International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 7 (2017) pp. 1244-1246

Development of an Automatic Luminaire Control System

Olowoleni J.O.[1], Adoghe A.U.[2], Agbetuyi A. F[3], Awosope C. O. A. and Arokoyo J. B.[5]

[1,2,3,4,5,] *Department of Electrical and Information Engineering, College of Engineering,*
Covenant University, Ota, Ogun State, Nigeria.
Corresponding Author e-mail: anthony.adoghe@covenantuniversity.edu.ng

Abstract

The Inability of the countries discos to effectively load shed the available power to as many customers as the available power should carry has become a disadvantage not to the entire populace but to mainly the not so important people, an example is the SMEs who have to run generators to keep their businesses alive while the important people have electric power at their disposal, due to this availability of power it has been discovered that the energy is wasted, after all they have the money to pay for it. Our main focus in reducing this waste is by developing a simple and extremely cheap device that will automatically switch off lighting points at natural luminations less than what is visible to the human eyes. This light sensing will be done by the light dependent resistor which is a variable resistor whose value at any time t, is dependent on the amount of light falling on it, therefore with appropriate calculations, we will accurately choose the exact visibility chosen to turn on and turn off the lights. There are a variety of useful components that aid this project to doing its work such as the 555 timer that gives the output to the light bulb.

Keywords: Luminaire, Light Dependent Resistor (LDR), NE555 timer

INTRODUCTION

The automatic luminaire control system is an electrical device simply made to monitor the available natural light in a room and turn off or turn on the luminaires, when the natural light available in the room is enough or not enough for the humans visibility. The automatic luminaire control system also comes with the addition of an alarm. Its function is to alert operators of when to turn off luminaires that are not connected to the system. The main components of this system are light dependent resistors, NE555 timer and a relay.

METHODOLOGY

The automatic luminaire control system operation is based on the mono stable characteristics of the NE555 timer as its main component.

The luminaire control design is divided into two exclusive operating modes and an alarm mode

The two exclusive or operations which are the day mode and night mode get their power from the AC mains of 240V. This is stepped down to 12v AC and then rectified and filtered to 12V DC, using the full wave rectifier process with the aid of the 1n4001 diode and bulk capacitor of 1000micro farad respectively. This AC system is backed up by a rechargeable 9-V or 12- V battery. 150-k**Ω** resistor is used to charge the battery while AC is available and another diode of 1n4001 is used to allow the current to flow from the battery while mains fail in one direction thereby avoiding the discharge of the AC source. Be it the supply or backup, the system is designed to operate on constant 6V dc, which is achieved using the IC 7806.

The sensor of the system is the light dependent resistor whose resistance is determined by the amount of light that shines on its surface. The lesser the light the higher the resistance

OPERATION OF THE NE555

The NE555 timer has 3 modes of operation. These are the

- Mono-stable mode
- Bi-stable mode
- A-stable mode

Its mode of operation is dependent on its purpose. Mono-stable property of the NE555 timer is employed in this research.

As the word mono-stable goes, it means we want its output to be on or high as long as its input requirement is satisfied. In the case of the NE555, its input should be about 3.9V dc, meaning that if we want our luminaires to come on, then our input voltage to the NE555 timer must be 3.9V. The NE555 timer has 8 legs or pins similar to a microcontroller. Each pin serves its own purpose. Pin 1 serves as the ground for the NE555 timer, pin 2 is the input which must have a dc voltage of about 3.9V, pin 3 is the output to the relay, which turns on the luminaires, pin 4 and pin 8 put a 6-V input across the NE555 timer, Pin 6 and pin 7 are connected in parallel with a 0.01-micro farad capacitor so as to eliminate the timing effect of the IC. Pin5 is the main controller, it could be left open or connected in series with a 0.01-micro farad capacitor and then grounded.

OPERATING MODES

The Luminaire control system is designed in such a way that it has three tasks to perform depending on the sensors it is to

- TURN ON LUMINAIRES AT NIGHT
- TURN OFF LUMINAIRES AT DAY
- TURN ON THE ALARM AT DAY

Turn on Light at Night

From the description of the property of the NE555 timer, we know that in order for our luminaires to come ON, the input should be about 3.9V, meaning that after the voltage stepping down, rectification, filtering and even bringing out a constant output of 6V, we still have to get an output of 3.9V to the pin2 of the NE555 timer.

With the knowledge of voltage divider, if we have two resistances and we know the input, we can successfully calculate the output voltage. In this case, we know we want our output, which is the input to the NE555, to be 3.9V and our input to the two resistors to be 6V, what is left are the values of the two resistances LDR1 and R2 to be used. Already it is known that the light dependent resistor is one of them, and will have a very high resistance at night. All that is needed to get is the exact resistance at which the user wants his or her luminaires to be turned ON. It is advisable for a series of tests to be carried out by the user to know the exact amount of unavailable sunlight for which the user will want his light to be turned ON. This unavailable sunlight is what we are looking at as the resistance of the light dependent resistor. After tests were carried out the resistance of the LDR needed is about 280,000 ohms. All that is needed now is to use the simple voltage divider rule to calculate the value of resistance R2. The calculation process is as follows:

V_{OUT} = 3.9V

V_{IN} = 6V

$R_{(LDR)}$= 280K ohms at night time resistance is high

∴ By divider rule, we have

$$V_{OUT} = \left(\frac{R_{(LDR)}}{R_{(LDR)} + R2}\right) V_{IN}$$

$$\frac{V_{OUT}}{V_{IN}} = \frac{R_{(LDR)}}{R_{(LDR)} + R2}$$

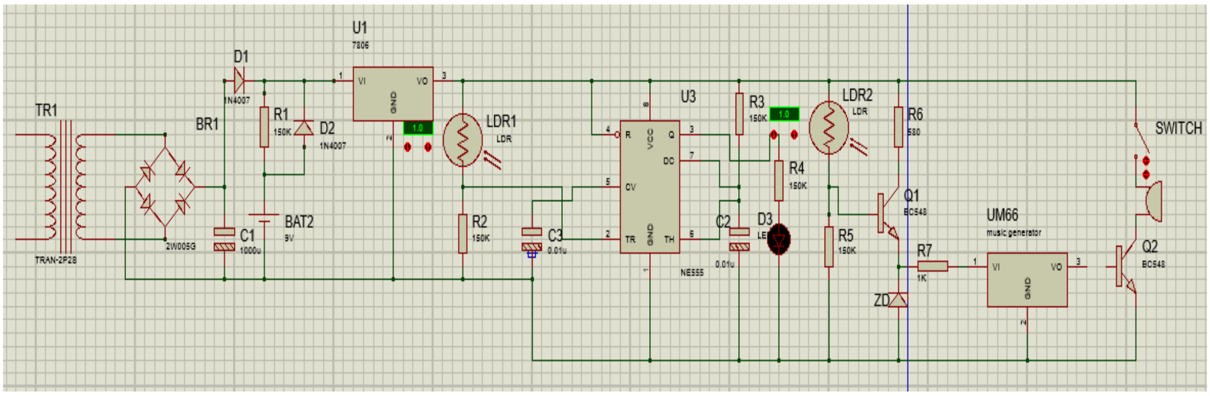

Figure 1: The System Circuit Diagram

$$R_{(LDR)} + R2 = \frac{R_{(LDR)}}{V_{OUT}/V_{IN}}$$

$$R2 = \left(\frac{R_{(LDR)}}{V_{OUT}/V_{IN}}\right) - R_{(LDR)}$$

$$R2 = \left(\frac{280000}{3.9/6}\right) - 280000$$

R2=430,769.2308– 280000

∴ R2 = 150769.2308 ohms

R2 ≅ 150kohms

Therefore we know that at an illumination of sunlight that is equal to the resistance value of the LDR1, the luminaires will turn ON due to the fact that 3.9V is applied across pin 2 of the NE555 timer.

Turn off Luminaires at Day

Since the luminaires will turn ON at a resistance of LDR greater than 280K ohms, it is expected that as daytime approaches, the resistance of the light dependent resistor 1 decreases, and at an illumination less than 3.9V, the relationship between the LDR1 and R2 will fail to produce an input voltage to the NE555 timer of 3.9V which will, in turn send a low signal to the output pin 3 which is then instantly turned OFF and the luminaires will then be turned OFF at daytime.

Turn on Alarm at Day

Due to the fact that the automatic luminaire control was not in existence when most buildings were built and their electrical luminaire wiring were designed, it might not be an easy task to connect all luminaires to the luminaire control system, therefore an alarm system is added to the luminaire control design to alert its users when it is morning and can turn OFF luminaires that are not connected to the luminaire control system. The system is designed using the second Light-dependent resistor LDR2, independent of the first Light dependent resistor. As a fact the only relationship between the two LDRs is that they are tapping from the same 6-V power source and earthed at the same point.

As sunlight shines on the LDR2, its resistance begins to drop, transistor Q1 then begins to conduct and its emitter supplies the melody generator IC UM66 the supply voltage, this supply voltage like the IC 7806 is made to dissipate an output of only 3.3V by the use of a zener diode, also the current is limited using resistor R7 which is just about a thousand ohms. The UM66 melody generator IC therefore produces the sound rhythm and not the sound actually. The sound is gotten from the speaker or buzzer whose input has been amplified by a transistor Q2.

PERFORMANCE EVALUATION OF THE AUTOMATIC LUMINAIRE CONTROL SYSTEM

Simulating a physical working process of the automatic luminaire control system, a switch and two ldrs were left on the outer layer of the prototype.

A. The switch is for the manual override of the alarm, which comes ON in the mornings.
B. LDR (1) is for an input signal to be sent to switch ON or OFF the lights depending on the time of day

C. LDR (2) is for another input signal to switch ON the alarm, which can only be turned OFF at the switch located at (A) , else if the alarm rings till night, when the signal cannot be sent again due to external or natural luminance .

This switch and two ldrs will allow us simulate all the possible situations that can occur, these situations are as follows:
1. Turn OFF all luminaires at morning times.
2. Turn ON all luminaires in evening times.
3. Turn ON alarm in the morning.

A light bulb was used to serve as a luminaire in a real scenario.

CONCLUSION

This work though has achieved its designed purpose. The control system is extremely cheap as the electricity meter will not read when the lights are OFF thus saving some amount of money, it is also very easy to operate. This will go a long way to improve load shedding, most especially for the low income group of people who can not afford generating sets.

REFERENCES

[1] http://www.electronicshub.org/
[2] Prof John Samuel Ndueso 'Unpublished embedded systems lecture note' 2007
[3] www.howstuffworks.com
[4] paul horowitz and Winfield hill 'The art of electronics' Patience hall. 2003.
[5] http://www.engineerserge.com
[6] B.LTheraja and A.K Theraja A text book of electrical Technology' chand and co. Ltd, revised edition, 2005
[7] Eludire, A.F 'Design and construction of an automatic electrical appliances control system, unpublished B.sc thesis, Covenant University' Ota, 2011.
[8] http://www.circuitsgallery.com/