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Remote Lectures Programming and Audience Notification System using Internet of Things Technology

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Abstract

In recent years, resourceful technology and innovation advancement has occurred in the area of web applications development, especially with advance integration of smart embedded systems (SES) which has contributed immensely to the collaborations between web applications and embedded system developers. Several challenges have been experienced in adopting computerized system for activities such as scheduling of work, time-tabling, lecture notes preparation and distribution, power point slide, results preparations and notifications of events in most institutions of higher learning, colleges, industries, banks and others. In this paper, the authors developed a remote lectures programming and audience notification system using internet of things technology (IoT) based on 6LowPAN platform. The proposed system herewith consists of an embeddedATmega328 microcontroller for the information processing, SIM900 GSM/GPRS module for SMS notification through the android web application. The web application was developed using MySQL database with Code-Igniter PHP Framework in conformation with the Model-View-Controller (MVC) as concept of software engineering, which all support application layer protocol using RESTful HTTPREQUEST and HTTPGET commands. Thus, the conceptual design of the computerized notification system is well-defined to provide regular notification of lecture periods, available course materials among others,with a regular information dissemination and time-delay management.

Keywords: ATmega328, Computerize system, embedded system, MySQL, Software engineering, Web application developer.

I. Introduction

The advent of computerization and the internet facilities has taken over almost every activities been executed manually by human in every organization. Scheduling of time and alarm monitoring system play an important role in the management of every activities of human lives which go beyond just to tell the actual time of the day [1]. But

development of a smart embedded remote notification and emergency message alert system implemented with adoption of 6LowPAN platform of internet of thing (IoT) will absolutely render the needed services and shortcomings of digital clock and alarm system in an organization that involved large numbers of people notification.

Therefore, an automation notification system can be described as a programmable real-time system dedicated for the remote message and alert system over the global system for mobile communication device using short message services (SMS). It used a central interface to send SMS messages to any-size of audience on any device over any communication channel of Internet protocol version 6 low Personal Area Network (6LowPAN) globally. During an emergency period or an event threatening situation in a big organization, this system could be fast employed to widespread messages across the people irrespective of their location about the danger

According to [2] defined IoT as a widespread network technology that allows trillions of things to be associated and interact to each other over the 6LowPAN platform using IPv4/IPv6 addresses. It enables things, devices to be monitoring and control of the physical environment by collecting data, processing data, and analysing the data generated by sensors or smart objects. Therefore, the 6LowPAN is designed for an IPv6 platform to accommodate trillions of things, machine-to-machine (M2M) or human-to-machine (H2M) communication, interconnectivity and sharing of resources over the network globally.

Many institutions, governments, industries and public organizations with large population needs to adopt a notification systems for the information dissemination across to the people concerned within a stipulated period. This will facilitate the public notice dissemination among the concerned groups in the organization. In 2013, the Turkey Trot Dallas YMCA implemented a new alert system called "RedFlag" design for race of over 40,000 people participants in the congregation Thanks giving [3]. This alert system helps to broadcast signal alert across the thousands of people in the congregation at a go.

There are various techniques for broadcasting communication about events across the people which includes a telephone notification service that can be used by a wide variety of organizations like government, businesses and academic world using SMS text messages on mobile devices [4]. Voice broadcast emergency notification systems is the most traditionally popular for message broadcasting either within or public. This notification has the advantage of being instantly available and scalable enough to send out hundreds or thousands of alerts within an hour. It also helps government agencies to send critical notifications, such as weather-related warnings, resource information, extended utility interruption, missing children, fleeing suspects or other police-related operation announcements, evacuation preparation announcements, and other critical alerts [5].

This developed university lecture scheduling and notification system consist of several components in its framework for the purpose of acquiring, storing and distributing data. It includes the users, hardware, software, procedures and data as depicted in the (Fig.1). Involvement of these components aids the communication processes and speed the broadcasting of SMS messages and alert through the gateway provider. With the implementation and development of both software and hardware technology based on remote university lecture and audience notification, the system can improve accuracy of the information, reduced the cost, effort and time expended on searching for information with ultimate accesses.

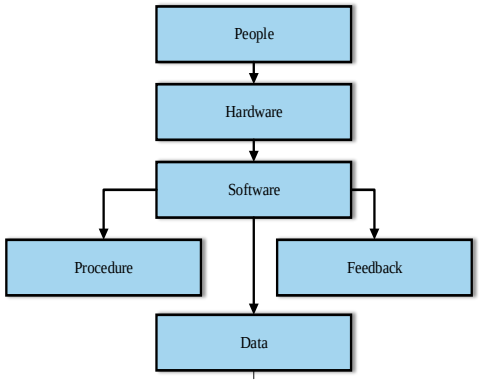

Fig. 1. Information System Framework

II. Related Works

In [6] University time table scheduling system was developed using android web apps which coded in visual basic language. The system automatically schedules the university time table according to faculty, and based on the number of courses offering by various department in each faculty. Although, this system is automated, the notification capability and remote access of information are not included.

The author [7] developed a mobile University Notification System for educational institutions using the Jabber Protocol or Extensible Messaging and Presence Protocol (XMPP) for distributed messages between the client-server architecture. The system was operated in a real-time basis in the attempt of distributing messages to the client so that it is less expensive to implement but require mobile phone with java application program. Intelligent agent based Student-Staff Scheduling System was also developed by [8]. The main purpose of this proposed system is to reduce the waiting time needed towards appointment scheduling between lecturers and students and also for appointment scheduling among the fellow lecturers within the organization. The success of this system has been made possible through the use of android based mobile phone

application. The proposed system utilizes the functionality of software agents to perform its feature functions such as scheduling, re-scheduling, update and cancellation of appointments. All these features are implemented using the JADE-LEAP agent development kit.

An android web application was created for academic calendar scheduler by [9]. This application designed mainly focuses on minimizing the difficulties encounter by the institution management during academic planning and management of student activities over a period of time. This application used a system administrative (server) to connect with the student android application (client) for accessing data or student profile for any activity. The application was designed to be simple, interactive and self-explanatory interface, thus making it easy to use and navigate through different modules. However, the shortcoming of this application program is the privilege interaction giving to the user that can make it vulnerable to the hacking attack and other cyber-crime.

The automated lecture alert management system was proposed by [10], where combination of high level programming language of Java and C program was used in the system coding. The hardware system includes Sony Erickson K700i mobile phone and GSM module for sending a Short Messages Service (SMS) alert over the circuit switched GSM network. The database was designed, updated and maintained using MySQL, which is always used to check the database for the lectures scheduling. Although, this system was proposed, but it's complex architecture which can results to error during message forwarding, and its efficiency also depends on the network facilities. Kind. An automated time table at a click was developed to generate a complete computerized time table scheduler sheets which when details information are provided (such as courses title and code, lecture venue, laboratory unit, lecturers' name and students' level) [11]. In this system, notification and remote message are not considered. Also, this system can only generate scheduled time table for a unit.

In this paper, the authors adopt different techniques for disseminating regular information across the audience at a remote network. The SMS messages and alert can be broadcast through the online electronic mail (E-mail) using wired or wireless network or through an automated phone call which utilize a text-to-voice (T2V) software for readable ability or messages translation to the users through telephone line network. Also, the application of Short Message Services (SMS) for broadcasting and message transmission is well factored into the designed to improve on the existing authors" development of lectures and audience message notification system. The system included three modules namely: the SMS Interface, the conduit module and the web application module, whose combined functions come together to bring about a positive result.

The system is dependent on both a GSM network and a high-speed internet connection. GSM network for sending SMS and the internet connection for data transmission between the SMS interface and the web application.

III. Methodology

The development and coding architecture of computerized remote lecture programming and audience notification system includes both hardware system andsoftware program design. The Android GUI is designed and implemented using technology of Android user interface studio (AUIS) that utilizes "Gradle" console to compile ".apk" files for the android communication. This module is developed for the use of authorized administrators (Class Representatives) to access and provide details of the course schedule information to the audience. The information includes name of the lecturer, the course code and title, the lecture venue and time as shown in the (Fig. 2). Fig. 3 shows the block diagram integration of both hardware and software interactive model.

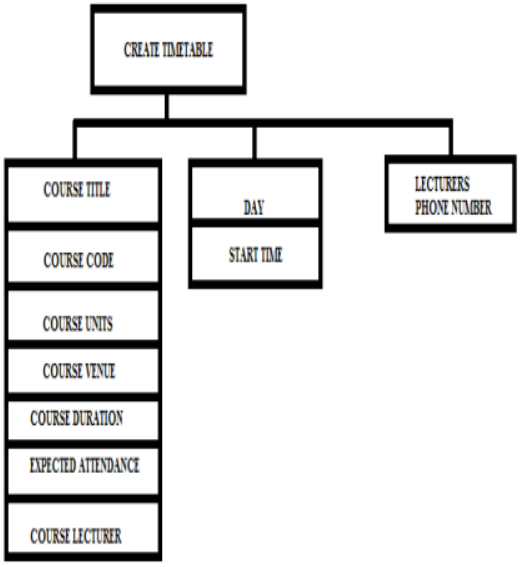

Fig. 2. Course Schedule Outlines

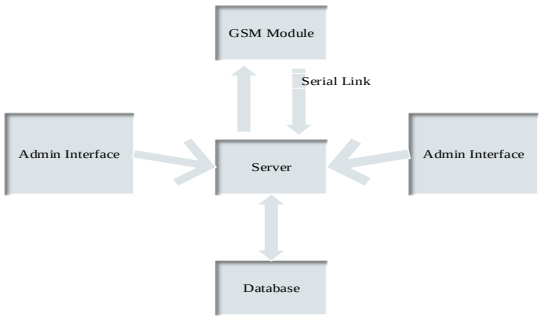

Fig. 3. Lecture Notification system block diagram

The PHP scripting language is used in the software development for backend architecture of the available data, and MySQL is used for database development and relational structured model of the data.

IV. System Design and Implementation

In the development of remote university lecture scheduling and notification system involved different hardware component. The SMS graphic user interface is implemented for the messages readout through hardware components which includes SIMCOM's SIM900A module which used to sends and receives information (short messages services SMS) from the android mobile web application. It consists of GSM/GPRS module, an ultra-compact wireless module that communicates with microcontrollers chip through SIMCOM advance technology (AT) Commands. The GPRS/GSM is controlled by the universal asynchronous receiver-transceiver module (UART) and configured with Arduino board using simple AT commands. The following available pins was used in the connection and configuration with Arduino ATmega328 for SMS forwarding and received (The power (+5V), ground (GND), Receiver (RX), transmitter (TX), PWR, and reset button (RST). The Fig. 4 depicts the connectivity of GSM/GPRS module architecture.

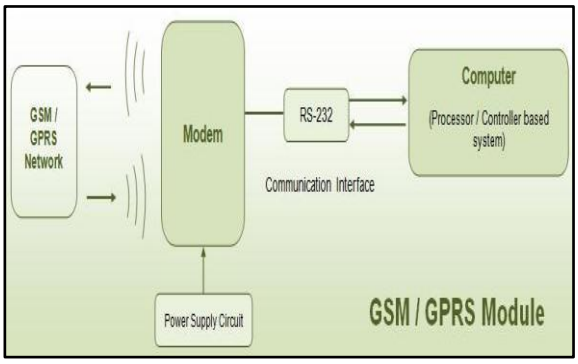

Fig. 4. GSM/GPRS module architecture [12]

The ATmega328 is an 8-bit, single chip and reduced instruction set computer (RISC) microcontroller, it consists of 32Kb flash storage unit, 2Kb SRAM, 1Kb EEPROM with read/write capacity. It also includes 32 general purpose registers with about 23 input/output lines, counters with different mode, interrupts, serial programmable and so on. The controller has different software selectable modes of power saving, and operates between voltage levels of (1.8-5.5) volts in order to achieve throughput of one million instructions per second MIPS/MHz. The instructions per second (IPS) for a processor can be calculated as given in(1).

$$P_{IPS} = N_{sockets} * \frac{N_{cores}}{N_{socket}} * N_{clock} * \frac{IPS}{N_{cycle}} \qquad (1)$$

where, P_{IPS} is the instruction per second for a processor, N_{socket} is the number of socket, N_{cores} is the processor cores, N_{clock} is the number of clock rate and N_{cycle} is the number of complete clock cycle.

All these components are interface together to achieve a periodically query of remote processor for the lecture course scheduling and notification using the HTTP GET request command to extracts the phone number of the lecturer or candidate and sent the 60-character SMS message through the GSM/GPRS module. The remote lecture scheduling and audience notification system architecture is depicted in (Fig. 5).

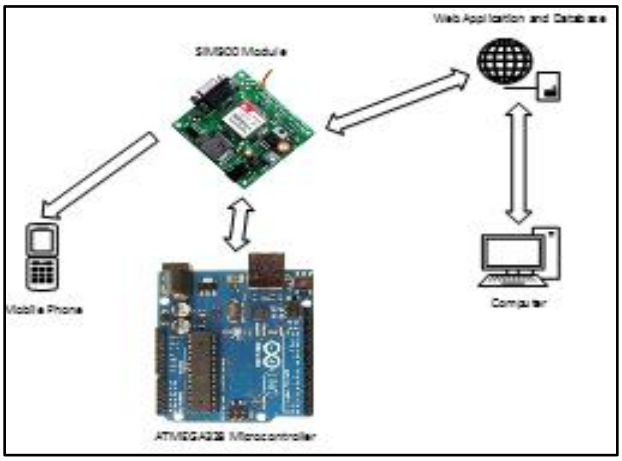

Fig. 5. System Modular Representation

The modular system architecture of remote university lecture scheduling and audience notification system based IoTs technology can be mathematically represented as expressed in (2) [13].

$$R_{NS} = \sum_{j=1}^{n}\sum_{i=1}^{j} E_{system} + \sum_{j=1}^{n}\sum_{i=1}^{j} N_{facilities} + \sum_{j=1}^{n}\sum_{i=1}^{j} I_{tech} \qquad (2)$$

where, R_{NS} is the remote lecture scheduling and notification system, E_{system} is the embedded system, $N_{faciliities}$ is the network facilities, I_{tech} is the information technology involved like programming languages, and j is constant that represent number of components or facilities used for both hardware and software programming in the system modular architecture (j=1, 2, 3,…n).

Also, the total time cost for sending a notification SMS can be calculated as the transmission time of the SMS interface initiates a request to the the SMS notifications have been sent out and the processing time at both the web application and the SMS interface are expressed as given in (3).

$$Tt_{\cos t} = \sum_{j=1}^{n} Tt_{transmit}(t) + Tt_{processing}(t) \qquad (3)$$

where, $Tt_{\cos t}$ is the total time cost for sending a single SMS, processing and received, $Tt_{transmit}$ is the time taken an SMS for transmitting message, $Tt_{processing}$ is the time taken the SMS during processing.

The system integration flowchart process is depicted in the (Fig. 6) which described details operations of remoteuniversities lecture scheduling and audience notification system.

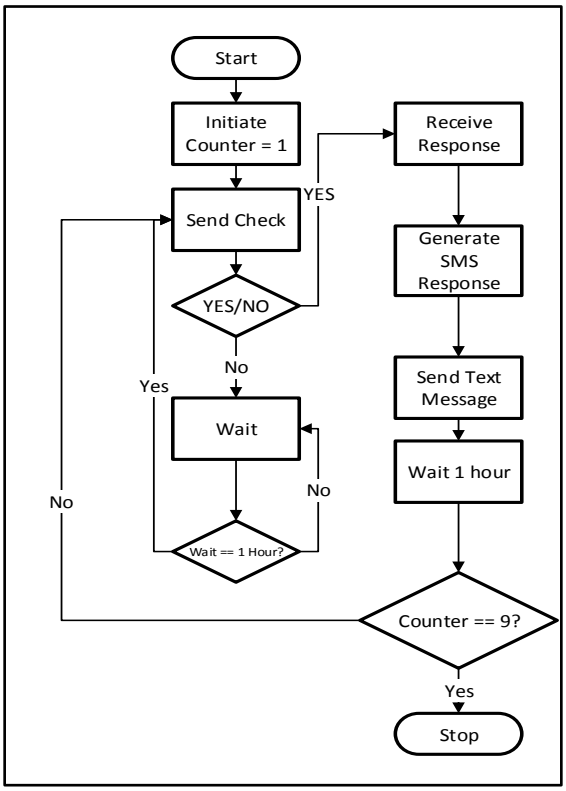

Fig.6. System Process Flow Chart

V. Software Development

The software development framework was considered for the successful structure, plan, implementation and control process of the developed combination of hardware-software based remote university lecture and audience notification system. This is to ensure the quality of the software and hardware design in the software development life cycle requirements (which includes requirement gathering and analysis, system analysis, design, coding, testing and implementation. The Fig. 7 shows the use case diagram, (Fig. 8) depicts the software development architecture and (Fig. 9) show details of data flow diagram of the software development life cycle of the remote university lecture scheduling and notification system which explains the user role and the administrator respectively. The class representatives (Administrator) have the authority to add, remove any classes and monitor the website statistics (such as students' registration, lecturer registration, available courses, or any other information).

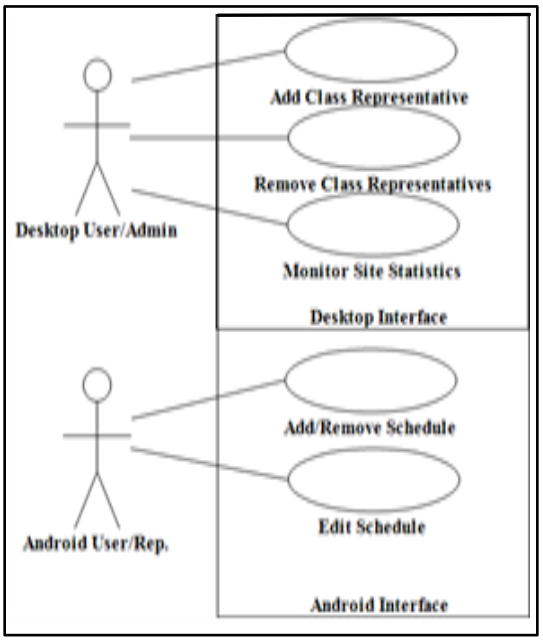

Fig. 7. Lecture Notification Use Case Diagram

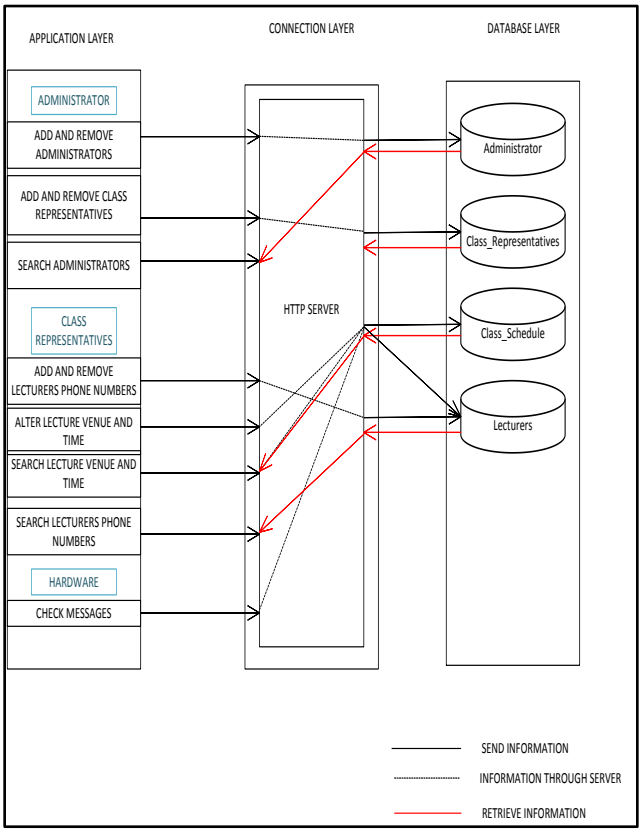

Fig. 8 Lecture Notification System Architecture

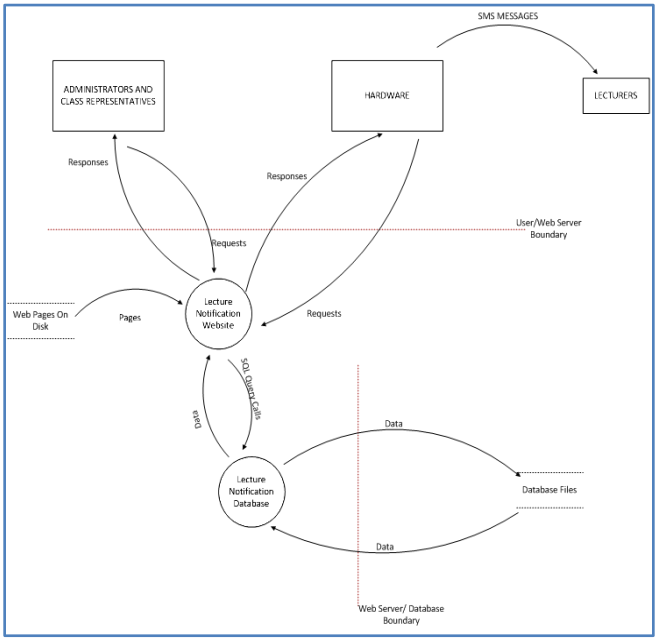

Fig. 9. System Data Flow Diagram (DFD)

VI. Results and Discussion

The android application was designed to serve the purpose of remote university scheduling and audience notification system for both the system administrator and the individual class representatives. Fig. 9 and 10 shows the login/authentication android web page for the class representatives (administrator). This interface was provided as first level of security measure which necessitated protection of unauthorized access of the platform.

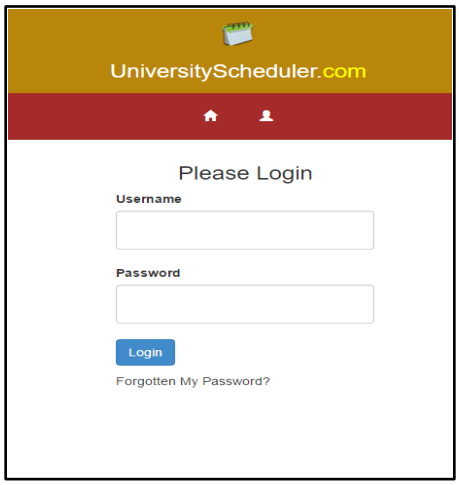

Fig. 10. Class Representative Login

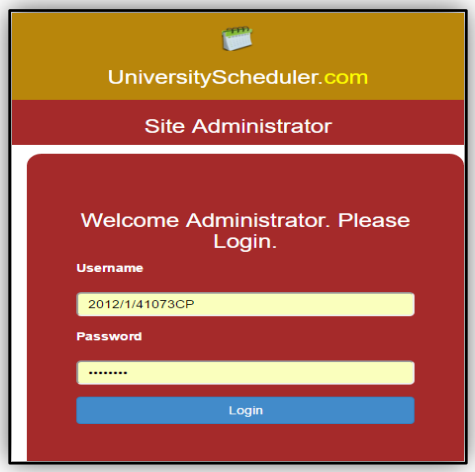

Fig. 11. System Administrator Login

After login processes, it will take the administrator to the dashboard web application database where he can view, edit, update and add class schedules for the audience notification as shown in (Fig. 12, 13 and 14).

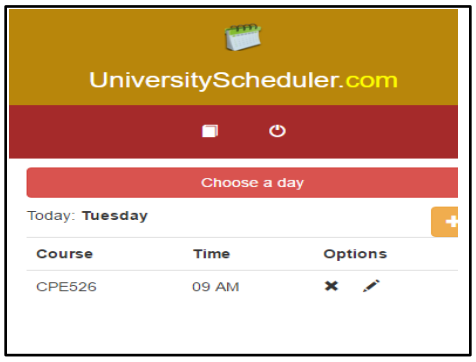

Fig. 12. Administrator web apps dashboard

The add schedule dialog, Fig. 13, comes up when the class representative clicks the button for adding new course schedules. On the dialog, the representative can add the course title, the scheduled time, the lecturer name and phone number.

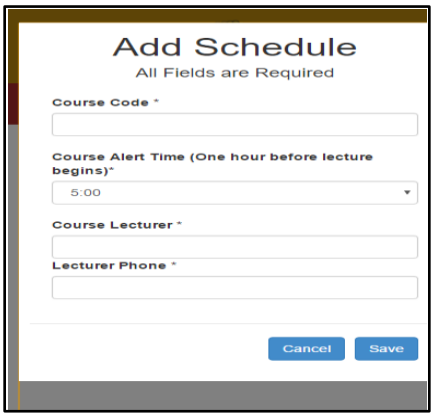

Fig. 13. Class Representative Add Schedule

The Fig. 14 shows the edit schedule dialog. Here the class representatives are able to make changes to the class schedules as and when the changes happen. They can change the time, the phone number of the course lecturer or even the course lecturer him/herself.

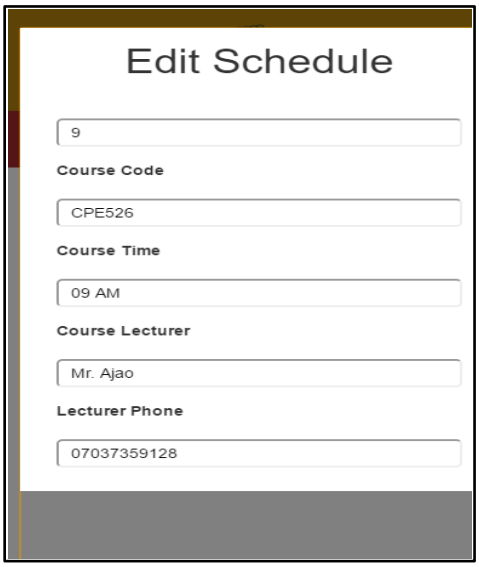

Fig. 14. Class Representative Edit Schedule

The system administrator is responsible for granting permissions to the class representatives. Figure 14 is the login/authentication view for the system administrator. This is needed to prevent unauthorized accesses being granted to anybody who is not a class representative.

The new class representative dialog allows the system administrator to grant permissions to new class representatives by inputting their matriculation number, student ID number, department and finally the year of graduation for the class. The dashboard for the system administrator, Fig. 15, shows the system administrator the number of class representatives, the number of schedules, lecturers and departments that are already in the system. This is necessary to enable the system administrator know when traffic is becoming high and if need be, make an upgrade on the server. From this panel, the system administrator can remove a class representative for a graduating class.

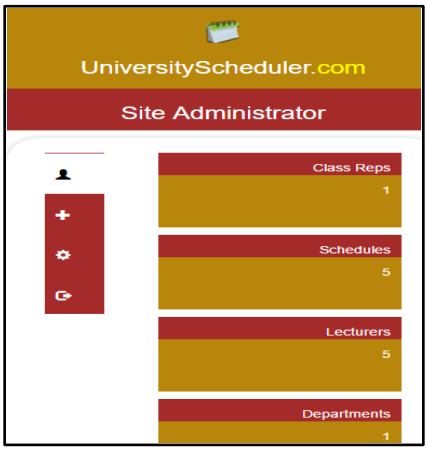

Fig. 15. System Administrator Dashboard

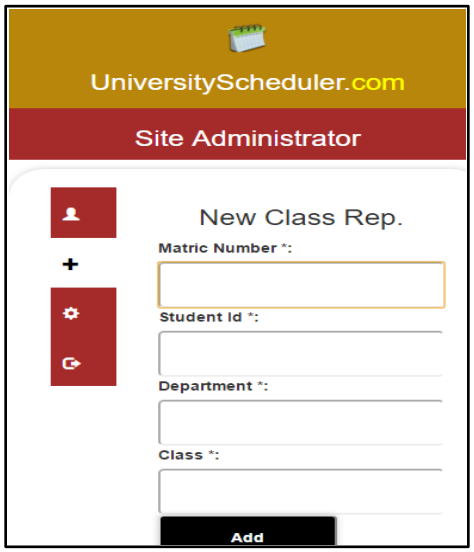

Fig.16. System Administrator Add New Class Rep.

The hardware and software integration of remote university scheduling lecture time table and audience notification system is presented in the Fig. 17, which consists of remote android mobile web application, the embedded remote scheduling and audience notification system with conduit apps running on the laptop during testing of the system. This is to ensure the workability, reliability, functionality of the remote system developed as things operations depends on internet of things platform technology.

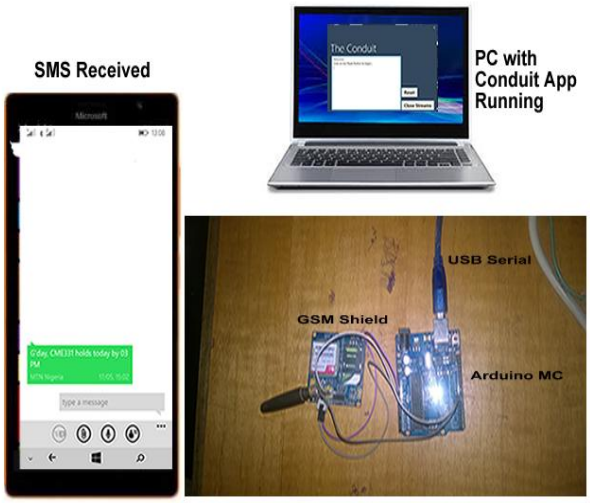

Fig. 17. Remote University scheduling lecture and audience notification system

VII. Conclusion

The remote lectures programming and audience notification system was developed and implemented to provide a fast mechanism of disseminating SMS messages information to the large population within a twinkle of an eye as 6lowPAN platform for IoT technology has been in existence. This will support communication of large crowd on the network among human-to-thing (H2T) widely. Therefore, this system was designed for university lecture scheduling and audience notification, but can also be used by the commercial industries for their customer notification SMS message about an events when modified. Others are government, military and para-military organization. This system is flexible in the area of user interaction and render additional operation services over the existing in the literature since it support 6LowPAN platform based on IoT using GSM/GPRS and the android web apps that support application layer protocols such as HTTP REQUEST and HTTP GET commands.

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