

**DESIGN AND CONSTRUCTION OF AN AUTOMATIC
STAIRCASE LIGHTNING CONTROL SYSTEM**

BY

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AUCHI, EDO STATE.**

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CERTIFICATION

This is to certify that this project titled “Design and Construction of an Automatic Staircase Lightning System” was carried out by **OLUMIDE OSOSE PRAISE**, with Mat no: **AST/2372051367** which meets the standard deemed acceptable by Science Laboratory Technology, Auchi Polytechnic, Auchi Edo State.

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DEDICATION

I dedicate this project work to the almighty God who made it possible for me to accomplish this.

ACKNOWLEDGEMENT

My profound Gratitude goes to the almighty God for His love, care protection and provision throughout my academic pursuit.

My undying thanks go to my beloved parents and siblings, who inspired and motivated me spiritually, morally and financially in pursuit of my academic goal in Auchi Polytechnic.

I equally appreciate my able supervisor and also the Head of Department of Science Laboratory technology for his efforts towards the success of this project work. I extend my dully appreciation to my lecturers and most especially those in Science Laboratory Technology.

I also want to appreciate my friends and course mates who stood by me in every season and situation in making sure my success is assured.

Once again, thank you to all the unfathomable contribution and may the Almighty God reward you, Amen.

ABSTRACT

The device has the potency to detect the presence of human beings and automatically either switch ON or OFF the lamp illuminating the staircase area. In this project work the lightning control is purely based on human presence and hence eliminating the need for manual switching .This device can be used to save power, and it can be used an emergency backup light. The Device has Passive Infrared (PIR) motion sensor which is the key detecting component in the present in the automated lightning control device. Some additional components such as light emitting diode, fixed resistors, variable resistor, transformer, voltage regulator, wires, bulb, diode, capacitor and Vero board were employed in the construction of this device. As the individuals step on the staircase, the motion detector of the staircase lighting control system will sense the presences of the persons and transmits the information to the Passive Infrared (PIR). Then the Passive Infrared (PIR) motion sensor then executes the instruction programmed in it and commands the relays to either automatically switch ON or OFF the lamps to illuminate the staircase. Users can easily receive feedback status of the automatic staircase control system when the system automatically either switches off or on the lamp illuminating the staircase area, thereby offering safety of having a proper view of where to put your feet, Elegance in terms of customization and practicality.

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CHAPTER ONE

1.0 Introduction

1.1 Background of the Study

The idea behind the design of this system is to make available the required illumination on our stairs, for nighttime events, security and beautification. This goes a long way in helping to curb the problem frequently encountered as a result of darkness during night time such as staircase accidents.

With the discovery of fire, the earliest forms of artificial lightning used to illuminate area were campfire. As early as 400BC, fire was kindled in the caves of pecking man. Prehistoric people used primitive's oil lamps to illuminates the surrounding. These lamps were made from natural occurring materials such as shells, horns and stones, were filled with grease and had a fibber wick (James 2011). Lamp typically employed animals or vegetables fats as fuel. Hundreds of these lamps (hollow work stones) have been found in the Lascaux caves in the modem day France, dating to about fifteen years ago. Candles and glass were also invented (Israel et *al*, 2018).

Segmented sleep patterns disappeared, improved night to time made more activities possible at night, and more invention of light reduced urban crimes. (Smith Kimberly, 2015). Today, inventors have been able to invent different automatic lightning systems with the aid of various components including the Automatic stair case lightning systems.

One place where power wastage occurs most in homes and offices is at the staircase. We usually turn on the light at the staircase and leave it in a hurry. The intention of this work is to design a staircase lighting system which works and turn

on the light only when someone is present there. This circuit can be used to save power. The circuit works on the condition of when human beings are present in the location of installation, and this condition is tested by the PIR motion sensor module the is used to detect the presence of human beings in its range. The PIR sensor is basically an Infrared Receiver (IR). It consists of sensitive IR receives which detects the IR (infra-Red) rays in its region. We know that every living organism emits IR rays and so the human body. Whenever there is a human in the sensor module region, it detects the presence of IR rays. (Robert, R. 2012)

In this project work, the automatic staircase lighting system was constructed and its performance was evaluated by employing it to detect the presence of human beings via motion detection sensor and then command the relay to switching on the lamp to illuminate the staircase.

1.2 Statement of the Problem of the Study

- The demand for electronics systems that can illuminate the staircase of it senses the presence of human beings is extremely high.
- The need to construct a home automation with the potency to collects data from the surrounding area and detects the presence of a person.

1.3 Objectives of the Project

The objectives of this work are:

- To develop an electronic system capable of illuminating the stairs.
- To construct an electronic system that can automatically collect data from the PIR Motion Sensor interface with the switching on of light.
- To implement motion detection system

1.4 Scope of the Study

The research work covered only the performance and Design of staircase lighting system. It gives detailed explanation of how the performance evaluation of lighting staircase can be constructed and implemented.

1.5 Significance of The Project

- In terms of safely.
- Used to access various floors quickly.
- By adding an inviting glow to the place.
- Illuminating the entire area effectively.
- For improving existing lighting conditions and also adding decorative look.

1.6 Limitation to study

The major limitations encountered in the cause of this project work are;

- Time constraint
- Poor power supply in carrying out this project
- Unavailability of components which results to travelling to and fro one place to the other in search of them

1.7 Definition of Terms

1.7.1 TRANSISTOR

Transistor is an electronic circuit device which is made by sandwiching a P-type semiconductor between a pair of opposite type (Twist and Turns, 2015).

It is a three terminal device which is capable of achieving amplification of weak signals in a fashion comparable and often superior to that realized by the vacuum

tubes. They are made from silicon or germanium diode for higher temperature operation.

There are two type of transistor such as the bipolar junction transistor and the field effect transistor or unipolar transistor. It consists of two P-N junctions formed by sandwiching either P-type or N-type semiconductor between a pair of opposite type or when a third doped element is added to a crystal diode.

Basically the BJT consist of back to back P-N junction manufactured in a simple piece of semiconductor crystal. These two junctions give rise to three regions such as emitter, base and collector.

Bipolar junction transistor is classified into two types such as PNP and NPN transistor. In this project both types were employed for amplification of weak signals in being strong enough to power other components of the electronic circuit.

Figure 1.1 shows the circuit of both bipolar junction transistors.

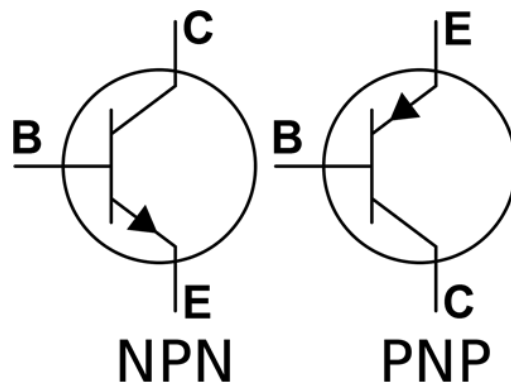


Figure 1.1 Circuit symbols of NPN and PNP Bipolar junction Transistors.

1.7.2 CAPACITOR

A capacitor is an electronic device or component that has the ability to store and release energy. It consist of two equal parallel metal plates separated by an

insulator called dielectric (a dielectric is a non-conducting material) such as air, paper, plastics, glass etc. (Donald et al.)

The dielectric help to boost the charging capacitor of the capacitor, and also help to block spark.

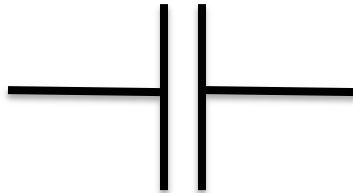


Figure 1.2 Symbol of a Capacitor

Capacitor is classified into two types such as fixed and variable that can be further divided into Polarized capacitor (Fixed and variable capacitor), and Non polarized capacitor (Others include electrolytic capacitor, ceramic capacitor (non-polarized), Mylar capacitor (non-polarized capacitor) and others). In this project work, the ceramic capacitors were employed since they can bias by both ac and de supply. They were used to further filter the supply and serve as coupling device in the circuit.

1.7.3 RESISTOR

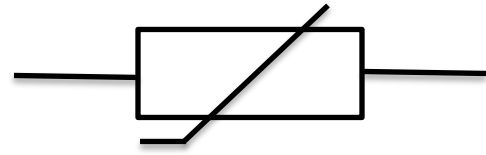
Resistors are electronic circuit components that offer higher resistance to the flow of electric current in an electronic circuit. In other words, resistors are circuit devices made to have specific values of resistance between their ends. They act to reduce current flow and at the same time act to lower voltage level within circuit.

Resistor is classified into two main types such as fixed resistor, and variable resistor- potentiometer.

Circuit symbols of fixed and variable resistors are shown in Fig. 1.3



Fig. 1.3 Circuit symbol of Resistor



1.7.4 DIODE (LIGHT EMITTER)

Light emitter diode gives off light when a current Passes emitting through it is forward bias. Light emitting diode is a transducer which is used to change electric energy. For it to work it must be connected in forward biased direction, when forward biased anode is positive and cathode is negative, it conducts and emits yellow, red or green color of light depending on its composition. No light emission occurs if the light emitting diode is reversed biased.

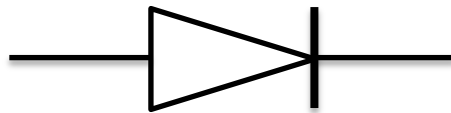


Fig. 1.4 Diode (Light Emitting)

1.7.5 SENSOR

A sensor is a device that Detects and responds to some types of input from the physical environment. The input could be light, heat, motion, and pressure etc. Sensors are classified as such PIR sensor, Ultrasonic sensor and Touch sensor. We employed PIR sensor in this project work to detect the motion of individuals and send signal to PIR which in turn process the command signal in accordance with the programmed instruction and driven the relay to switch on the light to illuminate the staircase,

1.7.6 SWITCH

Switches are mechanical device that interrupt or divert electric current flow within circuit. Switches are component that can pass current (closed) or break the flow of current (open).



Figure 1.5 Circuit Symbol of a switch

Switch is used to switch on and off the lighting system.

1.7.7 RELAY

Relay is electrical activated switch. The three basic types of relay are: mechanical relay, reed relay, and solid state relay. In this project work, relays were used to switch on and off the lamp that illuminate the stair case. Figure 1.7 shows the portrait of a relay.



Figure 1.6 Portrait of a Relay

1.7.8 INTEGRATED CIRCUIT

An integrated circuit is a complete electronic circuit in which both the active and passive components are fabricated on a tiny chip of silicon. Integrated circuit is

classified as monolithic integrated circuit, thick and thin film IC, hybrid or multiple I.C, linear integrated circuit, and digital integrated circuit

1.7.9 PASSIVE INFRARED MOTION SENSOR (PIR)

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. PIRs are basically made of a pyroelectric sensor which can detect levels of infrared radiation. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted.



Figure 1.7 Diagram of a PIR

1.7.10 TRANSFORMER

A Transformer is a device that transfers electric energy from one alternating current circuit to one or more other circuits, either increasing (stepping up) or reducing (stepping down) the voltage. Transformers are employed for widely varying purposes; e.g., to reduce the voltage of conventional power circuits to operate low-voltage devices, such as doorbells and toy electric trains, and to raise

the voltage from electric generators so that electric power can be transmitted over long distances.

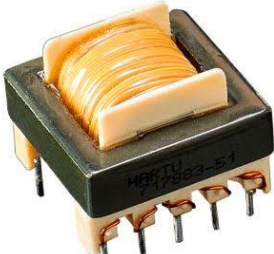


Fig. 1.8 Diagram of a Transformer

CHAPTER TWO

2.0 Literature Review

2.1 Introduction

Staircase lighting system is growing rapidly; they are used to provide convenience, comfort, and safety for residents. This system can be designed and developed by using a programmable PIR such as motion, human detector or sensor which has the potency of automatically switching OFF/ON an electronic system such as the staircase lighting. Its main advantages are that this system can easily be controlled by human motion or presence, employing detector or sensor, improves safety either indoor or outdoor and adds an inviting glow to the place.

Modern staircase lighting system consists of a simple circuit that employs motion/human detector or sensor to automatically switch ON/OFF the staircase light as the presence of a human being is sense by the motion detector. It enhances the landscape, amplifies deck lighting when entertaining, commercial exterior lighting and brightens the stairs. A lighting control system is an intelligent network based lighting control solution that incorporates communication between various systems inputs and outputs components relating to lightning controls with the use of one or more central computing devices. Automated lighting control uses the principle of home.

Automation where an occupancy sensor collects data from the surrounding area and detects the presence of a person and with the lights turning it on. The major advantages of a lightning control panel over stand-alone lighting controls or conventional manual switching is the ability to control individual lights or group of lights from a single user interface device. This ability to create and to control multiple light sources from a user device allows complex lighting scenes to

be created. The major benefit of lighting control systems provide additional benefits including reduced installation costs and increased flexibility over where switches and sensors may be placed.

Data sensors is acquired, it is important to transform this data into a form where our device will be able to distinguish between the type of presence in the target area, by extracting features like distance from sensors, number of persons in the area, speed of the target persons, etc. this may be made possible by accurate sensing data and efficient machine learning Algorithms.

2.2 Literature Review

In the year 1791-1867, electricity was discovered by Michael faraday. The relative continuity and the economics of scale they come together to increase the growth of central station electrical power service when was the main objective.

MC Clark, design and constructed electron equipment which was not fully accepted by the ministry of power and service in the year 1989.

Samuel, S. (2014): constructed a staircase lighting control system but the equipment could not sense the presence of human being effectively because the sensor employed in the work was not varying well.

Adams, M. (2017): he did work on the design and construction of stair lighting system but it _z discovered that the source employed to power the said electronic system was not able to bias the system accordingly.

Reza, M., Aboltazi F.H. and Mohamad, J.M.S. (2011): they worked on the novel design of an automatic lighting control system for a wireless sensor network with increased sensor lifetime and reduced sensor numbers. The explained in detailed the effects of automatic lighting control system.

In this project work, all this were looked upon in the design and construction of a staircase lighting control system was embarked to correct were spotted in previous works and come up with an equipment that capable of detecting the presence of human being and automatically switch ON or OFF the lamps on the staircase.

2.3 Summary of the Chapter

This project work majorly deals with the design and construction of staircase lighting control system to detect the presence of human beings, control and switch On or Off the lamps on the staircase to illuminate and thus prevent accident.

CHAPTER THREE

3.0 Research Design and Methodology

3.1 Research Design

3.1.1 Circuit Design and Procedure

This section deals with design and analysis of this project work with the aid of circuit diagram. The design incorporates both hardware and software.

3.1.2 Power supply stage

In this research design, the power requirements had been carried out in relation to the various components that would be used. In order to get all of these components bias at different voltage levels and types, a linear power supply was employed.

A 9V battery is employed to power the electronic circuit system along with a 22pF filter capacitor which smoothed the output from the battery, and 5V voltage regulator to stabilize output voltage from the filter capacitor 5V.

3.1.3 Motion Detector

Motion detector is an electronic circuit component that has the potency of detecting or sensing the presence of human being and sends the signal to Passive Infrared (PIR). The 9V battery is used to power the motion detector is the heart of this project and serves as the receiver and transmitter in this work

In this design work, the motion detector is employed to sense presence of human being before stepping on the staircase and transmit signal to the Passive Infrared (PIR) which in turn process the command and instruct the relay to either switch ON or OFF the lamps that will illuminate the staircase area.

3.1.4 PIR Stage

A passive infrared sensor is an electronic sensor that measures infrared light radiating from objects in its field of view. This type of motion sensor is only the receptor of infrared waves and does not release any infrared beam so they are called passive infrared sensor. All the living beings emit infrared radiation to surrounding. Warmer the object more will be the infrared emission. The Passive Infrared sensor is a thermal infrared sensor that detects the motion of objects by these infrared radiations variations in environment.

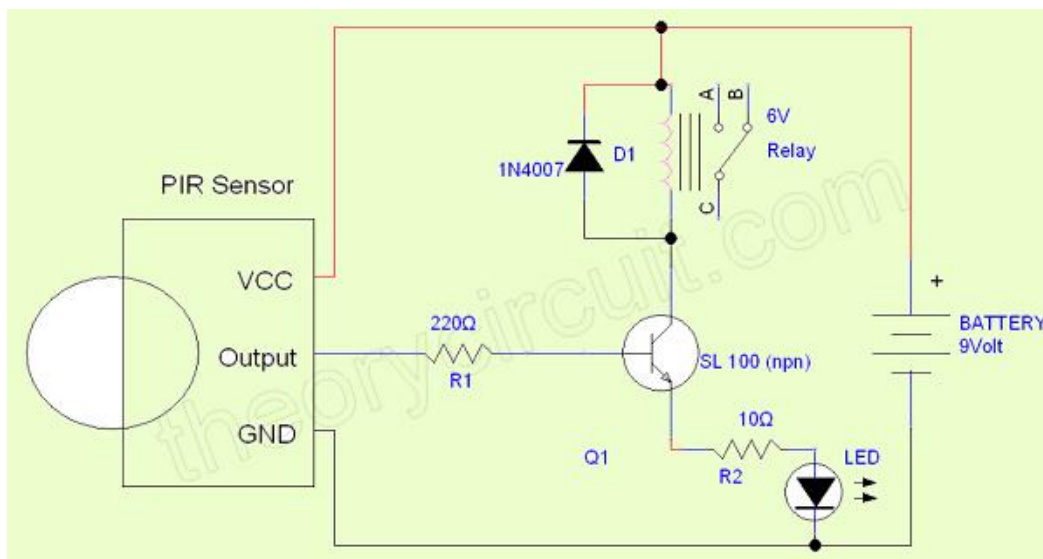


Figure 3.1 PIR Structure

3.1.5 Switching Stage

Relays are employed in this work to either switch ON or OFF the lamps that would illuminate the stair for an individual about step on the stair. The relays were connected to the output of the Passive Infrared (PIR). When the presences of human beings are detected by the motion detector, processed by the Passive Infrared (PIR) and the relays will automatically either switch ON or OFF the lamps that illuminate the stairs.

3.2 Principle of Operation of Luminous Intensity Counter System

As the individuals step on the staircase, the motion detector of the staircase lighting control system will sense the presences of the persons and transmits the information to the Passive Infrared (PIR). Then the Passive Infrared (PIR) motion sensor then executes the instruction programmed in it and commands the relays to either automatically switch ON or OFF the lamps to illuminate the staircase.

3.3 Construction and testing

In the cause of construction each component and material was tested before configuration to know the values of the components and to know their working conditions, so that there would not be any problems after the components had been soldered or configured on the Vero board. Point to point continuity test was carried out; the following faults were traced and corrected.

3.3.1 Process of Construction

Multimeter was used in testing the component to ensure that they are all in good condition before putting them together. After finding out that they were all in good condition, we began to mount them (the components) on the Vero Board. And afterwards input voltage was supplied and then the Sensor was coupled along with the switching circuit and then we tested the construction.

3.3.2 Constructed Design

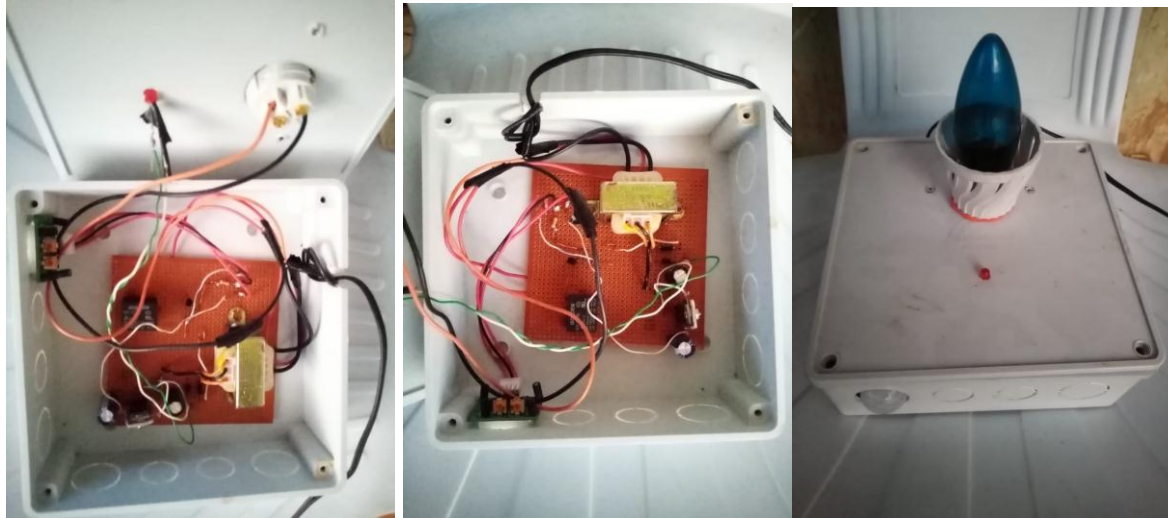


Figure 3.2. Open and Closed view of the designed Lightning Control system

3.3.3 Staircase with Implemented Design



3.4 System Performance

The staircase lighting control system was implemented to co-ordinates, controls and senses the presences of persons and automatically switches either ON or OFF the lamps that illuminate the staircase.

3.5 Instrumentation/ Material (component)

3.5.1 Instrumentation/ Tools

The instruments used for the construction of this project include:

- Screw drivers
- Multimeter
- Cutter
- Soldering iron
- Screw drivers
- Pliers
- De-Soldering pump etc.

3.5.2 Components

The component used includes:

- Voltage Regulator
- 12v Transformer
- AC Bulb
- PIR Motion Sensor
- Variable Resistor
- Fixed Resistor
- Vero board
- Transistor
- Diode
- Ten Pin Socket
- Ceramic Capacitor

- Motion detector
- Light Emitting Diode
- 6x6 Packaging Board
- Lamp holder

3.6 Casing of Luminous intensity Counter System

In this project work, plastic was employed for casing the staircase lighting control system.

3.7 Circuit Diagram

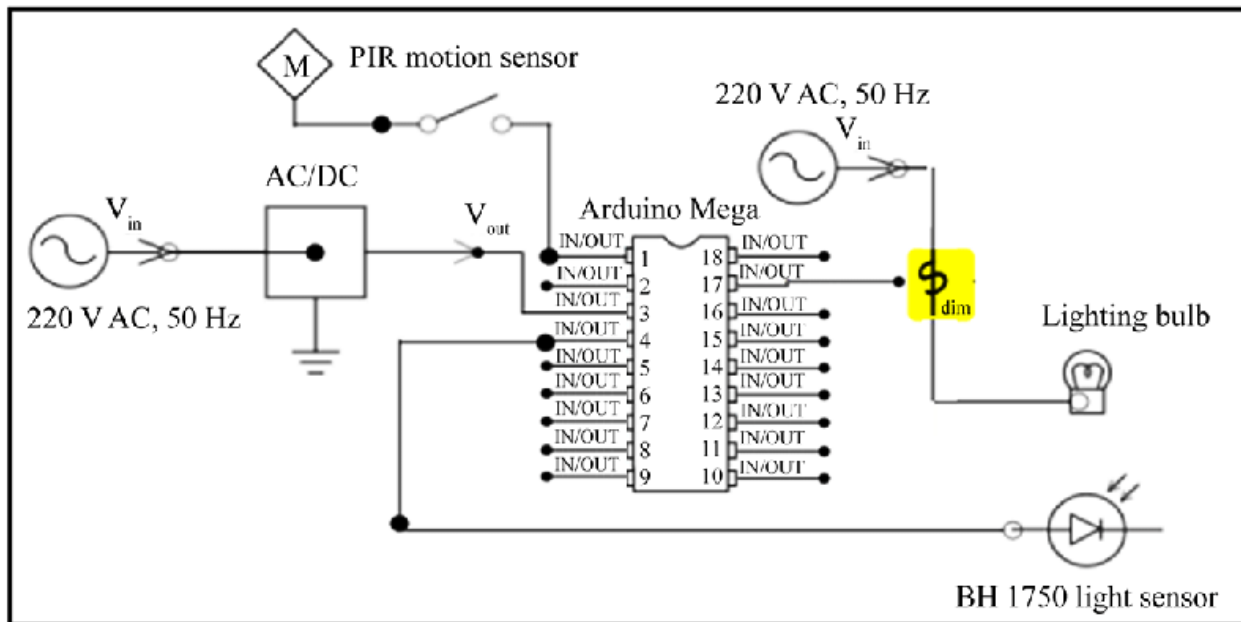


Figure 3.3 Circuit Diagram

CHAPTER FOUR

4.0 Result, Discussion and Summary

4.1 Result

In this chapter, the constructed work is presented. The electronic device was constructed employing a programmable PIR motion detector sensor and other components. With this, the system is working properly and can automatically detect the presence of human beings and illuminate the staircase by switching ON the lamps and OFF once there is no one to detect.

4.2 Discussion

In this project work, the design, construction and testing of an automatic staircase lightening system has been properly handled. The aim of this project is achieved because the piece of electronic equipment can detect the presence of human beings and automatically illuminate the staircase. This piece of equipment is of low cost, easy to implement, occupy lesser space, easy maintenance, fast, efficient and more reliable. This electronic system works with a great compelling result.

4.3 Summary

This project is titled Design and Construction of an automatic lightening control system is built and implemented to detect the presence of persons and illuminate the staircase. This project work is constructed employing a programmable PIR motion detector and other components. With this the system is working properly and it illuminates the staircase once someone is about to step on it.

CHAPTER FIVE

5.0 Conclusion and Recommendation

5.1 Conclusion

In this project work, the design, Construction and testing of an automatic staircase lightening control system has been properly handled. This piece of equipment can be implemented to detect the presence of persons and switch ON and OFF the lamps. After numerous tests were carried out and programing with different codes, eventually the obliged outcome is put forward. It's a fast, simple and efficient approach to illuminate the staircase without the help of a personnel.

5.2 Recommendation

- Building and practical implementation of an automatic staircase lightening control system that can be improved on.
- Constant power supply is needed for proper performance evaluation of the project work.
- The construction of this system should be encouraged because it can be employed to reduce high risk of accident on the staircase.

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