place his or her fingerprint module which is attached to the node. The node return an ID number after a successful registration process and this ID number or otherwise called template number will be required of the server in order to complete the registration of the student in registration for the course and as well be used by the ICT department in verifying the registration of each student. The ICT department will then assign center/hall for every successful student qualified to write any examination. The student is then granted an access to write the examination only if he or she satisfied all the pre-requisite which include:

- Porter Registration for the course to be examined on.
- Full Payment of Tuition as shown by the following GUIs.

The 'Record' window contains the following fields:

- Student Finger ID: 1
- Student name: Aderibigbe Johnson
- Matric number: 090765
- Department: FSE
- Level: 200

Navigation buttons at the bottom include back, forward, search, and an 'Exit' button.

Fig. 6a. Record requirement (student's record)

The 'Payment' window contains the following fields:

- Matric number: 090765
- payment: Full Payment
- session: 2011/2012

Navigation buttons at the bottom include back, forward, search, and an 'Exit' button.

Fig. 6b. Record requirement (for financial clearance)

The 'Register Courses' window contains the following fields:

- Matric number: 090765
- courses: FSE211
- Level: 200
- Department: FSE
- Semester: Hammattan

Navigation buttons at the bottom include back, forward, search, and an 'Exit' button.

Fig. 6c. Register courses requirement

The 'TimeTable' window contains the following fields:

- Courses: FSE211
- Centre No: 2
- Exandate: 12 February 2012
- Exam Time: 3:00

A 'CENTRE No.' dropdown menu is open, showing the following options:

- 1. MEXD LT
- 2. 1200 LT
- 3. 1000LT
- 4. SPAXLT
- 5. 1300LT
- 6. 230 LT
- 7. LH

Navigation buttons at the bottom include back, forward, search, and an 'Exit' button.

Fig. 6d. Time table requirement

## 5 Conclusion

In this development, we accomplished the use of wireless sensor network for the success of examination attendance management after verifying student's registration and payment. This was done by design a working system to store and use fingerprint of student to mark the attendance of students during an exam.

One of the biggest challenges is the designing of efficient network management architecture to continuously support WSNs for providing services for various sensor applications.

## 6 Recommendation

A better implementation will require an intelligent transmitter and receiver for better speed of transmission and increased range of coverage distance. Likewise the number of nodes should be increased so that at least each examination hall can have its own node in the case of multiple exams holding simultaneously in a large institution of learning.

## Competing Interests

Authors have declared that no competing interests exist.

## References

- [1] Sangwon L, Dukhee Y, Amitabha G. Intelligent parking lot application using wireless sensor networks. *Processing of IEEE Conference*, 978-1-4222-2249-4/08; 2009.
- [2] Liu K, Abu-Ghazaleh N, Kang KD. Jits: just-in-time scheduling for real-time sensor data dissemination. *Fourth Annual IEEE International Conference on Pervasive Computing and Communications*. 2006;5-46.
- [3] Culler DE, Mulder H. Smart Sensors to network the world. *Scientific American (Technical Report)*. 2004;290:52-59.
- [4] Sharath P, Prabhakar S, Anil K. On the individuality of fingerprints. *IEEE Transaction on Pattern Analysis and Machine Intelligence*. 2005;24:8.
- [5] Maltoni D, Maio D, Jain AK, Prabhakar S. *Handbook of fingerprint recognition*. Springer, New York; 2003.
- [6] Weaver AC. Biometric authentication. *IEE Computer Society*. 2006;39(2):96-97.
- [7] Fakhreddine K, Jamil A, Mo N, Milad A. Multi modal biometric system: A state of the art survey. *Pattern Analysis and Machine Intelligence Laboratory, University of Waterloo, Waterloo, Canada*; 2005.
- [8] Anil KJ, Arun R, Prabhakar S. An introduction to biometric recognition. *IEEE Transaction on Circuits and Systems for Video Technology*. 2004;14(1):4-20.
- [9] Lee HC, Gaensslen RE, (Ed). *Advances in fingerprint technology*. Second Edition, CRC Press, New York; 2001.
- [10] Helmy Mohd, Abd Wahab. Design and development of portable RFID for attendance system, 978-1-4244- 5651-2/10; 2010.
- [11] Lim TS, Sim SC, Mansor MM. RFID based attendance system. *IEE Symposium on Industrial electronics & Applications, (ISIEA)*. 2009;2:778-782.
- [12] Yongqiang Z, Ji L. The design of wireless fingerprint attendance system. *International Conference on Communication Technology, ICCT '06, Handan, Hebei, China*. 2006;1-4.

- [13] Man M, Kyng LY. Utilizing MYKAD touch N Go features for student attendance system (TITO). Proceeding of 1<sup>st</sup> International Malaysian Educational Technology Convention 2007, Johor Bahru, Malaysia. 2007;114-120.
- [14] Sidi J, Syahrul N, Junaini, Lau SL. ISAMS: Tracking student attendance using interactive student attendance management system. Third Malaysian Software Engineering Conference (MySEC'07), Selangor, Malaysia. 2007;1-5.
- [15] Talaviya G, Rahul R, Shete AK. Wireless fingerprint based college attendance system using Zigbee technology. International Journal of Engineering and Advanced Technology (IJEAT). 2013;2(3): 2249–8958.
- [16] Shoewu O, Idowu OA. Development of attendance management system using biometrics. The Pacific Journal of Science and Technology. 2012;13(1):300-307.
- [17] Alonso – Fernandez, et al. Alonso – Fernandez F, Fierrez J, Ortega- Garcia J, Gonzalez – Rodriguez J, Frunthaler H, Kollreider K, Bigun J. A comparative study of fingerprint image-quality estimation methods. IEEE Transaction on Information Forensics and Security. 2007;2(4):734-743.

---

© 2016 Obayemi et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**Peer-review history:**

The peer review history for this paper can be accessed here (Please copy paste the total link in your browser address bar)  
<http://sciencedomain.org/review-history/14103>