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AUTOMATED LIGHT CONTROL SYSTEM FOR OFFICES

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ABSTRACT

Electricity is one of the most important resources in this century that should be conserved. On several occasions, we get out of rooms, offices, hall and forget to turn off the lights/fan, thus the electricity is wasted and billing is also increased. Manual operation of light in offices is one of the challenges being faced by members of staff in any organization. This research work is focused on design and implementation of an automatic light controller used in offices in order conserve electricity as well as reducing electricity bill.. The major component used for the implementation of this research was Light Dependent Resistor (LDR) which works on the principle of changes in resistance of LDR according to light falling on it. This will ensure proper conservation of energy which reduces the cost of bill paying to IBDEC (Ibadan District Electricity Company). Manual application of controlling bulbs is eliminated by using this system. This automated system is not only applicable to offices but also applicable in, rooms, Hostels, Street lights, Garden lights, Hotels etc. Automatic light control requires less labor to operate since it works automatically therefore the running and opportunity cost is encouraging.

KEYWORDS: *Light Dependent Resistor, Automatic, Relay, Voltage Regulator, Power Supply*

I. INTRODUCTION

The automatic light control is an electronic device designed to provide an alternative to the switching system of existing one. In the modern day technology, almost every electrical and electronics are being operated automatically. Light is very important, most especially during the night because it stimulates sight and makes things visible. It is also old as man, back from the early man to the present age; man has been devising means of providing light for illumination for the primitive method of using fire lantern, candle stick, gas burner to electricity today (IBDEC). There will still be power failure (Black out) from the supply authority (IBDEC) for an average of two hours if there is no major fault.

The automatic light control becomes imperative to overcome the short comings of previous and existing methods of switching to control light supply. The automatic light control is therefore designed and developed to replace manual ones. It is made up of different unit to perform and serve its purpose. It is suitable for use at home, offices where illumination is of paramount important.

Wastage of power is not desirable in any system, so it is very much economic to have this arrangement so that power is not wasted during day time where manual operation is not possible. Though, we can use it in our daily life also for the betterment of our system. Automatic light controller provides flexibility in adapting the lighting system to different uses. For example, a school and auditorium which is home to a diverse range of activities would need different lights levels for these activities.

There are several significances of the research, among which (i) It requires less labor to operate since it works automatically therefore the running and opportunity cost is encouraging (ii) The design is cheap and economical, thereby, it can be established as one main business since it requires less capital to organize the business (iii) It gives room for more technology experience for electrician.

The automatic light controller has provided a means of switching ON or OFF the lamps at the correct time in the night and in the morning ever occasionally when there is darkness in the weather. When there is darkness, the resistance of the light dependent resistor (LDR) decreases and the resistance of the light "ON" but when there is brightness, the resistance of the light dependent resistor (LDR) increase

and the light goes "OFF". Automatic light controller is not working for household use alone it can also work for streetlight to switch it ON when it is night and as a switch for any other purpose.

II. RELATED WORKS

Light [5] has many applications in robotics and industrial control. Some examples include sensing the edge of a roll of fabric in the textile industry, determining when to activate streetlights at different times of the year, when to take a picture, or when to deliver water to a crop of plants. There are many different light sensors that serve unique functions.

Design and fabrication of a circuit that can control (on/off) distribution line of a specific region based on the intensity of the daylight was implemented by [1]. The circuit was designed in such a way that if the light intensity varies with seasons or some other factors, it is adjustable and if there occur any damage (short circuit) or if any bulb/tube does not work, it could point out the location and could provide alarm.

Independent Solar Tracker (IST) was designed by [2] that used photo resistors to track the position of the sun from any out- door location. If sunlight is more prevalent on one side of the solar tracking head than the other, the servomotors will adjust the face angle accordingly so that the solar tracking head can face the direction of maximum sunlight.

Automatic sliding door with a room light control system was modeled and designed by [3]. The research was achieved by considering some factors for the designing process. The performance of the system after test met design specifications. The system works on the principle of breaking an infrared beam of light, sensed by a photodiode. It consists of two transmitting infrared diodes and two receiving photo- diodes. The first one is for someone coming in and the second one is for someone going out of the room. The photodiodes are connected to comparators, which give a lower output when the beam is broken and high output when transmitting normally. The door is meant to open automatically but in a case where there is no power supply trying to force the door open would damage the mechanical control system of the unit. There is another system designed by [4] that used photoresistor as the major component to achieve their aim.

III. METHODOLOGY

3.1. Principles of Operation

The major components of this research are Light Dependent Resistor (LDR) and Transistor. The resistance of LDR depends on the light falling on it. It varies according to the level of light intensity falling on LDR. The Light dependent Resistor is connected to comparator which gives a low output when the LDR receives no light and high output when light intensity falls on it. This research uses 15v, 500mA power supply. The 7812 regulator IC with three terminals is used for voltage regulation. Bridge type full-wave rectifier is used to rectify the A.C. output, y.

There are several stages involved in the design of the system

3.1.1. Power supply stage

This stage is the circuit block that is necessary for the provision of regulated D.C. power supply to circuit components like ICs, relays in order to operate. The input voltage from the mains is taken to be closer to constant power supply from the Power Supply Company (220 – 240 A.C)

The power supply stage comprises of 15v step-down transformer and a rectifier. The transformer changes the 220v AC mains supply to a low voltage AC supply.

(a) Rectification Side

Rectification of AC to DC is achieved by a full-wave bridge rectifier configuration. The rectifier changes low voltage AC to a low voltage DC. Full-wave bridge rectifier was used in the circuit which consists of four (4) 1N4001 diodes configured in a manner that the pulsating AC voltage is transformed to DC voltage.

The current flowing through the load is in the same direction during both half cycles. Therefore, a fluctuating direct voltage is developed across the components in the circuit. This fluctuating voltage is not suitable to power an electric circuit which requires stable voltage.

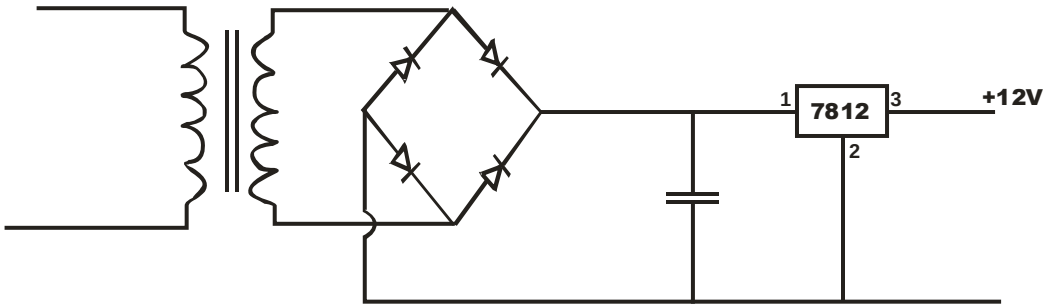

Figure 1. Power Supply stage

(b) Voltage Regulator (LM7812)

The main supply can vary by some percentage and this variation would be reflected in the output DC of the power supply unit. Voltage regulator (LM7) was used to give a constant DC voltage. It acts as a stabilizer due to the fact the components in the circuit are to run on DC voltage that contains negligible or no pulsation at all. The regulator gives an unvarying output. The LM7812 gives an output of 12v that is fed in the comparator while the relay used in the circuit was also fed from this terminal.

3.2. Sensor stage

Light Dependent Resistor was used in this stage to sense light intensity. The resistance of Light Dependent Resistor (LDR) decreases when the light falls on it. This stage was incorporated to detect whether there is darkness or light. The Light Dependent Resistor LDR1 and resistor (100k) was set up in potential divider arrangement feeding the pin 2 (inverting input) of 741 Op-Amp IC which serves as voltage comparator. The voltage at pin 2 is referred to as reference voltage or threshold. Potentiometer P1 was connected to the pin3 (non-inverting input) of the 741 Op-Amp and is used to adjust the circuit to room's ambient light. By placing the hand on the LDR1 we can easily turn the transistor on and off. Potentiometer P1 also formed another voltage divider to pin 3 of the LM 741.

If the output at pin 6 is high this causes the transistor T1(BC 547) to saturate and turn on like a switch, allowing current to flow from R3 through the transistor T1. Resistor R3 was used to limit the current to the base of the transistor.

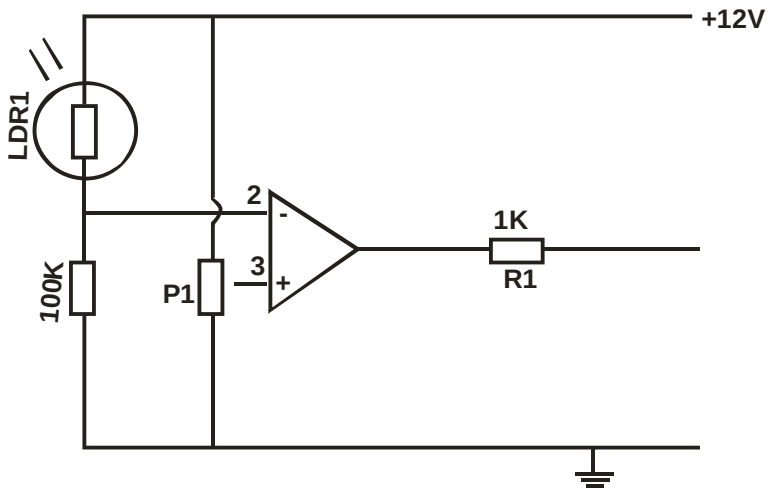

Figure 2. Sensor stage

2.4. Driver stage

The driver stage consists of a switching transistor which switches the relay that controls six 200w lamps.

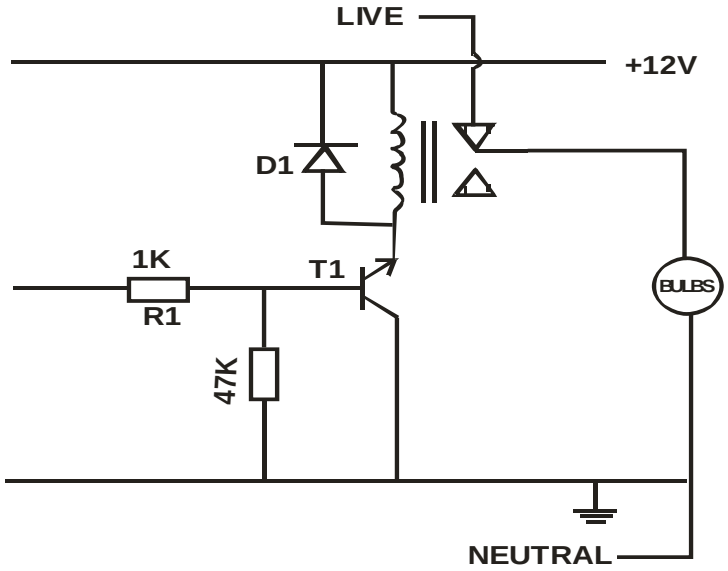

Figure 3. Driver stage

When the voltage on pin 3 of the Op-Amp Lm 741 is greater than the voltage on pin 2, there would be output on pin6 to turn on the transistor T1. We turn the potentiometer so that the bulb is on and we also turn it so that the bulb is off, just to ascertain the circuit is working properly. Then, we cover the LDR1 to see light is coming on when the potentiometer is adjusted indicating that the circuit has sensed a dark condition.

Diode D1 was used to prevent sparking of relay-coil when it opens.

The complete circuit diagram is shown below

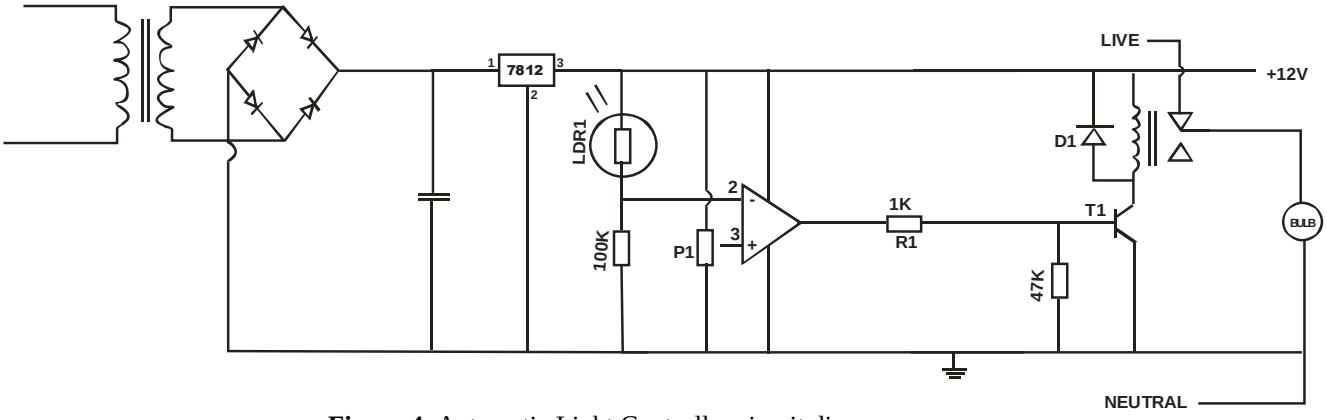

Figure 4. Automatic Light Controller circuit diagram

3.3. Design Analysis

The power rating of the lamps used was 200w and its working voltage is 220v.

The current rating of the lamps is calculated as follows:

$$I_{(lamp)} = \frac{P}{V}$$

$$= \left(\frac{200W}{220V}\right)A$$

$$= 0.9\ A$$

Therefore, the current rating of the lamps used is 0.9A

The number of bulbs used is 6,

Therefore, the total current consumption of the lamps used = (0.9 x 6)A

$$I_{(lamps)} = 5.4\ A$$

Since the total current consumption of the lamps used is 5.4A a Relay of 10A contact current is selected for the control circuit of the lamps.

3.3.1. Selection of suitable transistor for the Relay

Since the voltage rating of the D.C. power supply used for the lamps controlling the circuit is 12v. A 12v D.C. relay is selected for automatic switching ON/OFF. The coil resistance of the relay used is 82Ω.

Relay working voltage = 12v
Resistance of the Relay = 82Ω

Therefore,

$$I_{(relay)} = \frac{V}{R}$$

$$= \frac{12v}{82\Omega}$$

$$= 0.15 \text{ A}$$

Since the current consumption of the relay used is 0.15A, a BC 547 transistor with collector current rating of 0.8A, collector to base voltage of 75v, collector to emitter voltage of 40v and emitter to base voltage of 6v is considered suitable to drive the relay used in the output of the control circuit.

3.3.2. Selection of Suitable Cable for the Wiring System of the Lamps Used

The total current consumption of the lamps used is 5.4A, according to IEEE wire table, a cable with cross sectional area of 1.5mm^2 with current carrying capacity of 20A is considered suitable.

3.3.3. Determination of voltage and current rating of the components used in the D.C. Power Supply Circuit

The current consumption of the control circuit is 0.16A and its working voltage is 12v.

Since the current consumption of the control circuit is 0.16A, 1N4001 diodes of with Maximum Peak Reverse of 600v and Maximum Average Forward Current of 1A is considered suitable as rectifying diodes used for rectification in the D.C. Power Supply Stage.

A 500mA 220/15v transformer was used for the D.C. power supply since the working voltage of the control circuit is 12v and its current consumption is 0.16A and the output of the D.C. power supply voltage is regulated with the aid of 12v voltage regulator I.C.

Assuming that the input voltage to the LM7812 is greater than the required output voltage by a factor of 4 i.e. 12v + 4v = 16v, the voltage regulator IC will start getting hot and damaged.

The diodes drops 0.6v and there are 4 rectifying diodes,

the voltage drops = 0.6 x 4
= 2.4v

The peak voltage = 16 + 2.4 = 18.4v peak

$$\text{r.m.s voltage} = \frac{18.4}{\sqrt{2}}$$

$$= \frac{18.4}{1.4}$$

$$= 13.143\text{v}$$

Therefore, 220v/15v transformer was used.

Assuming a ripple voltage of 20%

$$dv = \frac{20}{100} \text{ x } \frac{18.4}{1} \qquad \frac{20}{100} \text{ x } \frac{18.4}{1}$$

$$= 3.68$$

$$dt = 1/ 2f = 1/100$$

$$= 0.01 \text{ F}$$

$$C1 = dt/dv = 0.0027173913\text{F}$$

$$= 27173913\mu\text{F}$$

3,300µF capacitor was chosen for the smoothing capacitor

3.3.4. Precautions

The ICs used were fixed on hint sinks to dissipate heat especially when the current drawn close to the maximum value of the ICs.

3.4. Testing and Implementation

The physical realization of the design is vital. This is where the beauty of all the idea comes to reality. After carrying out all the analysis and design on paper, the project was implemented and tested to ensure that it is working normally and properly, it was finally constructed to meet a desired specification. The process of testing and implementation involved using of multi-meter. The digital multi-meter is basically used to measure resistance, voltages, current, continuity, transistor type etc. The design and implementation process on the board required the measurement of common parameters like continuity, resistance values, and voltages. The digital multi-meter was used to check the voltage drops at all stages and to check the reference voltage in the comparator circuit. The multi-meter was also used for troubleshooting the soldering and coupling to know whether they in contact or not.

3.4.1. Implementation

The whole design was first implemented on breadboard. All the stages involved in the design were tested one after the other before they were permanently soldered on the ferro-board. These stages were later coupled to form a complete circuit and properly packaged inside a metallic casing with special perforation to prevent overheating which was later installed on building block of Computer Engineering offices at Federal Polytechnic, Offa.

3.4.2. Problems encountered

Among the problems encountered during the design of this work are (i) lack of power/ low voltage power which made the work to be very difficult and uninteresting. (ii) Burning of some components which were replaced by another ones.

3.4.3. Conclusions

In this work we have designed an Automatic Light Control system used in offices and the performance of the work after testing met the design specifications. The design was installed in an office for power management and it is sensitive to darkness for its operation. During the night time when there is darkness, the system automatically turns on the bulbs and simultaneously switches off the bulbs during the daytime with the aid of Light Dependent Resistor. Automatic light Controller can be applied in areas where lights are being left unnecessarily without offing them. Automatic Light Controller can be employed in many places like Hotels, Schools, Hostels, Homes etc

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