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Design and Implementation of Auto Switch Lighting Monitoring and Control System

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Abstract -The havoc that the electricity can cause may be unimaginable compared with the benefits if not proper controlled, maintained, managed and used. Developed countries has setup good system of management and maintenance of electricity supply. Studies have shown that electricity supply should be properly distributed and managed with respect to the use, however, only a few of these studies were implemented in developing countries including Nigeria. Therefore, this research was aimed at the design and development of auto switch lighting monitoring and control system. The research adopted multiple concepts by making use of the development of software, and hardware configurations. The configurations combined a micro-controller (Arduino), sensor GSM module for wireless communication, battery, Real Time Clock (RTC) and LEDs (Light Emitting Diodes) for display purpose. By considering the time set by Real Time Clock (RTC) and from the status of (Light Dependent Resistor) LDR sensor, the controller turns the light ON/OFF. The results showed that the photoelectric (presence) sensor turns on the light only when the presence is detected during night time and Current Sensor will sense the current value from which power consumed is calculated. It also provides the information about the faulty lamps which ease the fault detection. The research concluded by ensuring that the objectives were met. The research employed the synchronization of database created and linked with a mobile software that was further linked with a digital board. The designed software was implementation and it was able to control the auto switching, monitoring and control of the lighting system in Babcock University. It was recommended that this software should be replicated for the country.

Keywords-Arduino; Battery; GSM; Sensor; Real Time Clock (RTC); Light Emitting Diodes LEDs

I. INTRODUCTION

The history of power (electricity) is almost as old as humanity. The history of power generation was marked by various skyrocket technological milestones from hundreds of writers. Many authors reported that power generation began with Stephen Gray, with the demonstration of electric conduction that led to the invention of glass friction generators in Leyden, Germany which also inspired Benjamin Franklin (1752) [1]. And the history went on from one supporter to another and today, the world can boast of electricity.

Growing up in Nigeria schools, the majority of the song chorused were the benefits derived from the government called social amenities which were; good road, electricity and water supply. However, the old folks may one way or another benefit from these amenities, but from the last three decades, the so-called social amenities were no longer free for all but only meant for the highest bidders in government. These challenges created the need for the independent generation or electricity, water and road. However, for schools that are still getting electricity supply from the government, they pay dearly for it.

Babcock University Nigeria has lost a number of buildings and other properties to fire outbreaks in the past and that is why there is a need for the automation of electricity usage on campus. The campus street lights are always lighted in the night and most times and it takes a number of workers hours to go from one junction box to another every day in an attempt to switch off these lights. Also, on many occasions, the bulbs may have malfunctioned for months without replacement and those

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in charge do claim ignorant of it. There are a number of researches available in Sub-Sahara Africa, Africa and globally that have discussed the solution to this challenge but the institution believed in solving her problems with inhouse inventions. Therefore, this research was aimed at the design and implementation of auto switch lighting monitoring and control system.

II. LITERATURE REVIEW

The emphasis of the literature review was on the concepts of design and implementation of auto switch lighting monitoring and control system. The literature search was undertaken by the team members using the following search engines: google scholar, and science direct. Three searches were done, the first involved design and implementation of electricity, the second procedure was the auto switch lighting and the third was the combination of the two key terms (auto switch lighting system), and (monitoring and control system of electricity).

The literature search was confined in texts published in English language between 2019 till date even though some vital information were relevant, but obsolete as defined. The team also assessed abstracts, technical papers as well as webpages. The team adopted a matrix method of review and used a review matrix for the review of documents. The documents were examined carefully. The use of automations has been widely circulated by a number of researchers. It is one of the most important things in life and it plays a big role in the world. Automatic system in Science and Engineering is the global practices and every country should embrace this technique. Automations have been seen in airplanes, trains, banks, schools, places of worships, homes and in fact, in all facet of lives. If there are still countries that are not fully automated, then we consider such as developing.

Reasons for Automation [2] established that automation is necessary because of the busy schedules of lives which has been increasing from day to day. To make the lives of individual easier, better and also to save huge amount of power. The time gained in one operation can be ploughed in another. Meanwhile, [3] previously gave this assertion and did not stop in the areas of minimizing consumption but extends further intensifying that each unit must have a considerable amount of allocated power which should be based on the building size, occupancy, and operation function, the lighting energy used is the largest contributor to the commercial buildings' energy consumption.

A. *Control and Monitoring System of Lighting*

Buildings are the best avenue for energy consumptions because of various appliances used. Also, an inefficient controlling of lights can result into wastage of energy. The authors of this study discussed various methods of reducing energy consumption such as implementing a smart lighting system that integrates sensor technologies, using a distributed wireless sensor network (WSN) and ZigBee protocol with illumination control rules [4].

[4] emphasized the importance of street lighting however, there appear to be challenges with the detection and monitoring of bad bulbs and malfunctioning connections. [5] used a Geography Information System (GIS) to locate the faulty street lamp. The GIS technology was added to the intelligent lighting system to improve the accuracy of intelligent dimming with the aid of an intelligent dimming algorithm.

In addition, it was discovered that most educational institutions spent more electricity in the illumination of the classrooms and for switching the fans, computers among others. [6] designed an efficient equipment to minimize the energy consumption in the classrooms to avoid energy waste during unoccupied and daylight hours. A lighting control system was established in which the light circuits and fans in classrooms remain switch off in the absence of students and will return back on in the presence of students. This is a very good concept in relation to the ongoing research which is aimed at switching on the light when it is necessary and also switching it off when it is not useful. The auto switching will also monitor the circuitry to know when the bulbs and other components are malfunctioning.

III. METHODOLOGY

The methodology employed made use of presence sensor, current censor, Real Time Clock (RTC) connected with an Arduino microcontroller to effectively monitor and control the street light, while at the same time send an SMS to an electrical personel when the light failed to come up. The device was divided into two parts, the first part consists of Presence Sensor, Current Sensor, Real Time Clock (RTC) and Arduino microcontroller which effectively monitor and control the street light while the second part consist of GSM modules that send a message to the worker and also get update form the database as shown in figure 1 The web application was divided into client and server sides. The client side was built using Hypertext Mark-up Language (HTML), Cascading Style Sheets (CSS) and JavaScript, while the server side was built using Hypertext Pre-processor (PHP).

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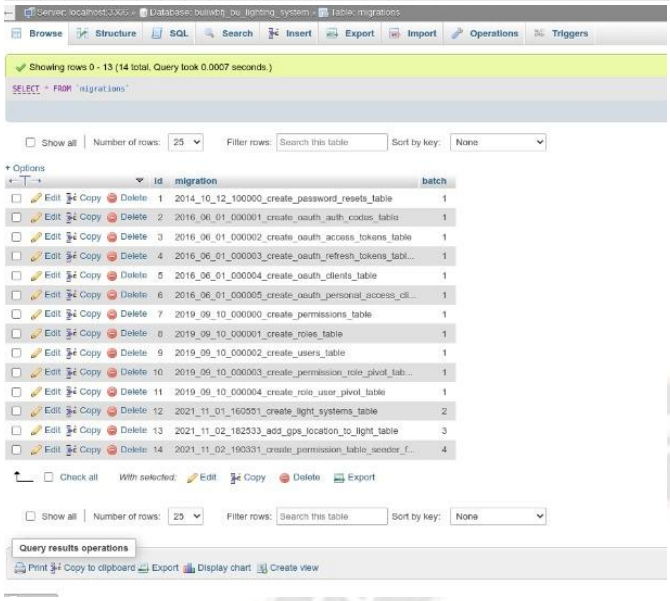

Figure 1 The database Design

A. *Mechanism of how it works*

Hardware implementation of auto light intensity and auto switching system control for Smart Street lighting system was proposed using the AT COMMAND which is used by GSM for sending commands to the street light, just like using server. The GSM Module communicates with the server and database to check for requests and passes it onto the micro-controller which then switches the street lights based on the request and command made by the user. Using contactor and relay to protect and control maintaining of supply. Inbuilt circuit is where power supply is given to module, therefore with the help of ac capacitor, the ripple is reduced and then converted into DC with the help of a bridge rectifier by further using antenna, they transmit the message (MSG) to micro controller which reads and accept if they match with the AT COMMAND after then MSG is received, the emitted led light unit of street light (unit 2 or unit 3) will be open. They should also repeat the same process to be switch OFF.

B. *The Software Development Involvement*

The developed platform interacts with the hardware through GSM module. The GSM module will have a GPRS, which helps to send packet of data to any online server, such as, Pinging of Google from the GPRS which uses data from the sim card. There are several methods of sending information between the hardware and the software which varies from the STP and the GET request. But this software used the GET method request for the easy exchanging of data information request between the hardware and software. Through the GET method, information are sent using a like link or Uniform Resource Locator (URL) which then sends the link to the GPRS module, it will then ping such information from the link to our web server which will respond to the logic we have integrated to our backend. The GET method request contains the operational needed information such as response time, time to go off, time to go on, which is part of the URL (link) information sent from the GET method which our server picks and sends to our database. The database is the link between the GPS end and the web end, so our web end goes to the database to collect the current information and update the front end.

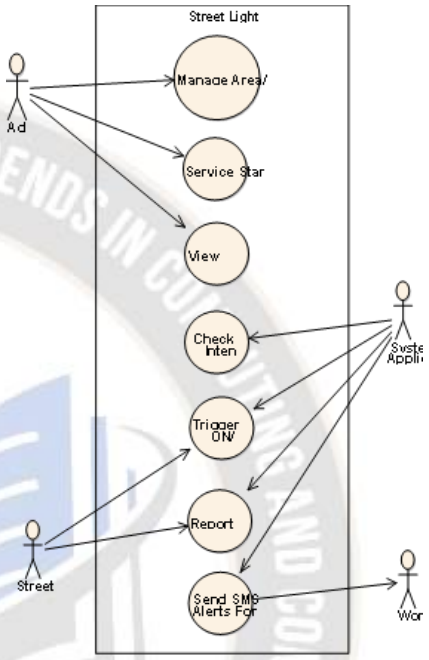

Figure 2 Usecase diagram

Figure 2 is a Use Case diagram that introduces the major characters of the project i.e. Admin, System/Application, Street light and the worker. It also demonstrated their respective functions. The admin is mainly responsible for managing the area and also responsible for when to start or stop the service. System/application periodically gets light intensity value from the light intensity sensor based on the triggering functions (ON/OFF).

C. *Street Lamp Switching*

The auto switch is control by the automated structure that is been programmed using the Arduino Uno with the help of the IR sensor.

D. *Sensor and GSM Module*

The sensor module which is integrated with DS323 1 RTC for real time and clock timer of the street light. GSM Module is the main hub of the project which Maneuvers the street lamping system. The main work of this module is to get the information or record the information and send the same to the main server. The module is on the whole collaborating with a micro controller which controls the recording or intimidating the information. This is further illustrated in figure 3

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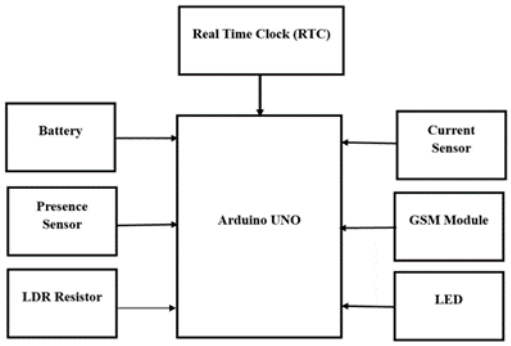

Figure 3 Block Diagram

Figure 1.3 shows the block diagram which consist of micro-controller (Arduino), sensor GSM module for wireless communication, battery, Real Time Clock (RTC) and LEDs (Light Emitting Diodes) for display purpose. By considering the time set by Real Time Clock (RTC) and from the status of (Light Dependent Resistor) LDR sensor, the controller turns the light ON/OFF. Also, the photoelectric (presence) sensor turns on the light only when the presence is detected during night time and Current Sensor will sense the current value from which power consumed is calculated. It also provides the information about the faulty lamps which ease the fault detection.

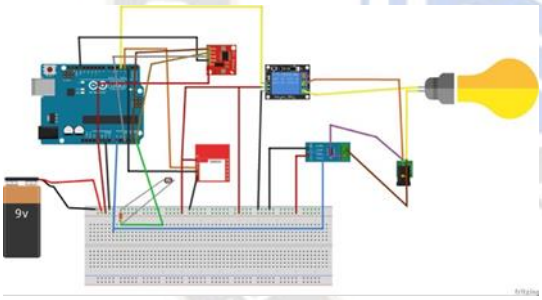

Figure 4 Bread-Board Diagram

Figure 4 depicts a model connection of the various components needed in this system to a bread-board. The micro-controller (Arduino Uno) is connected to the 9v battery. This supplies power to the micro-controller. The GND (Ground (-)) of the GSM Module is connected to the GND of the micro-controller while the Voltage Common Collector (VCC (+)) of the GSM Module is connected to 5v of the micro-controller and the positive terminal of the relay. The transmitter (TX) and received (RX) of the GSM module are connected to digital-pin 2 and 3 of the Micro-controller, respectively. The negative terminal of the relay is connected to the GND of the micro-controller while Pin A of the relay is connected to digital-pin 4 of the micro-controller. Pin (NO) of the relay is connected to one side of the bulb and the common pin (C) is connected to one side of the plug. The other side of the plug is connected directly to the other side of the bulb. The SDA, SCL (Serial Clock) and the Square Wave (SQW) of the RTC are connected to the analog-pins 4, 5 and 2 of the micro-controller, respectively. The GND and VCC of the RTC are connected to the GND and 5v of the micro-controller. The GND and VCC of the ACS712 Current Sensor are connected to the GND and 5V of the micro-controller respectively, while the IP+ pin and the IP- pin of the ACS712 Current Sensor are connected to the Plug and the bulb respectively

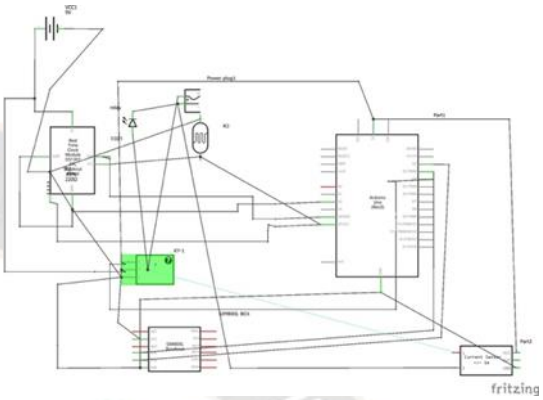

Figure 5 Schematic Circuit Diagram

Figure 5 shows a detailed schematic circuit diagram of the connection between the Micro-controller (Arduino), RTC Module (Real Time Clock), GSM Module, Current Sensor, Light bulb, Relay, LDR (Light Dependent Resistor) and the Battery.

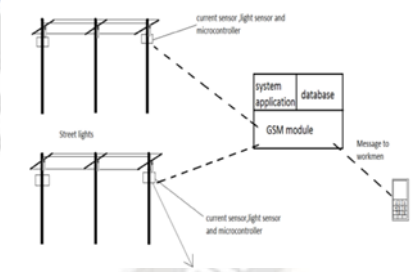

Figure 6 Graphical Representation of the operation

Figure 6 shows a graphical representation of how the system is meant to work. From this figure, we can see the major components, where they are placed and how they interact with the streetlights and the entire system.

IV. RESULT AND DISCUSSING OF FINDINGS

We tested the system using some of the streetlights in the school and other outputs as load. From the test scenarios, it was conclude that the system can generate about 10A (10 amps) and hence, can power 10 bulbs simultaneously. Here are some visual representations of our testing session in figures 6 to 12.

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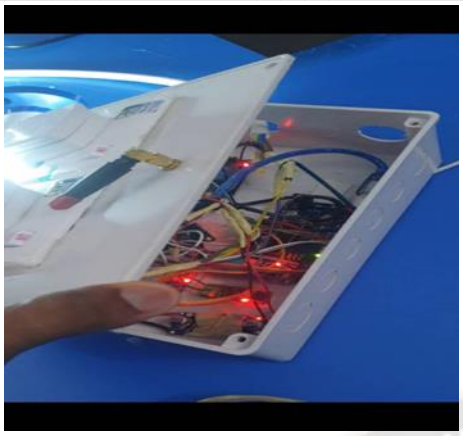

Figure 6 Output Representation

This is the first screen the user will see once the website is accessed. It is the screen where the user can login into the system by entering the required details. If these details (username and password) are correct, the user will be authenticated and can then proceed to the next page.

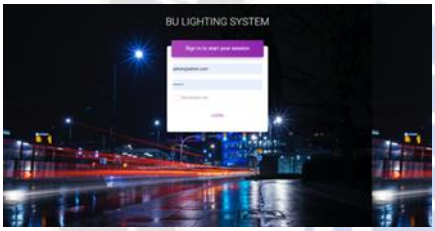

Figure 7 Index/Login page of the software

After the login, the user will be directed to the dashboard as seen in figure 8 where they will be able to navigate to several parts of the system. The dashboard enables the user to view the number of lights installed and the operational status.

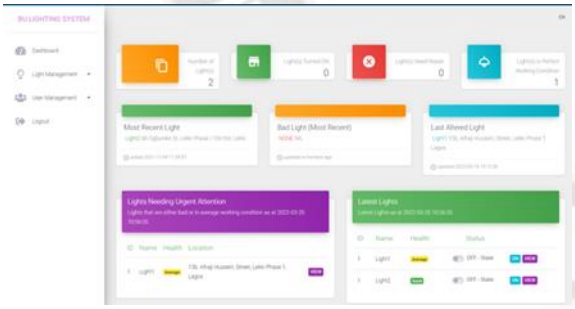

Figure 8 Dashboard of the developed software

This page allows the user to add/delete new lights (after being physically installed) on/from the system. This is the menu that controls the switch.

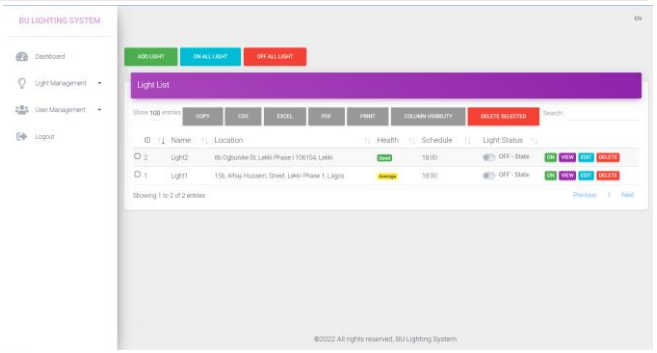

Figure 9 Light Management Page

User Management (Permission, Roles, Users)

This part of the system is where created users' credentials are stored, manipulated where roles and privileges are granted. It's sub-menus are Permissions, Roles, and Users.

A. Permissions

This contains the permissions list. It allows the admin to enable/disable certain permissions to specific users on the usage of the system. Here, several permissions are listed, and each can be assigned to a user on what action they can and cannot perform on the system as illustrated in figure 10.

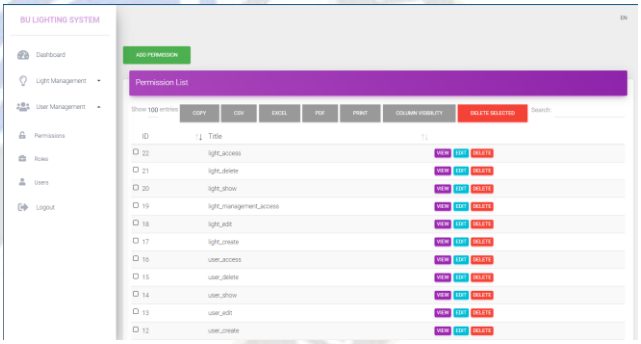

Figure 10 Permissions page

B. Roles

This contains the roles list. It allows the user to enable/disable certain actions that directly affect other users of the system. The roles are assigned to several users on what they can and cannot perform. The difference between this and the permission list page is that the permissions list contains all the permissions that can be assigned to a user on what action they can and cannot perform on the system while the role page is where these permissions can be assigned to users to enable them to perform certain actions as demonstrated in figure 11.

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Figure 11 Roles page

C. Users

This contains the list of created users. Their details can be viewed, and their roles can be added/removed. In this page, users can also be deleted preventing such deleted user from having access to the system anymore as seen in figure 12.

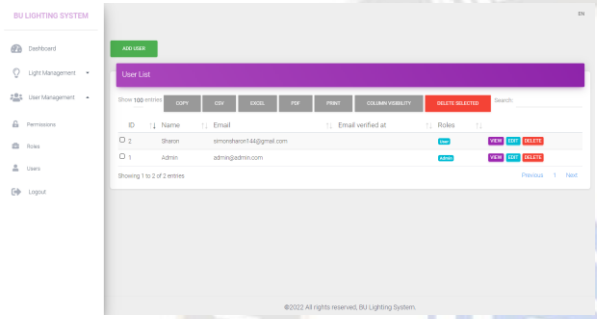

Figure 12 Users page

V. CONCLUSION AND RECOMMENDATION

The research concluded by ensuring that the objectives were met. The research employed the synchronization of database created and linked with a mobile software that was further linked with a digital board. The designed software was implementation and it was able to control the auto switching, monitoring and control of the lighting system in Babcock University. It was recommended that this software should be replicated for the country.

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