SMART CLASSROOM LIGHTNING AND AUTOMATION USING SOME LOCALLY SORT OUT MATERIALS

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MAY 2024

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A PROJECT SUBMITTED TO THE DEPARTMENT OF MECHATRONICS ENGINEERING, FACULTY OF ENGINERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR (B.Eng) IN MECHATRONICS ENGINEERING, UNIVERSITY OF BNIN, BENIN CITY, EDO STATE

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CERTIFICATION

This is to certify that the project "Smart Classroom Lighting and Automation" was carried out by: **AIGBOKHAEBHOLO JOSHUA OSEGHALE AND AGHAMA FAVOUR IYOBOSA**, in the Department of Mechatronics Engineering, Faculty of Engineering, University of Benin, in partial fulfillment of the requirement for the award of Bachelor of Engineering (B.Eng.) in Electrical Electronics Engineering.

______________________ ________________

Engr. G.A. Ojariafe Date

Supervisor

__________________________ ________________

Head of Department Date

Mechanical Engineering Department

DEDICATION

This project is dedicated to every member of our Family.

ACKNOWEDGEMENT

First and foremost, we want to express our heartfelt gratitude to the Almighty God for His guidance, blessings, and strength throughout this project. Without His grace, none of this would have been possible.

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Lastly, we would like to acknowledge the University of Benin for providing us with the resources and environment conducive to learning and innovation.

ABSTRACT

Traditional classroom lighting systems often lack adaptability and responsiveness, hindering the creation of optimal learning environments. This report presents the development and evaluation of a smart classroom lighting system designed to address these limitations. The system utilizes motion sensors and passive Infrared sensors] to detect the motion of people within the classroom and to check the current status of the classroom lights based on pre-programmed schedules. A mobile app interface allows for user interaction and customization.

The project methodology encompassed system design, control algorithm development, user interface creation, prototyping, and performance evaluation. The system was evaluated through energy consumption monitoring, user surveys, and lighting environment measurements. Findings revealed that the smart lighting system led to a reduction in energy consumption, improved user satisfaction with the learning environment, and potential for enhanced student learning outcomes.

This report concludes by discussing the system's potential for implementation in educational settings and future research directions.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Education is undergoing a significant transformation, with technology playing an increasingly central role in the learning process. This transformation extends beyond just digital content and tools, encompassing the very environment where learning takes place. Smart classrooms are emerging as a key element of this evolving educational landscape, aiming to foster engaging and impactful learning experiences through intelligent automation and optimized conditions.

In this field of study, we consider the classroom. A conventional classroom not only consists of tables and chairs that make learning convenient but also indoor environmental conditions like; light, temperature and humidity. Among these, it is clearly believed that light is one of the most important as a study showed that light contributed 21% to the increase in students' progress. Lighting not only affects visibility but also significantly impacts student well-being, alertness, and cognitive performance. Traditional classroom lighting systems often lack flexibility and adaptability, failing to cater for the diverse needs of different teaching methods and activities. . Indeed, research conducted showed that the relative poor performance of students in learning environments can be traced to poor lighting.

Illumination is a very important environmental and learning factor in classrooms. As a result, there has been a rising need for energy efficient and sustainable indoor learning surroundings. The educational world delved into in depth research on how this can be improved on. This took many years as technology hadn't yet unleashed its true potential.

Many years of research all over the world finally yielded results and conclusions pointed in just one direction which is the development of smart lighting classrooms. The advancement of technology made this possible with a primary focus on energy efficiency and so much more. Smart Light Emitting Diodes (LED) lighting systems have proven to various technicians and engineers around the world that this can be achieved while also satisfying luminance requirements in conventional classrooms.

1.2 PROBLEM STATEMENT

Inefficient Energy Consumption

Traditional lighting systems in schools contribute significantly to energy waste. A study by the National Renewable Energy Laboratory found that lighting accounts for 15-25% of total energy consumption in K-12 schools. This translates to wasted energy and increased costs for school districts. Implementing smart controls can significantly reduce energy consumption and the associated environmental footprint of schools.

Suboptimal Learning Environment

Studies have shown that inappropriate lighting conditions can negatively affect student attention, alertness, and cognitive performance. Excessive brightness can cause glare and discomfort, while insufficient light can lead to eye strain and difficulty seeing. Static lighting fails to cater to the diverse needs of different teaching methods and activities. For example, presentations and group discussions may benefit from brighter lighting, while reading and independent work may require more subdued tones.

Lack of User Control

Traditional switches offer limited control over lighting intensity and color temperature, hindering the ability to adapt the environment to specific needs. This can lead to frustration and a sense of lack of control for both teachers and students. Limited control can lead to disengagement from the learning environment and a feeling of being passive recipients of information. Empowering users with control over their surroundings can foster a sense of ownership and engagement, potentially leading to better learning outcomes.

1.3 AIMS AND OBJECTIVES

This project aims to address the limitations of traditional classroom lighting systems by developing a smart lighting and automation system. Also, we are to construct a system that is capable of turning off and on lighting in a learning environment (classroom) automatically. This system should also be able to respond to external factors in the environment like motion and give out a corresponding output to ensure security.

The objectives of the smart classroom lighting and automation entails the following:

1. Developing Mobile app control: Users can manage classroom lighting remotely through a mobile app, providing convenient and intuitive control.

2. Automatic on/off: The system automatically turns lights on when occupancy is detected and off when the classroom is empty, promoting energy efficiency.

3. Enabling Adaptive lighting: The system adjusts light intensity and color temperature based on the time of day, specific activities, and user preferences, creating an optimal learning environment.

4. Traditional switch compatibility: The system integrates seamlessly with existing light switches, ensuring continued user control even if the mobile app is unavailable.

1.5 SCOPE OF STUDY

This project covers both educational and technology spheres. The project was simply done to aid students while also advancing the tech world and the world of embedded systems. It is geared towards providing convenience and an enabling environment for students.

1.6 RELEVANCE OF WORK

Optimized lighting can improve student focus, attention, and retention of information. Adapting lighting to different activities can enhance engagement and make learning more effective. Smart lighting allows for the creation of personalized learning environments that cater to individual needs and preferences. This can be particularly beneficial for students with learning disabilities or those who require specific lighting conditions for optimal performance.

Reduced Costs and Environmental Impact

Automated control and adaptive lighting can significantly reduce energy consumption, leading to substantial cost savings for schools. This can free up resources for other educational initiatives and contribute to a more sustainable future. By lowering energy consumption, smart lighting systems can contribute to a reduction in greenhouse gas emissions, mitigating the environmental impact of schools and promoting sustainability.

Increased User Engagement and Ownership

Smart lighting systems give teachers and students control over their learning environment, fostering a sense of ownership and engagement. This can lead to increased motivation, participation, and overall satisfaction with the learning experience. The flexibility and adaptability of smart lighting can encourage creativity and innovation in the classroom, promoting a more active and engaging learning environment.

1.7 METHODOLOGY OF WORK

The method adopted to achieve the aim and objectives of this research are as follows;

a. Literature Review of related works
b. System Design and Research
c. Planning of Data
d. Analysis of Data
e. Presentation of results
f. Conclusion and Recommendation

CHAPTER TWO

LITERATURE REVIEW

2.0 REVIEW OF PREVIOUS WORK

2.1 ACADEMIC PERFORMANCE AS A TEST PARAMETER

The most common way to measure the effect of light on students is to test their progression in test scores over time. Many researchers did this by conducting tests and analysing students scores from chosen periods of test rather than exploring the test grades.

Thus method was employed by Mayron, Ott, Nations (1974) over 40 years ago in investigating the effects of cool white and full spectrum fluorescent light on the reading performance of first grade students. Results were inconclusive as it was not possible to isolate the variables and an assumption was made, concluding that the observed difference in students performance was due to the observed method of teaching.

Mott, Robinson, Walden, Burnette, Rashford (2012) applied the use of standardised tests, the influence of two predefined light settings on reading performance – accuracy, speed and expression. This analysis showed that reading improved under the focus setting (6000 k, 1000 1x) in comparison to the normal (3500 k, 5001x). This test analysed the effect of light on students concentration, motivation and oral reading frequency.

After a preliminary study investigated the effects of light on arousal as a mediator of performance, a laboratory experiment was conducted which in contrast showed no change in performance of students when solving an arithmetical problem. However, a field study was conducted later on confirmed the results of the pre-test.

Between 2012 and 2014, four fields which were studied have examined the effects of light on concentration, using the d2 Test of Attention and experimented with LED, fluorescent lights, or both.

Barkman, Wessolowski, Schulte-Markwort (2012). conducted an experiment where seven fluorescent lighting settings were presented to the teachers and it was up to them to decide when, how, and how often to use them. The results showed that under the Concentrate lighting scenario (5800 K, 1060 lx) designed to test for concentration, motivation and oral reading frequency, the students made fewer errors of omission compared to the Standard setting (4000 K, 300 lx).

Choi and Suk (2016) investigated the effect of light on students use of the light by documenting HDRI

Sleegers et al (2013). investigated the effect of dynamic LED light, as opposed to fluorescent light, in one laboratory and two field experiments. The light differed in CCT and intensity and was controlled by the teacher, similarly to Barkmann's experiment. The results of the field studies resulted to a conclusion that children performed better on the d2 test in the experimental Focus setting (6500 K, 1000 lx) compared to the Standard (3000–4000 K, 300 lx). However, the controlled study showed no effect.

Barrett, Zhang, Davies (2015) conducted a test aimed at investigating the effect of light on academic performance using the 'QUAN' method and using the progression in test schools as as a tool.

2.1.1 BEHAVIOUR AND MOOD AS TEST PARAMETERS

Here, field research on the impact of dynamic light on behaviour, mood, and use of light in classrooms is presented.

Wolfarth (1986) observed under full-spectrum fluorescent light with shielded electromagnetic radiation the inattentive and off-task behaviours of students. This was measured by documenting the direction in which the students were looking and various other behaviours, using structured observations. The results of the study were contradictory as some of the behaviours increased in occurrence while others decreased under the experimental lighting.

Kuller and Lindsten (1992) conducted another study which investigated concentration as a dependent variable. First they assessed the classroom behaviour of students through a scale consisting of various items, including concentration, and they later compared it to the levels of cortisol (a stress hormone which is affected by light). What they reported was a possible negative relationship between the cortisol levels and concentration. However, no further research has examined this in relation to classroom environments.

Pulay et al (2016) conducted another investigation using a qualitative approach. The effects of colour temperature (3000 K and 4100 K, fluorescent light) on students' on-task behaviour by documenting their physical location during class, using structured observations.This analysis resulted in a conclusion showing an increase in their concentration under the cooler light setting.

Also, Wessolowski et al (2014). tested the effects of the Philips School Vision system, which is based on fluorescent lighting, and made a comparison with Relax setting (3500 K, 325 lx) to its Standard setting (4000 K, 300 lx). This was done to evaluate the effects on fidgetiness, aggressive, and pro-social behaviour [13]. The impact was explored through detecting the pixel changes in a digital recording through structured observations and by self-rating assessments.

2.1.2 RESULTS

The reviewed studies which includes academic performance as a test parameter makes up more than 75 percent of our reviewed literature. One-third of analyses the effect of light on behaviour, mood, and use of light. The following methods were used in our study. Half of the studies applied exclusively quantitative methods, less than 10% applied qualitative ones; 22% for mixed methods, and 18%, quasi-mixed method.

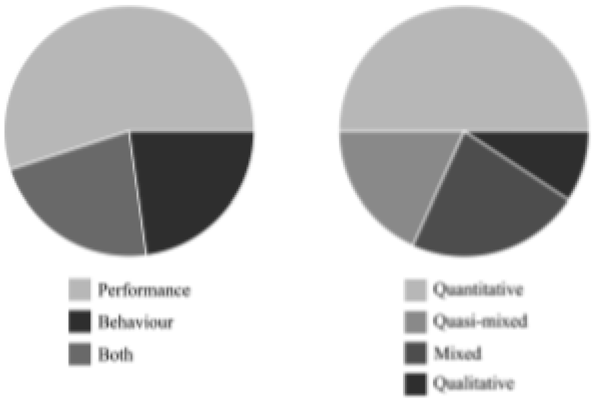


Figure 2.1: Methods and Parameters used in selected studies.

2.2 HISTORY OF SMART LIGHTING IN SCHOOL ENVIRONMENT

The lighting design has been in effect since the 19th century. In the early 1800s, the first electric lamp was designed followed by light bulbs in the 1830s. As technological development continued, the arc bulb was introduced in the 1840s in Paris. As advancement continued and education attained its peak, the need an effective and convenient means of lighting classrooms began to grow.

Lighting in educational spaces has been studied for years now. However, the idea of trying to adopt a system that could make lighting effective and convenient for students began to take effect since the 20th century. However, the implementation of such system has been recent. A good example is the implementation of Wi-Fi enabled devices that connect to the internet using wireless network. Initially, classrooms relied on traditional fluorescent or incandescent lighting which provided basic illumination but was lacking in energy efficiency.

Smart classroom lighting has evolved significantly over the years, reflecting advancements in technology and a growing emphasis on creating conducive learning environments.

The concept of smart lighting emerged as LED technology became more widespread. LED lights offered greater energy efficiency, longer lifespan, and the ability to be controlled remotely. Certain smart bulbs require a dedicated smart hub to connect wirelessly with the hub then plugging into an internet router. The hub acts as a gateway between the smart light and your phone tablet. Early implementation of smart classroom lighting allowed for basic adjustments such as dimming or switching on and off remotely. As technology progressed, smart lighting systems became more sophisticated. They began integrating sensors and automation capabilities, enabling lights to adjust based on factors like natural light levels, occupancy and time of the day.

Furthermore, advancements in connectivity and the Internet of Things (IOT) has enabled smart classroom lighting systems to be integrated with other building systems, such as HVAC and security for holistic environment and efficiency. .

The smart lighting aims to ensure that lighting is appropriate for the environment, responsive to changing need of occupants and does not compromise health. Smart lighting has evolved over several years and new studies have continuously uncovered new and effective benefits for lighting and control upgrades.

2.3 ADVANTAGES OF THE SMART LIGHTING

- **Benefits and Drivers of Smart Classroom Lighting Improved Learning Outcomes**

Studies have shown that optimized lighting conditions can positively impact students' cognitive performance, attention span, and knowledge retention. Smart lighting allows for dynamic adjustment of brightness and color temperature to create ideal environments for specific activities, maximizing learning effectiveness.

- **Energy Efficiency and Cost Savings**

Traditional lighting systems contribute significantly to school energy consumption, often reaching up to 25% of the total budget (National Renewable Energy Laboratory, 2012). Smart lighting systems implement automated control and occupancy sensors, leading to significant reductions in energy usage and associated cost savings.

- **Increased User Engagement and Control**

Traditional switches offer limited control over lighting, potentially causing frustration and disengagement among teachers and students. Smart lighting systems empower users to personalize their environment through mobile apps or sensor-based triggers, fostering a sense of ownership and participation in shaping the learning space.

- **Enhanced Comfort and Health**

Inappropriate lighting conditions can lead to visual discomfort, glare, and headaches, negatively impacting student well-being and concentration. Smart lighting systems can regulate brightness and colour temperature to create comfortable environments that promote student health and well-being.

These benefits, coupled with rising awareness of energy efficiency and the increasing integration of technology in education, are driving the adoption of smart classroom lighting systems globally.

- **Key Technologies and Approaches Sensors**

Occupancy sensors, such as passive infrared (PIR) sensors, detect movement and presence within the classroom, automatically turning lights on when occupied and off when empty, minimizing energy waste. Light sensors can adjust brightness based on ambient light levels, optimizing illumination without overconsumption.

- **Control Systems**

Microcontrollers and embedded systems, often paired with wireless communication protocols like Wi-Fi or Bluetooth, receive sensor data and control lighting fixtures. These systems can be programmed for diverse functionalities, including automated on/off cycles, adaptive brightness and color temperature adjustments, and user-controlled settings through mobile apps or touch interfaces.

- **Lighting Technologies**

Light-emitting diodes (LEDs) offer exceptional energy efficiency, adjustable color temperature, and long lifespan, making them ideal for smart lighting applications. Additionally, tunable white LEDs allow for dynamic control of both brightness and color temperature, further enhancing flexibility and adaptability.

2.4 TRADITIONAL MEANS OF LIGHTING CLASSROOMS

Before the advent of the smart classroom lighting system, classroom lighting basically involved fluorescent or incandescent lights controlled by switches. Lighting levels remain constant regardless of natural light or occupancy. Adjustments require manual operation often resulting in energy wastage and suboptimal lighting conditions. Overall, traditional classroom lighting methods lack the automation and energy efficiency features found in modern smart lighting systems.

Traditional methods of classroom lighting involves:

1. Overhead lighting features: fluorescent tubes or incandescent bulbs mounted on the ceiling provide general illumination throughout the classroom.

2. Light Switches: manual switches located near the entrance or on the walls allow teachers or occupants to turn lights on or off.

3. Dimmer Switches: this was not very common. However, in some cases, classrooms were attached with dimmer switches allowing for adjusting the brightness of light.

4. Natural light through windows: many classrooms incorporate windows to allow natural sunlight to illuminate the space, reducing the need for artificial lighting during the day.

5.Desk Lamps: in some cases, individual desk lamps may be used to provide focused lighting for specific tasks or areas within the classroom.

2.5 FUNDAMENTALS OR MAJOR MATERIALS USED IN DEVELOPING A SMART CLASSROOM LIGHTING SYSTEM

The major components used in the development of the smart classroom lighting system are as follows:

1. Microcontroller

2. Android App

3. Sensor

4. Relay

5. Vero board

6. Wireless connection

2.5.1 MICROCONTROLLER

A microcontroller can be described as a small computer on a single integrated circuit. It contains one or more cpu's, memory and other programmable peripheral components.

On its chip, it may likely have a program memory in the form of a NOR flash, OTP ROM or ferroelectric RAM. Microcontroller design has a reason and that is for embedded applications which is quite different from the microprocessors used in personal computers or other general purpose applications. A microcontroller is similar to a system on a chip (SOC).

An SOC may include a microcontroller as one of its component but usually integrates it with advanced peripherals. Examples include a Graphics Processing Unit (GPU), Wi-Fi and so on.

Automatically controlled devices make use of microcontrollers. Some of these devices include: automobile engine control systems, implantable medical devices, remote controls, appliances e.t.c. Some microcontrollers make use of four bit words to operate at low frequencies to enable low power consumption.

Types of microcontrollers include: 8-bit microcontrollers, 16-bit microcontrollers, and 32-bit microcontrollers.

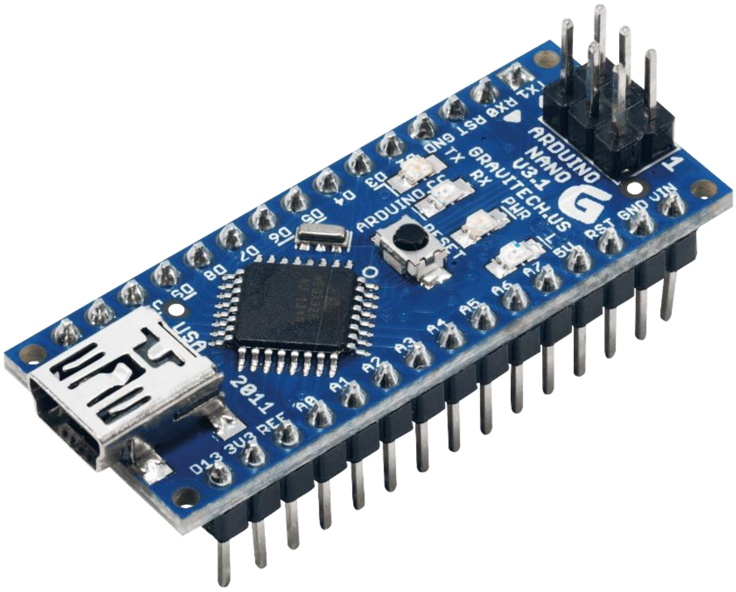


FIGURE 2.2: PICTURE OF A MICROCONTROLLER

2.5.2 ANDROID APP

This is the era of the internet of things so the implementation of smart classroom lighting will not be complete with only the improvement of hardware equipment. Also, intelligent and integrated software applications need to be developed.

In the application of android technology, the development of self attendance systems is taken in order to show how this technology can be applied. The inculcation and application of the android technology into the smart classroom system will further improve teaching surroundings, enhance interaction between teachers and students, thereby making teaching band learning more interesting and efficient.

2.5.3 SENSORS (MOTION SENSOR)

A sensor is a device that produces an output signal for the purpose of detecting a physical phenomenon. There are four main types of sensors. They are:

1. Active and Passive sensor.

2. Contact and Non-contact sensors

3. Absolute and Relative sensors

There are numerous examples of sensors. Some of them are listed below:

1. Temperature sensor

2. Gas sensor

3. Pressure sensor

4. Motion sensor

For this project, we will be considering the motion sensor. The motion sensor is a device that can be programmed to detect movement within the classroom environment and provide a corresponding output by turning on the light. This sensor is connected with the microcontroller and programmed using the c++ language syntax. It has three pin positions which are vcc, out and ground.

FIGURE 2.3: PICTURE OF THE MOTION SENSOR

2.5.4 RELAY

Another important component of this system is a relay, A relay acts as an electrically operated switch that consists of a set of input terminals for a single or multiple control signal and a set of operating contact terminals. It may have any number of contact in multiple contact form to either make, break or both make and break a circuit.

Relays are mostly used when it is necessary for a circuit to have independently controlled by a low-power signal or in a case where several circuits must be controlled by one signal.

The first use of relays was recorded in long distance telegraph circuits s signal repeaters. The traditional electromechanical form of relay uses an electromagnet to close or open the contact.

Relays with calibrated operating characteristics and multiple operating coils are usd to protect electrical circuits from overload.

FIGURE 2.4: A RELAY

2.5.5 VERO BOARD

A Vero board is a printed circuit board that is designed with rows of copper tracks with holes drilled so electronic components can be placed on it and soldered. It is characterized by a 0.1 inch regular grid of holes, with wide parallel strips of copper cladding running in one direction. This 0.1 inch spacing allows socket for ICs.

2.5.5.1 ADVANTAGES OF VERO BOARD

- They cost less than PCBs
- It is easier to modify a circuit on the Vero board than the PCB.
- Vero board is easily accessible.

2.5.5.2 DISADVANTAGES OF VERO BOARD

- A Vero board layout makes a circuit unreliable.
- Building errors are more likely using this board.
- Circuit layouts are very large.

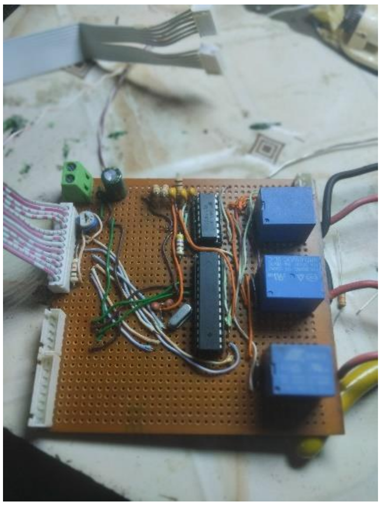


FIGURE 2.5: A VERO BOARD WITH SOLDERED COMPONENTS

2.6 WIRELESS CONNECTION

The wireless connection for our lighting system is provided by a Bluetooth module. The HC-05 is a Bluetooth module designed for wireless connection. It is to the microcontroller and ensures wireless connection between the microcontroller and the android app.

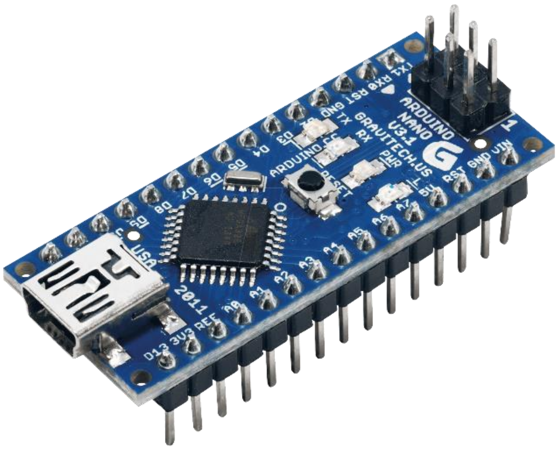


FIGURE 2.6: PICTURE OF THE BLUETOOTH MODULE

CHAPTER THREE

DESIGN AND ANALYSIS

3.1 BLOCK DIAGRAM

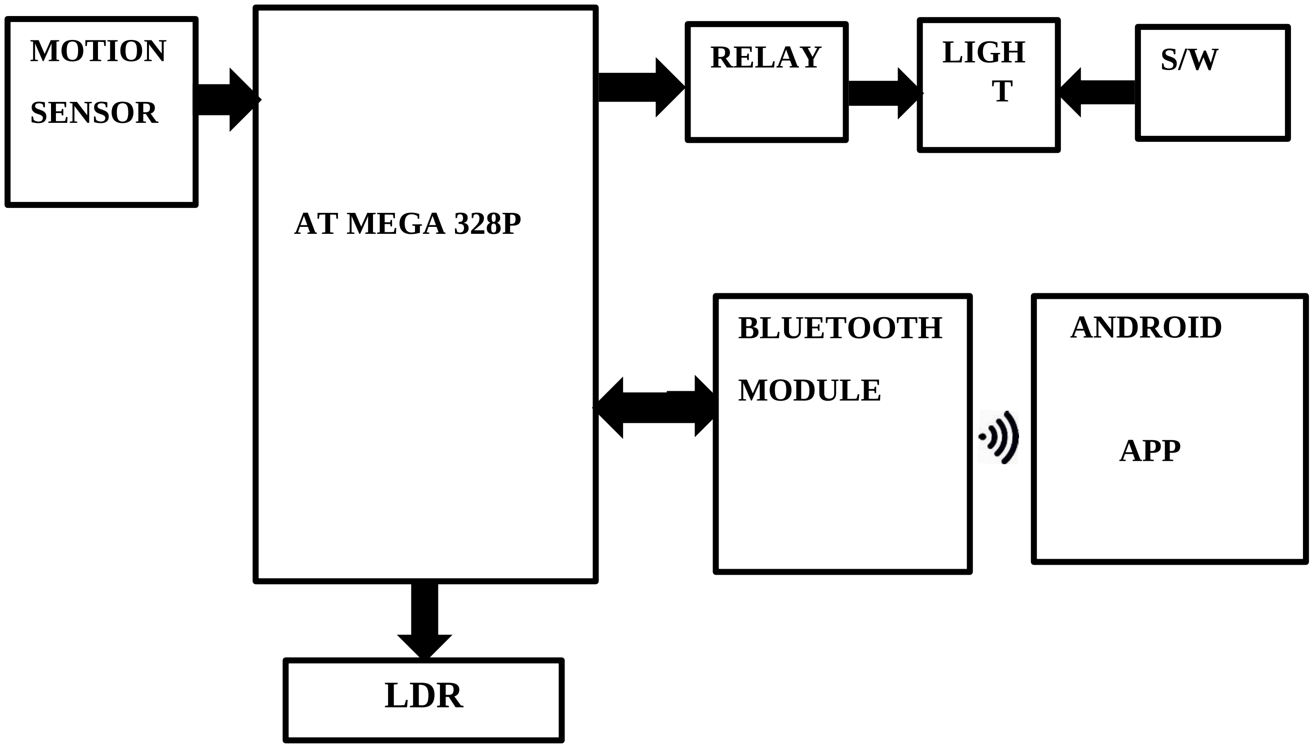


FIGURE 3.1: BLOCK DIAGRAM OF THE SYSTEM

3.1.1 MICROCONTROLLER UNIT (ATMEGA 328P)

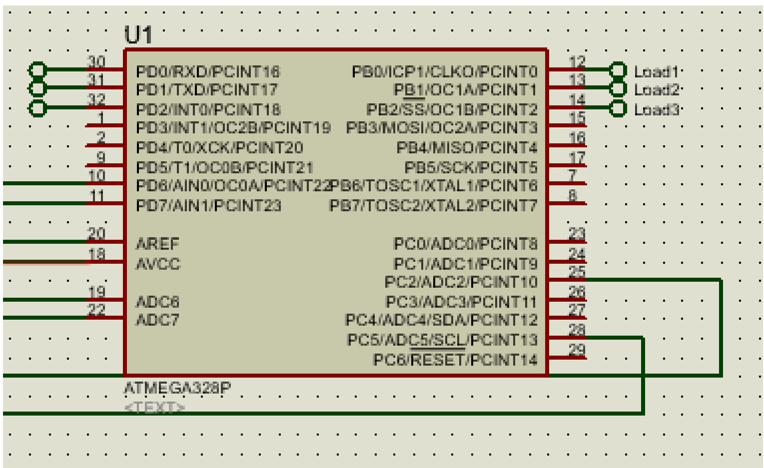


FIGURE 3.2: ATMEGA 328P

The microcontroller chosen is ATMEGA(328P). It has a variety of properties which makes it efficient for the system.

ATMEGA 328P is an 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash. It is a low power CMOS that executes powerful instructions in a single clock cycle.

By achieving throughputs before it reaches 1MIPS per MHZ, it allows the system designer to optimize power consumption and processing speed.

This microcontroller consists of a CPU core, Arithmetic and Logic Unit (ALU), a status register, an AVR status register(SREG), file register and stack pointer.

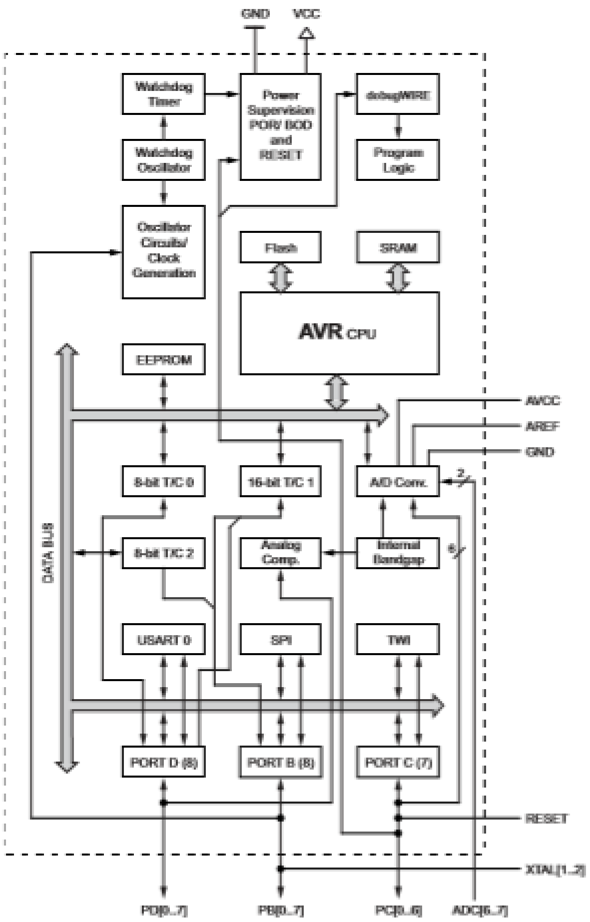


FIGURE 3.3: ATMEGA 328P ARCHITECTURE

3.1.2 NETWORK UNIT (HC-05)

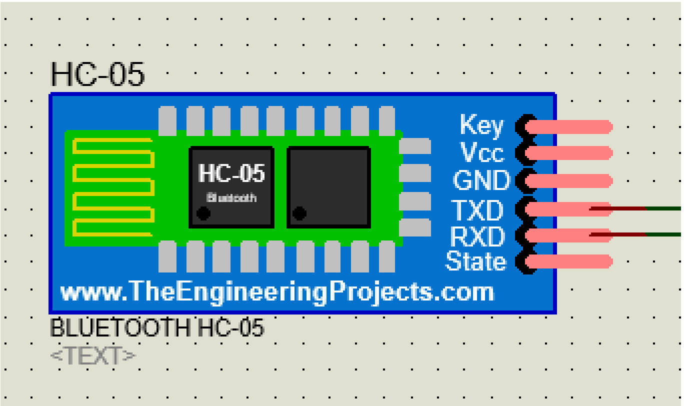


FIGURE 3.4A : BLUETOOTH MODULE HC-O5 ON PROTEUS

FIGURE 3.4B: HC-05 (BLUETOOTH MODULE)

This consists of the Bluetooth module HC-05 connected to their to the right pins on the microcontroller The HC-05 is a wireless Bluetooth to serial converter which allows for the connection of microcontrollers to other devices while ensuring effective communication. This module was chosen because of its effective capacity.

3.1.3 MOTION SENSING UNIT

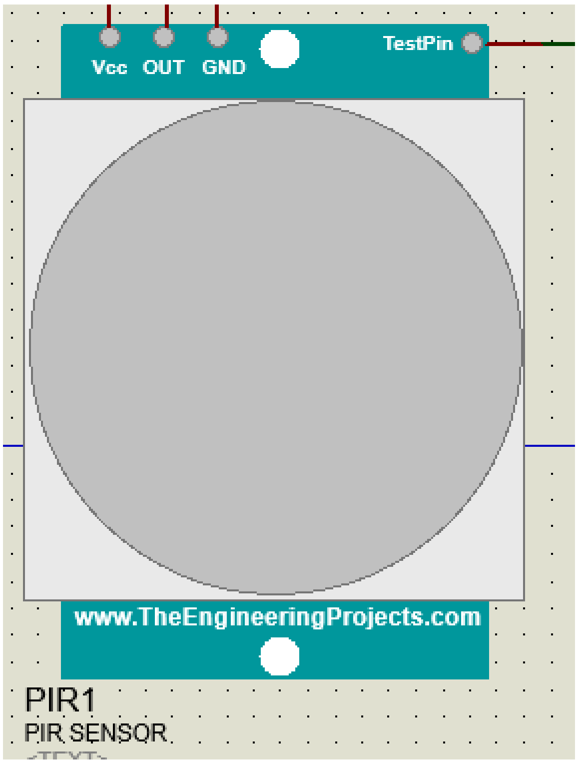


FIGURE 3.5A: MOTION SENSOR ON PROTEUS

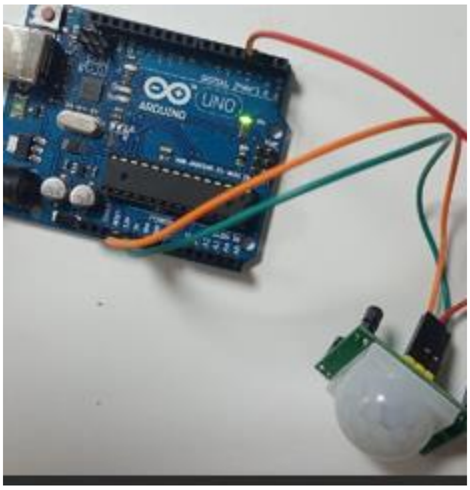


FIGURE 3.5B: THE MOTION SENSOR CONNECTED TO AN ARDUINO BOARD

This consists of a motion sensor which is used for detecting movement within the surrounding. It could be movement from humans or objects.

Once detected, it triggers a corresponding response from the lighting system. It operates by measuring the Infrared light emitted by or reflected from the source of motion.

3.1.4 RELAY UNIT

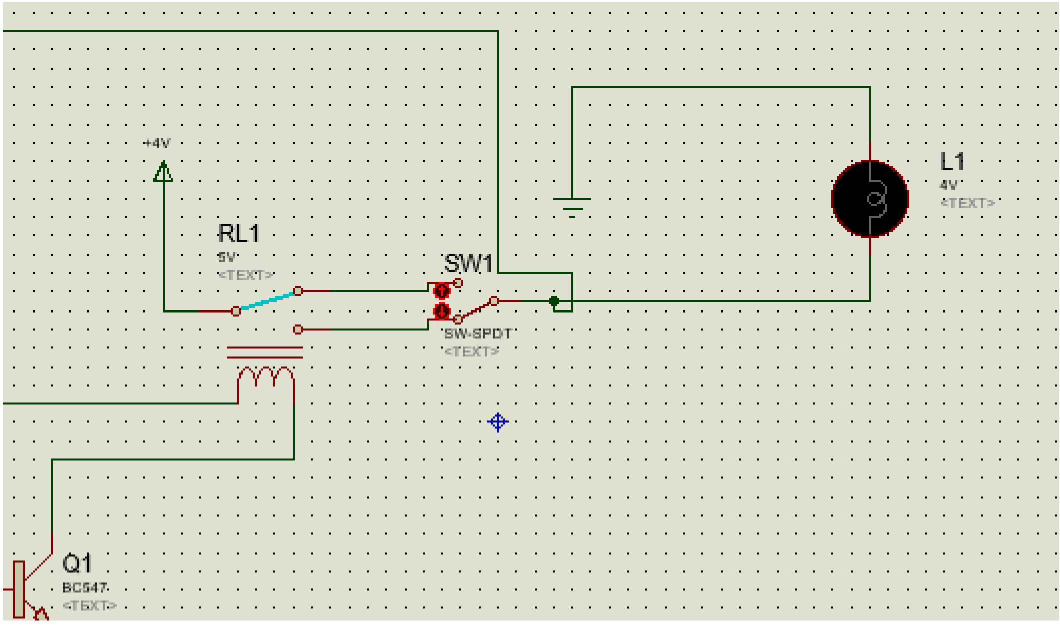


FIGURE 3.6: A RELAY CONNECTED ACROSS THE CIRCUIT

The load relay is the safety component in the system that protects the circuit from damage caused by high power loads.

In this case, a single relay is used and a single load is connected across the system,

3.2: DESIGN CONSIDERATIONS

In the design of the system, the following assumptions and conditions were made.

An Arduino Nano was used in the design of the project and the microcontroller on the Arduino Nano is the ATMEGA 328P.

The Microcontroller ATMEGA 328P was preferred over other microcontrollers because of its suitability for a wide range of projects in embedded systems and its speed.

A motion sensor was added to the system so the lighting system could produce a suitable output in response to such motion.

There was need for a wireless network module so the system could be interfaced with an android app. Hence, the HC-05 was considered and selected.

3.2.1 User Interface: Android Software application.

An android software application is used as the medium where which a user can send data to turn on or turn of desired electrical loads or control other devices upon request. The procedures leading to the development of this software are as follows;

Selection of software integrated development environment (IDE).

Writing of pseudo-code as a guide prior to android application development.

Programming language selection and software development

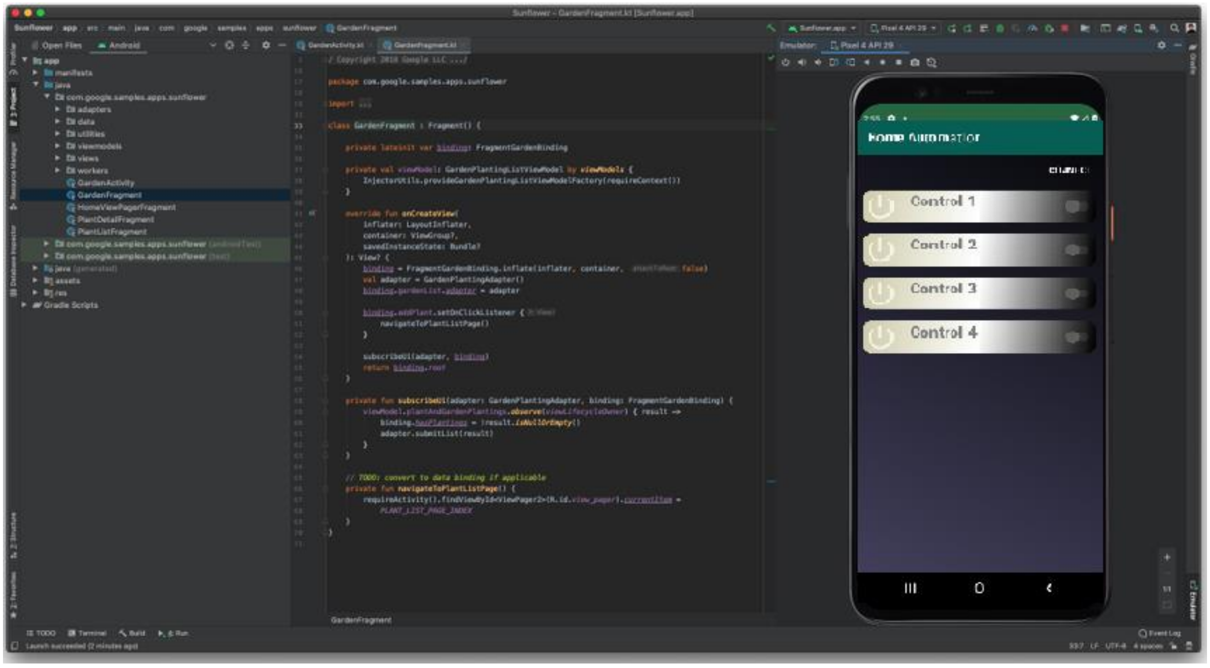
Simulation and Deployment of android application.

3.2.1.1 Software Integrated Development Environment (IDE)

The Android development tool used in this work is the Android Studio windows application. Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It provides a comprehensive set of tools and features to help developers design, build, and debug Android applications.

Android Studio offers a user-friendly interface, a powerful code editor with intelligent code completion, and a variety of built-in tools for testing, profiling, and deploying apps. It supports multiple programming languages, including Java and Kotlin, and offers extensive documentation and community support to assist developers in creating high-quality Android apps. (Wikipedia, accessed June 2023). Figure 3.2 below shows a picture of a window of the Android Studio application being used in the development of the software for this work.

Figure 3.7 Android Application development.



3.2.1.2 Pseudo-Code Development

Pseudo-code is an informal way of programming description that does not require any strict programming language syntax or underlying technology considerations. It is used for creating an outline or a rough draft of a program. Pseudo-code summarizes a program's flow, but excludes underlying details. System designers write pseudo-code to ensure that programmers understand a software project's requirements and align code accordingly. (Economic times, accessed June, 2023).

The Pseudo-code used in the development of this application is in steps as follows;

Step one: The users device (this case an android phone) Bluetooth module is turned on

Step two: The Android application requests access to use the device Bluetooth module

Step Three: once access is granted the Android application searches for the MASTER Bluetooth receiver/transmitter module and begins pairing.

Step Four: Once pairing is complete the Android application awaits for instructions from the user.

Step Five: The User sends instructions by clicking on any of the four buttons on the application screen, these buttons will generate a 4bit data depending on what key is pressed. The generated data is shown in a table below.

Table 3.1 4-Bit Data Generated from Android Application

S/N	KEY	4-bit Data Generated
1	Control 1	0001
2	Control 2	0010
3	Control 3	0100
4	Control 4	1000

3.2.1.3 Programming Language and Software development

The Android application used in this work is programmed using the JAVA programming language, JAVA is the traditional programming language for Android Development. It has been widely used for many years and has a large ecosystem of libraries and resources available. Android Studio provides excellent support for JAVA, including a powerful code editor with auto-completion, debugging tools, and integration with the Android SDK. JAVA is a widely-used programming language for Android app development in Android Studio. It offers an object-oriented approach with familiar syntax and integrates seamlessly with the Android platform. Android Studio provides robust support for JAVA, including a feature-rich code editor, access to Android APIs, and a vast ecosystem of libraries and resources.

The Java Code written for this work is shown in Appendix 1 of this work.

3.2.1.4 Simulation and Deployment

The Android Studio Windows application comes with a built in android application simulator so that programming and testing can be done simultaneously. After the application development is completed, the application is deployed into an APK file (abbreviation for android package). This file is installed on and android phone and can be used to send data to the other devices on the Bluetooth expansion network. A picture of the home page of this application is shown in figure 3.7 below.

Figure 3.8 Android Application Home Page

3.3: DESIGN COMPONENTS

The different components assembled together to give the system are stated below:

1. Microcontroller (ATMEGA 328P)

2. Motion Sensor

3. Switch (Two way switching)

4. Bluetooth Module

5. An LDR

6. Android Application

3.3.1 DESIGN OF BLUETOOTH MODULE (HC-05)

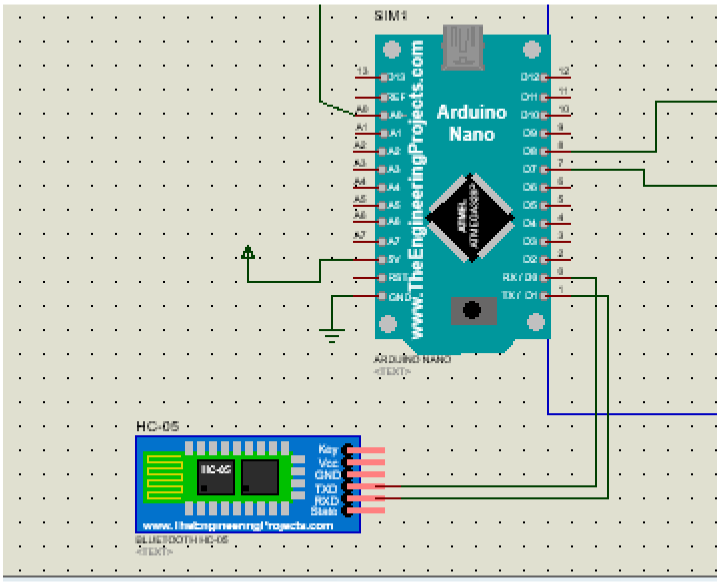


FIGURE 3.9: BLUETOOTH MODULE AND ITS PIN CONNECTIONS ON PROTEUS

The chosen Bluetooth module which was HC-O5 was connected to the microcontroller and simulated on Proteus.

Below are the Pin connections for the Bluetooth module.

1. RXD pin was connected to pin 1 of the Microcontroller.

2. TXD pin was connected to pin 0 of the Microcontroller.

This module can be used in a master or slave configuration. When connected, the red LED on the module indicates whether the Bluetooth is connected or not. Its data transfer rate when connected can vary up to 1Mbps in the range of 10 meters.

3.3.2 DESIGN OF THE MOTION SENSING UNIT

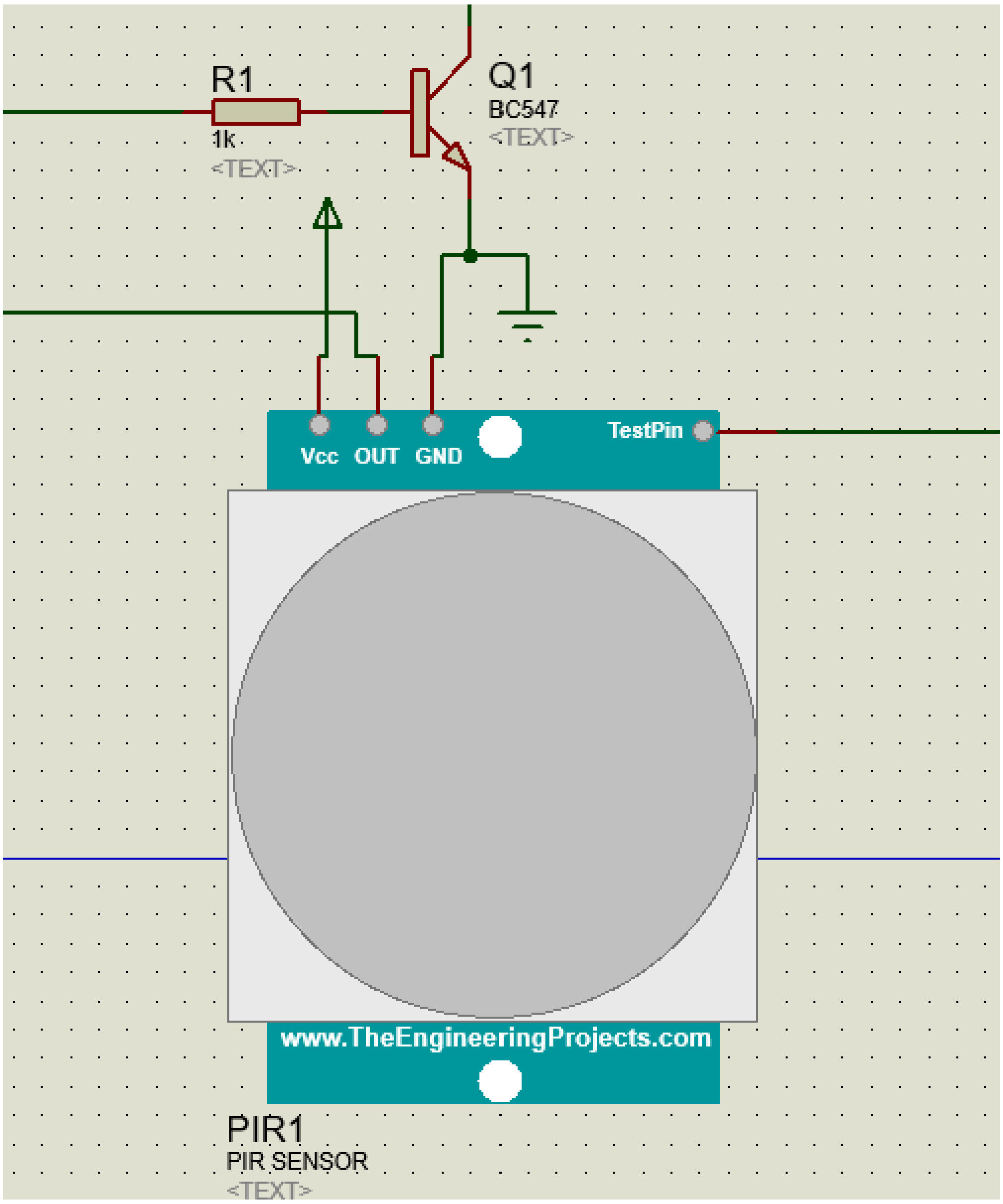


FIGURE 4.0: MOTION SENSOR CONNECTIONS ON PROTEUS

The motion sensing unit consists of a motion sensor that is integrated as a component of the system and its connections to the correct electronic component. When motion is detected, the motion sensor signals the lights to turn on.

It consists of three pin points;

1. VCC is connected to power.

2. OUT is connected to pin 7 of the microcontroller.

3. GND is connected to the emitter terminal of the Transistor BC547 which is earthed and connected to a resistor.

3.3.2.1 Transistor Base Resistor Calculations

The formula for calculating the base resistor of the transistor is given by the expression:

$$R = \frac{(Us - 0.6)hFE}{Relay\ Coil\ Current} \text{ --- } (3.7)$$

Where

R = base resistor of the transistor as seen in figure 3.6 above.

Us = Source or the trigger voltage to the base resistor,

hFE = Forward current gain of the transistor,

The last expression which is the "relay current" may be found out by solving the following Ohm's law:

$$I = \frac{Vs}{R} \text{ -- } (3.8)$$

Where

I = the required relay current

V_S = Supply voltage to the relay.

Given that the relay used is a 5V relay with a relay coil resistance of 500Ohms, hFE of the BC547 transistor is 8 the relay current I can be calculated as follows

$$I = \frac{5}{400} = 0.0125A$$

Applying the above values to equation 3.7 we get,

$$R = \frac{(5-0.6)8}{0.0125} \text{ -- } (3.9)$$

R = 2816Ohms, R ≈ 3KOhms

3.3.3 THE LIGHT DEPENDENT RESISTOR (LDR)

FIGURE 4.1A : A LIGHT DEPENDENT RESISTOR

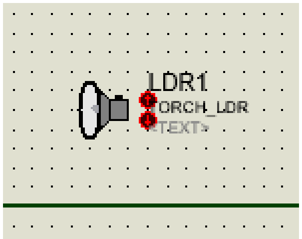


FIGURE 4.1B: AN LDR CONNECTED ON PROTEUS

The LDR is a Light Dependent Resistor. It decreases in resistance as a result of increasing Luminosity on its surface.

3.3.4 SWITCH AND TWO WAY SWITCHING

For this system, the two way switching was applied. Also, a one gang switch was connected to control the lighting system from one location,

Two way switching implies that the lighting system can be automatically turned off from wo different locations.

The configuration of the two way switching is similar to the Ex-OR gate.

3.3.4.1 TRUTH TABLE OF THE LOGIC GATE SYSTEM

SERIAL NO	SWITCH 1	RELAY	LIGHT
1	L1	NO	OFF
2	L1	NC	ON
3	L2	NO	ON
4	L2	NC	OFF

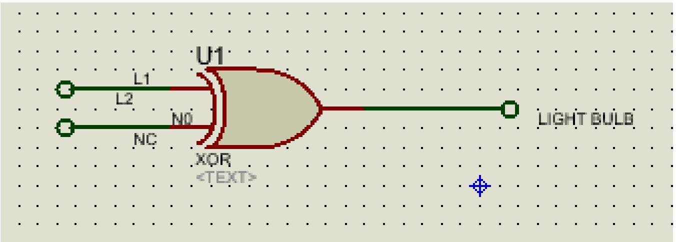
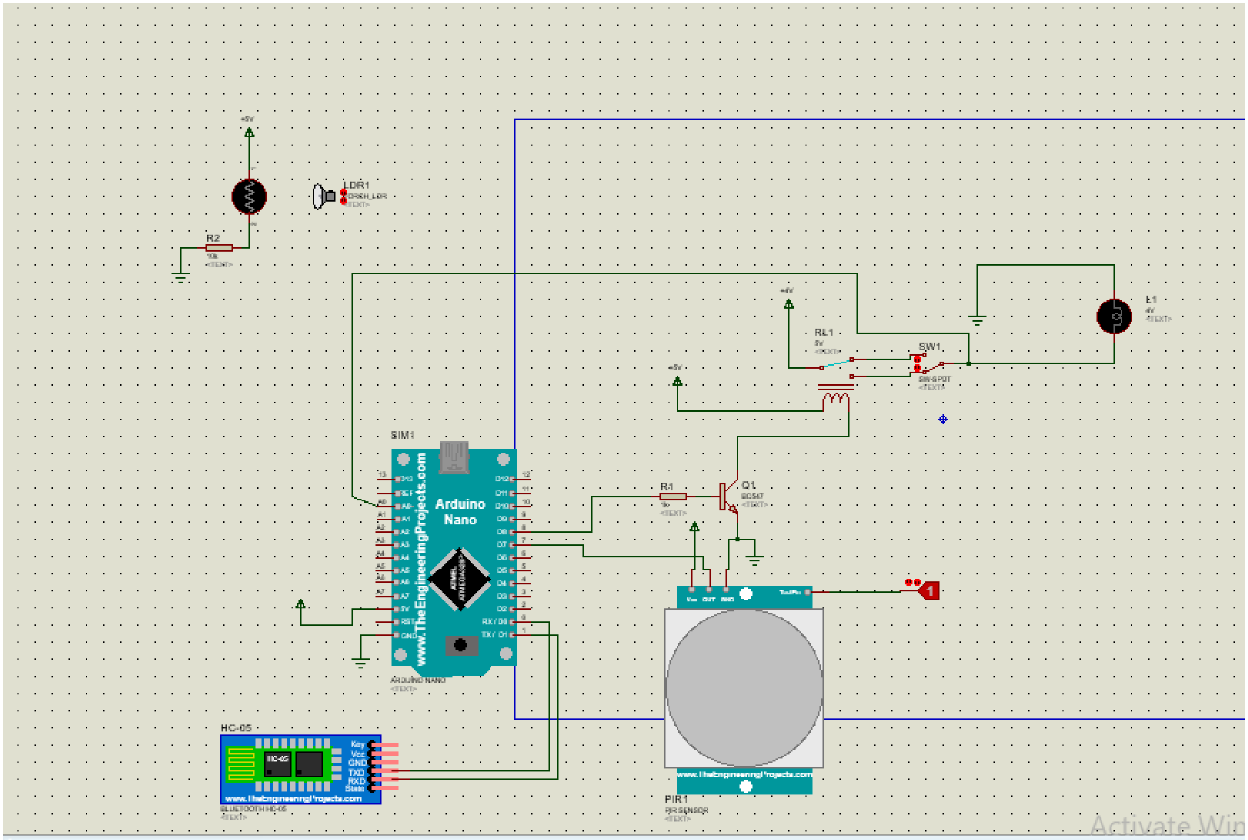
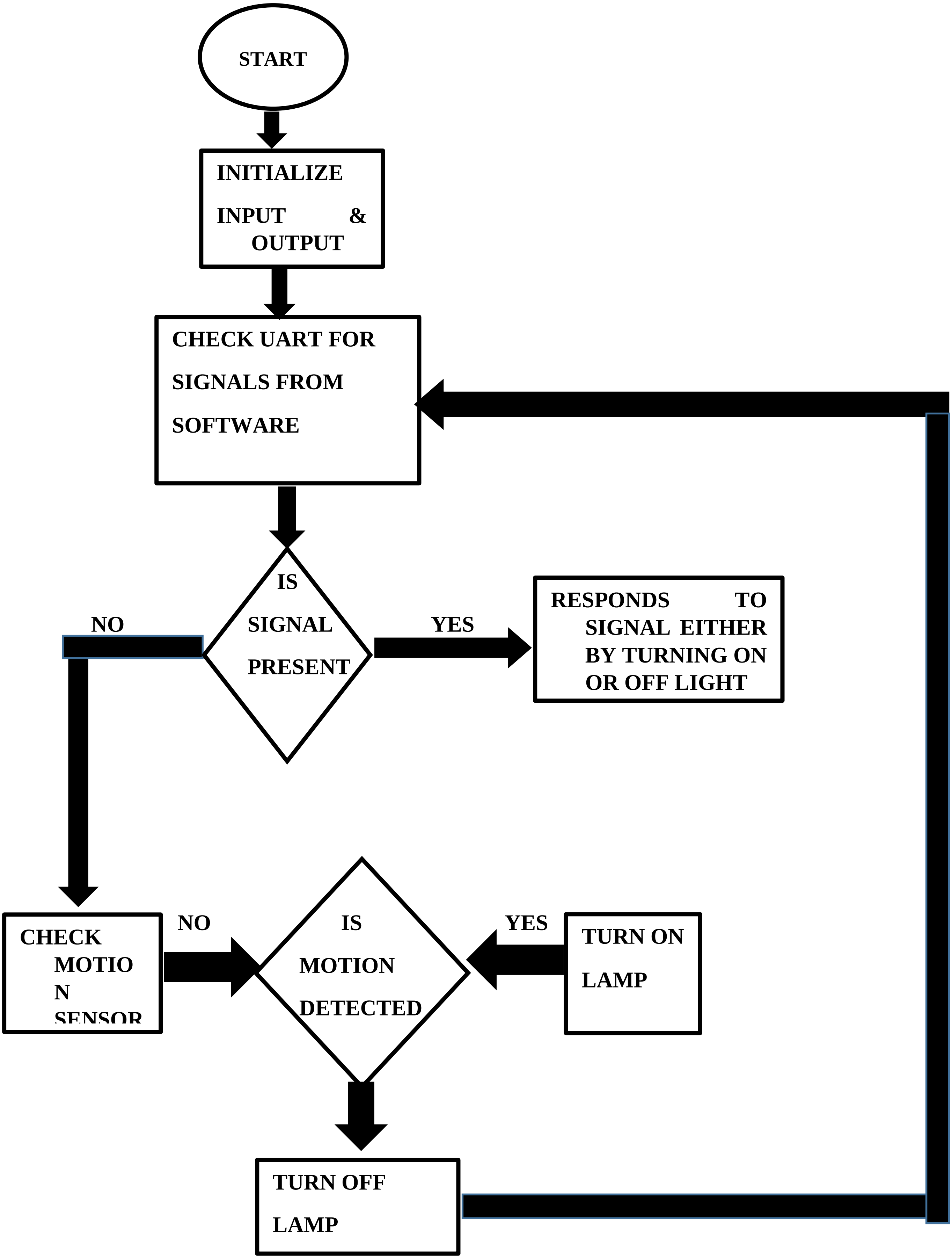


FIGURE 4.2: LOGIC GATE DIAGRAM USING EX-OR GATE

3.4: COMPLETE CIRCUIT DIAGRAM OF THE SYSTEM



3.4 SYSTEM FLOWCHART



CHAPTER FOUR

DESIGN AND CONSTRUCTION

4.1 CONSTRUCTION

After compiling the code and successful simulation, the next process is the building of the hardware.

This was not entirely an easy process as it included different sections such as purchase of components such as resistors, a motion sensor, Vero board and an LDR which were not entirely readily available.

Soldering of different components on the Vero board was next. The Vero board served as the base for mounting other components.

This had to be done carefully and firmly to ensure no two components were bridged. Program was then loaded into the micro controller and casing followed.

The process of construction is as follows;

- A continuous Vero board was chosen.
- Circuit was built on Proteus to serve as guide.
- Electronic components are mounted on the Vero board.
- Components are soldered correctly following their right electric paths on the Vero board.
- The Vero board was then placed into a 6 by 6 inches adaptable box.
- The circuit undergoes a number of tests for continuity, voltage, load and two-way switching test.

4.2: MOUNTING AND SOLDERING OF COMPONENTS

Components are mounted and soldered on the Vero board in accordance with the Proteus Design.

FIGURE 4.1A: MOUNTING OF THE LIGHT DEPENDENT RESISTOR

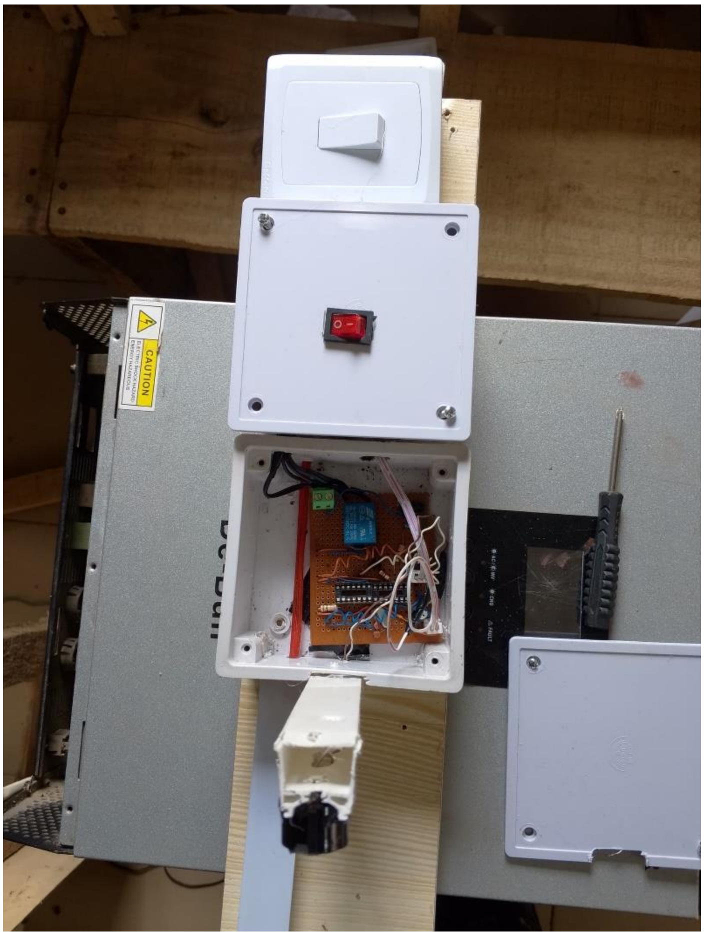


FIGURE 4.1B: MOUNTING OF OTHER COMPONENTS ON THE BASE

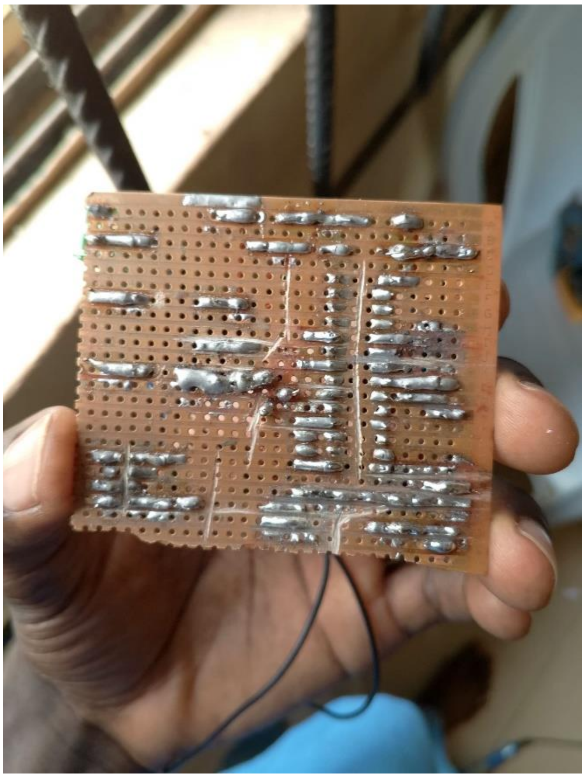
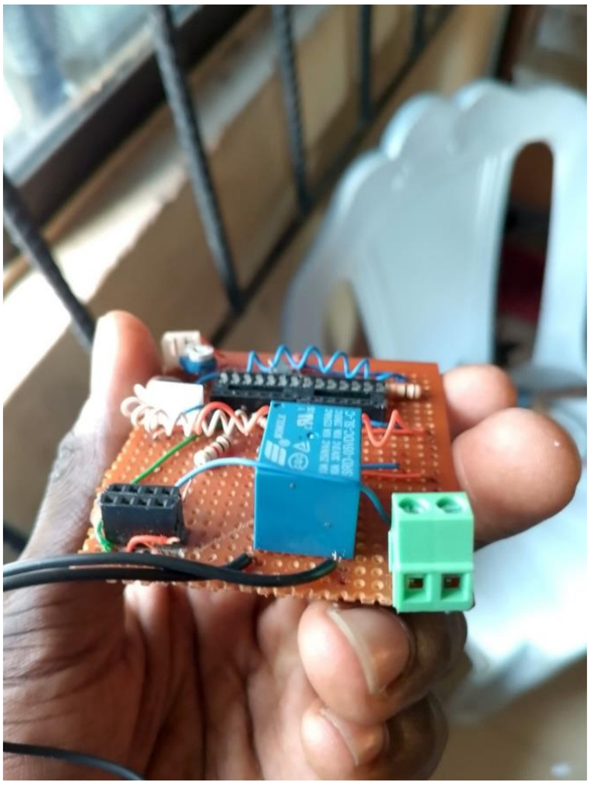
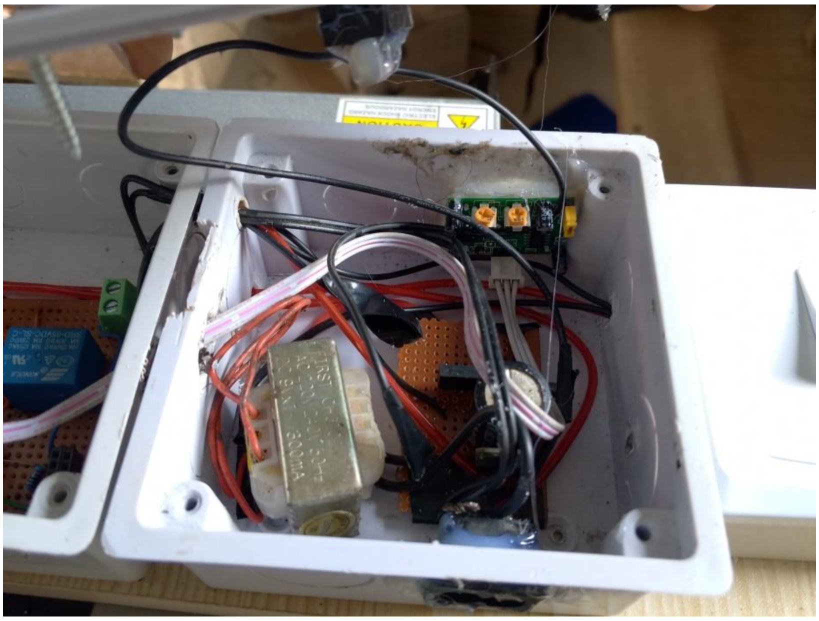


FIGURE 4.2: SOLDERING OF COMPONENTS ON THE VERO BOARD



FIGRURE 4.3A: MOUNTING OF OTHER COMPONENTS ON THE VERO BOARD



FIGURES 4.3B: CONNECTING WITH JUMPER WIRES AND PLACING IN THE ADAPTABLE BOX

FIGURE 4.4A: SIDEVIEW OF THE SYSTEM

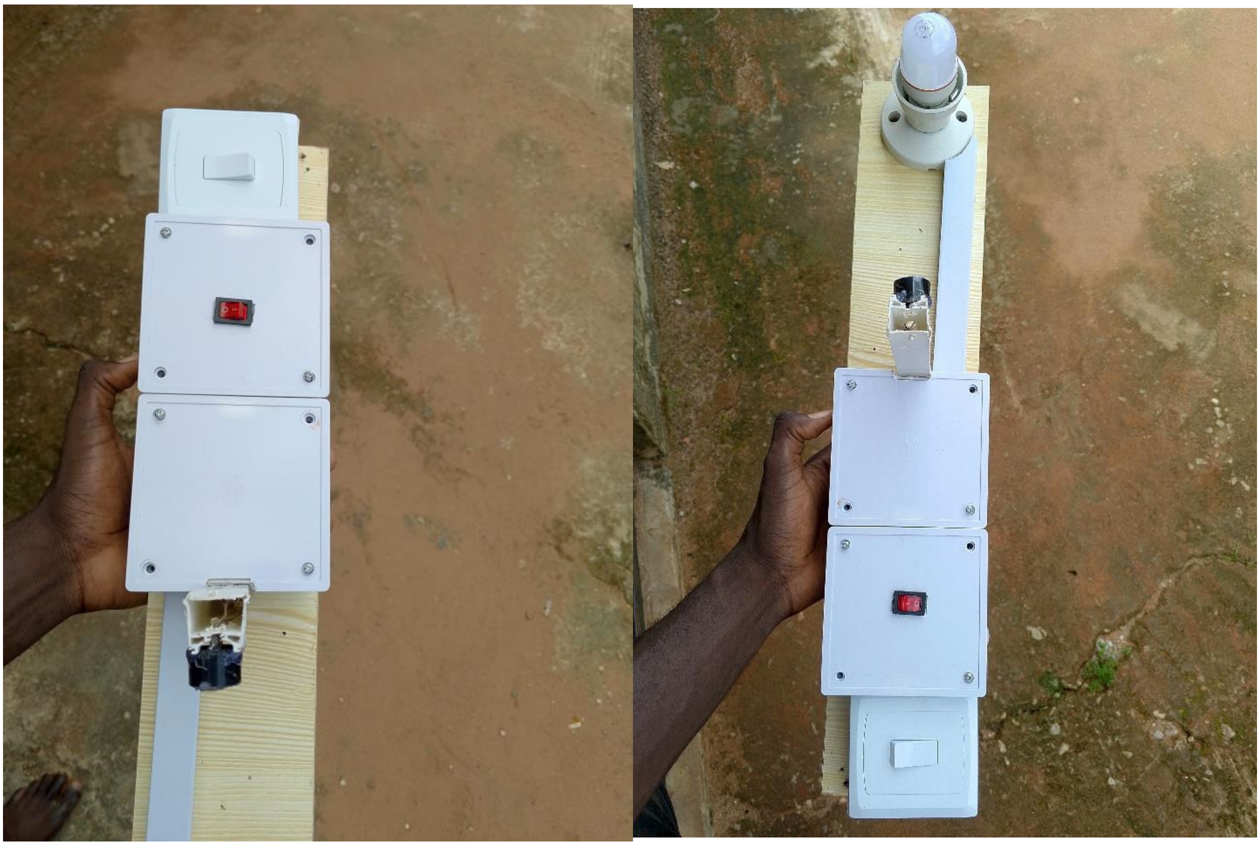


FIGURE 4.4B: TOP VIEW OF THE SYSTEM

4.3 CASTING, LAYOUT AND DIMENSIONS

A wooden base of dimension 540 by 100 mm serves as the base and support of the system.On this base, the switch, box carrying the Vero board, LDR, Lamp holder and bulb are mounted. The LDR is mounted on an LDR stand before mounting on the base. The LDR stand measures 165mm by 20mm.

The motion sensor also has a base of dimension 30 by 25mm.

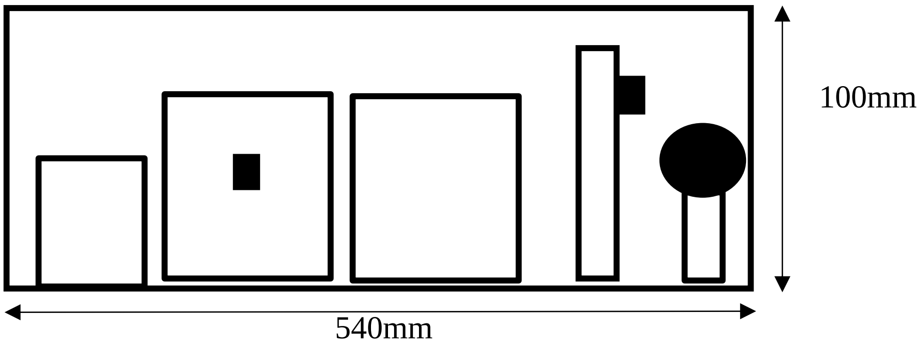
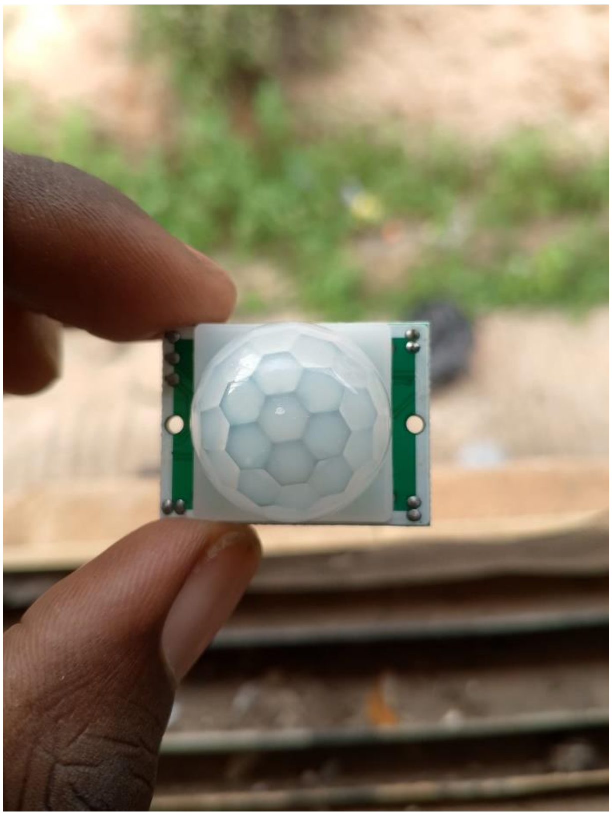
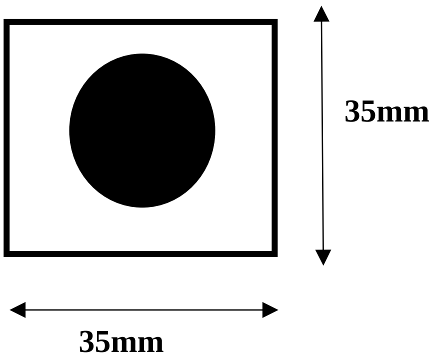


FIGURE 4.4 LAYOUT OF THE SYSTEM SHOWING THE SWITCH, TWO ADPTABLE BOXES, LDR ON THE LDR STAND, AND LOAD (BULB)



FIGURES 4.4B: LAYOUT OF THE MOTION SENSOR



FIGURES 4.4B: LAYOUT AND DIMENSIONS OF THE MOTION SENSOR

4.4 TESTING

Three tests were carried out on this system namely: Continuity test, voltage test and the two way switching test.

Carrying out the voltage test before testing the hardware is very essential. It helps limit the risk live electrical circuits pose to individuals. One of the easiest ways to test for voltage is to use a digital Multimeter. Measuring the voltage of a component on the circuit board entails connecting the probes of the digital multimeter to the terminals of the component. Red indicates positive terminal while black indicates negative terminal

A Multi-meter was used for the continuity test. This test is very important as it shows where isolation is required, as a results of bridging which can destroy electronic components.

With these tests carried out successfully, it is possible to determine the performance of this system under real life conditions.

4.5 RESULTS

The status of the system gives us our result. The system gives different results depending on the relay and the switch. See the table below.

NOTE: L1 AND L2 represents status for the switch.

N0 AND NC represents status of system for relay.

TABLE 4.1: RESULTS OF THE SYSTEM WITH THE RELAY AND SWITCH

SWITCH	RELAY	STATUS OF SYSTEM (SWITCH)	STATUS OF SYSTEM (RELAY)
L1	**NO**	**0FF**	**OFF**
L2	**NC**	**ON**	**ON**
L1	**NO**	**ON**	**ON**
L2	**NC**	**OFF**	**OFF**

4.6: BILL OF ENGINEERING MEASUREMENTS AND EVALUATION (BEME) FOR SMART CLASSROOM LIGHTINGS

Item	Amount	Unit	Price-per unit(N)	Total Cost(N)
Arduino Nano	2	Piece	10000	10000
AVR programmer	1	Piece	6000	6000
Crystal Oscillators	2	Pieces	150	300
Microcontroller Holder	1	Piece	750	750
HC-05 BlueTooth	1	Piece	5000	5000
Power Switch	1	Piece	2000	2000
DC-DC buck converter	2	Piece	1500	3000
PIR Sensors	5	Piece	1500	7500
LDR sensors	5	Piece	500	500
PVC Pipe	4	Trunks	500	2000
PVC box	3	Box	1000	3000

Plywood base board	1	Pieces	3000	3000
Black Tape	1	Piece	300	300
3s lithium ion Battery Charger	1	Piece	20000	20000
12 Channel Relay Module	1	Piece	8000	8000
IR proximity sensor	6	Pieces	1500	9000
Masking Tape	1	Roll	400	400
Cables, wires and jumpers	100, 50	Yards, pieces	200	3500
Diodes	8	Pieces	100	800
Capacitors.	10	Pieces	10	100
Resistors	20	Pieces	20	200
Wire Pegs	5	Pieces	100	500
Bolt and Screws	5	Pieces	50	1000
Glue Gun Sticks	2	Pieces	300	600
Shipping fee and logistics charge for materials	-	-	-	15000
TOTAL	-	-	-	**102450**

CHAPTER FIVE

CONCLUSION, RECOMMENDATION AND REFERENCES

5.1 CONCLUSION

In conclusion, the implementation of an automated light control system in classrooms offers a solution that enhances the learning experience while promoting environmental sustainability. By dynamically adjusting light levels to match natural light availability, time of day, the system promotes an optimal learning environment that boosts student participation and performance. True to science, integrating an automated light control system into classrooms offers a win-win solution that advances student success while promoting optimal sustainability and environmental responsibility. Finally, the device was fully tested and proven to perform optimally. Automated classroom monitoring was achieved via an app. Also, the motion sensing unit proved to be a reliable source of security against theft or other criminal tendencies. Upon testing this lighting system performed optimally. Thus, it is ready for mass production and installation in the different classrooms across Nigeria.

Due to technological advancement, this system can be modified later on in various aspects to ensure it is up to date with the latest technological trends. Some of them are listed below.

5.2 RECOMMENDATIONS

1. Based on the project's findings, I strongly advocate for the implementation of the automated light control system in educational settings, particularly in classrooms. This innovative solution offers multiple benefits such as optimized light levels, reduced energy consumption and so on. By installing the system in all classrooms and learning spaces, educational institutions can create a serene and enabling environment for optimum performance of students.

2. To maximize the impact and benefits of the automated light control system, I recommend integrating it with existing building management systems (BMS) to streamline energy efficiency and maintenance. Regular monitoring and evaluation are needed to ensure the system is up to speed and making a positive impact on student learning outcomes

3. To ensure an effective utilization of the system, comprehensive training and support should be provided to educators and facilities staff. Also, regularly assessing and refining the system to address the evolving needs of students and educators will foster a sustainable and adaptive learning environment. By embracing this cutting-edge technology, educational institutions can create a more supportive, efficient, and sustainable learning environment that ultimately enriches the educational experience and promotes student success.

4. The system can also be upgraded in the following ways:

1. Voice control integration. This will incorporate multi operational methods into the system, ensuring there is no overuse of primary methods of operation, thereby increasing the system’s lifespan.

2. Continuous testing and optimizing of the system. After installing the system and upgrading it, it is necessary to test in order to ensure that it works. This can be done by inspecting connections and components for sign of error.

3. Before deciding to upgrade your lighting system, ensure that the current system has been accessed and its strengths and weaknesses found. This enables the user determine what aspects of the automated system needs upgrading and the others that can be retained.

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