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Development of Automatic Switch using PIR and SSR for Day and Night Detection

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Abstract- None conservative attitude is observed among the African people in non-conservative utilization of public power supply. Individuals are often observed power on the lightings, cooling systems when not needed at homes, offices and commercial centers. This increases power bills and may hinders a nation from diverting power to industrial areas, limiting the process of industrialization and waste of energy. To avert these, this paper presents development of automatic switch using passive infrared sensor (PIR) and solid state relay (SSR) for day and night detection. The objective of this project is to replace the electromagnetic relays which may fail as a result of carbon forming resulting from arching in existing designs with solid state relay. Also, the system is to conserve energy more by ensuring that bulbs are not powered on during the day time except in cases of darkness. The circuit was designed using components such as; power supply, PIR sensor, Light Dependent resistor (LDR) sensor, Microcontroller and SSR, as showed in the circuit figures 1 and 8. The system is achieved using PIC16f628 which is programmed using Micro-C, SSR for switching, PIR for human detection and LDR to detect night and day. The system was tested and worked perfectly. It helped to conserve energy.

Keywords: Automatic, conservation, energy, SSR, PIR, LDR.

I. Introduction

Electricity has been found to be the most clean and easy way for transportation of source of energy. This is because of its dominance in the provision of energy among other forms of transportation. All over the globe, it is also seen as a means of development of nations [1]. However, in third world countries, the hindrance or slow rise in development especially in industrialization may be hinged majorly on the wasteful attitude of individuals in energy management and consumption at home especially

in powering cooling and lighting systems in unoccupied places. As a result of this, power can't be diverted to industrial areas so as to foster production. In 2008, Sambo [7] in a study, Matching Electricity supply with demands in Nigeria affirmed that. Oyedepo [6] in 2012, revealed the enormous energy potential in Nigeria. The study maintained that the use of generator is on the increase as a result of the demand for electric energy which isn't sufficient. This however, impedes the economy of a nation as it mounts pressure on the oil sector and reduces foreign exchange possibilities as a result of increase in the consumption of oil product locally. To avert this ill, this paper presents development of automatic switch using PIR and SSR for day and night detection as a means of energy conservation at home.

Efforts to increase conservation attitude among individuals towards energy has been on the pursuit for a long time. This has spurned technology towards the production of low wattage bulbs. In recent years, LED's are used to produce electric bulbs because of its characteristics to give output of an appreciable lumen with less power. All these efforts only reduce power consumption and not the wastes. Suman et al [2], developed a home monitoring system for disable and elderly where he used PIR among other sensors to sense intruder and then sends an alert via a GSM module. Ajay et al [3], worked on Motion Detection using PIR sensor and showed how an alarm blares when an intruder is sensed, also Okokpujie et al [4] developed a model for automatic control of home appliances using DTMF techniques. All these fabulous designs did not use the control to aid energy conservation except the design done by Adelekun et al [1]. In this study, automatic control of electrical energy consumption using PIR sensor module power supply was designed to fans and lamps using PIR. He used electromagnetic relays which could develop carbonized contacts as a result of arching which may reduce the efficiency of the system with time. In addition, the design did not pay attention on the fact that lightening may not be necessary at day time. This limitation was experienced in the study done by Adewale et al [5]. To improve energy conservation, present project apart from sensing an individual in an area, it also has a light dependent resistor (LDR) to detect both night and day. It ensures that the lights are turned on only at night or when it's getting dark [8-12].

II. Methodology

The system was achieved via the use of different components listed below.

- Power supply
- PIR sensor
- LDR sensor
- Microcontroller
- SSR.

These components are coupled together and presented seen in the block diagram in Figure 1.

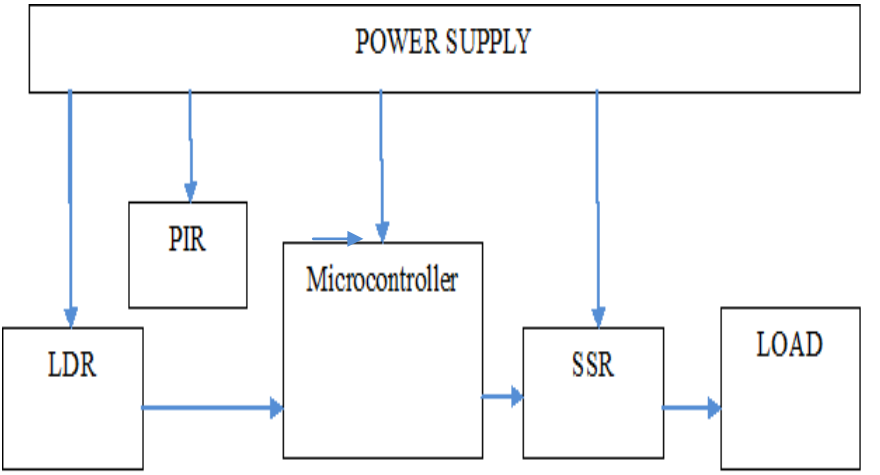

Figure 1: Block diagram of the system

Power Supply Unit

The unit was achieved via the use of a step down transformer to step down the AC voltage from 230V to 12V as shown in Figure 2. Furthermore, the 12V AC was converted to 12V DC via a block rectifier. Afterwards, the ripples were filtered off via the use of a capacitor. A 5V regulated voltage was then achieved via the use of 7805.

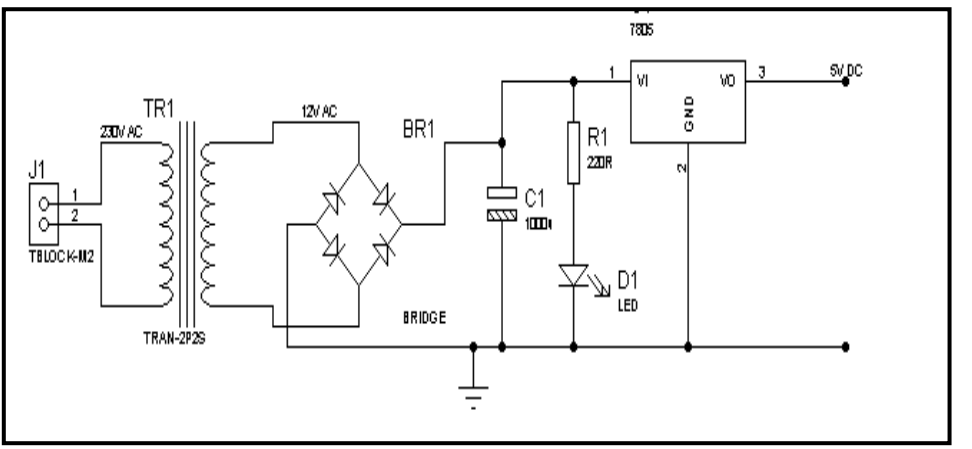

Figure 2: Circuit diagram of the power supply.

Passive infrared Sensor (PIR)

The passive infrared sensor is a module that senses human presence by measuring infrared light reflecting from its own field [5]. The light reflecting from its own field changes with the presence of man. Initially, the module outputs a low logic. However when human presence is sensed, the module outputs a high logic. Figure 3 shows the pictorial view of the module

Figure 3: Pictorial view of PIR module.

Light Dependent Resistor (LDR)

This photo resistor as shown in Figure 4 is a device that changes resistance with light. Usually, the resistance reduces with increase in light and vice-versa. In the presence of day light, the value of its resistance is 100k Ohms. However to convert the resistance into voltage, it was connected in series with a 100k Ohms resistor to enforce potential divider rule as shown in Figure 5.

Figure 4: Pictorial view of LDR

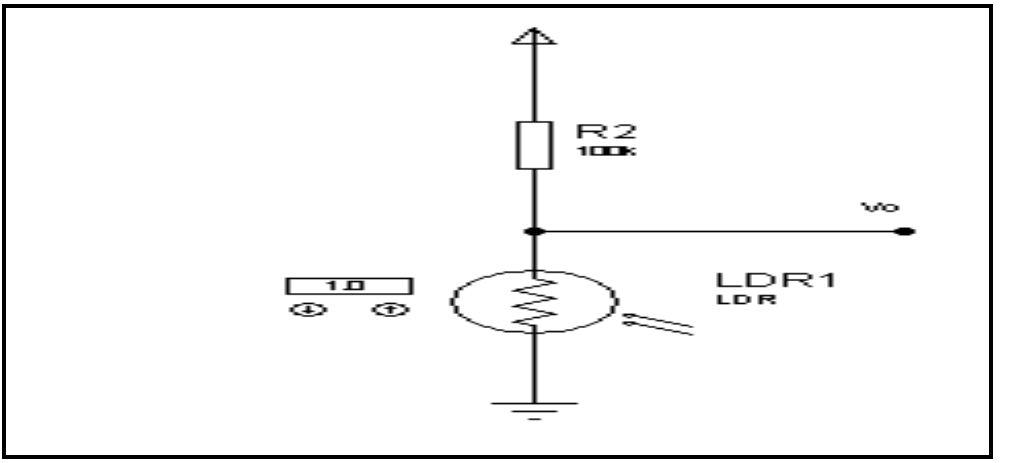

Figure 5: Circuit diagram of LDR in series with a 100k resistor

The connection of this device in series with a 100k resistor is to ensure that the voltage across it be $V_{cc}/2$. Furthermore, the setup will aid the project in the detection of night and day. This will ensure that when day light is detected, the controller will relay the message and ensure that the lamps don't come on even though it detects the presence of human.

Microcontroller

Although there are so many microcontrollers that can be used, however, the microcontroller used in this project is PIC16F628. This microcontroller was selected because of its small nature and because it is readily available. The controller has two ports A and B to be precise each having 8bits. Although some pins on port A are used for specific purposes like crystal oscillator and reset as shown in Figure 6, the remaining pins on the controller is sufficient for the project.

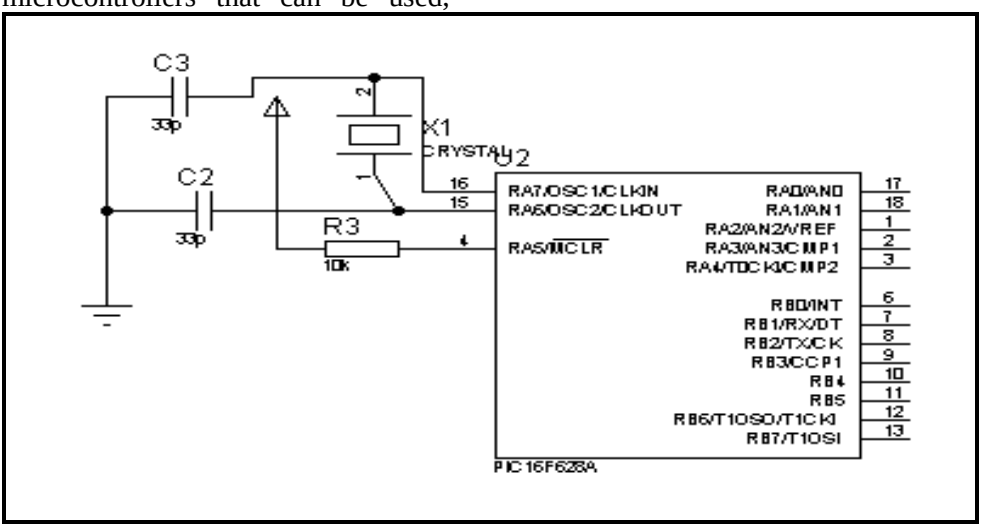

Figure 6: PIC16f628A

Solid State Relay

This is a device from LED and an opto switch. When the LED within lights up, the opto switch is turned on to allow current pass. Just like any other LED, a limiting resistor is used in series with the LED point. Usually, LED may not be powered with more than 20mA so as to avoid damage [5]. Studies from the data sheet of PIC16F628A shows that at high logic the controller outputs (V_{cc} -0.7) Volts [5]. Vcc which is the voltage used to power the controller = 5V. Therefore, output voltage from the controller at high logic = 5-0.7= 4.3V

To calculate the value of the limiting resistor, V=IR

Resistor value (R) = $\frac{V}{I} = \frac{4.3}{I}$

Since LED may not be powered with more than 20mAlet the current I flowing through the LED be 10mA

$R = \frac{4.3}{10mA} = 430\Omega \approx 470\Omega$

The SSR used in this project is Omaron G3MB-202P and is connected as shown in Figure 7.

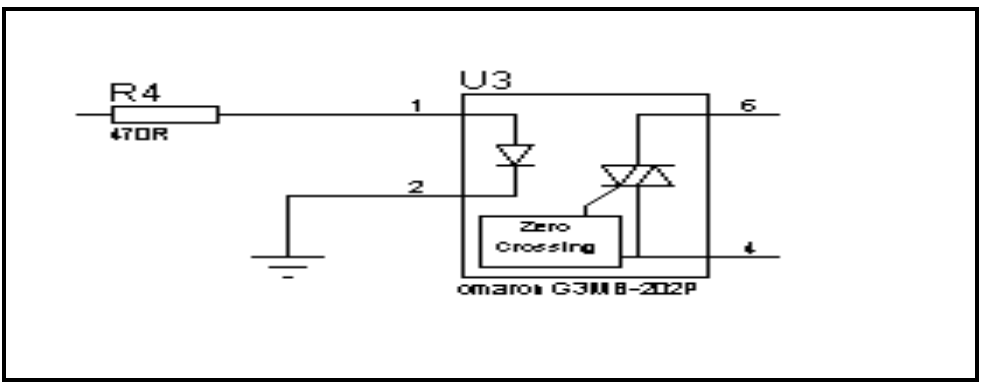

Figure 7: Circuit diagram of SSR.

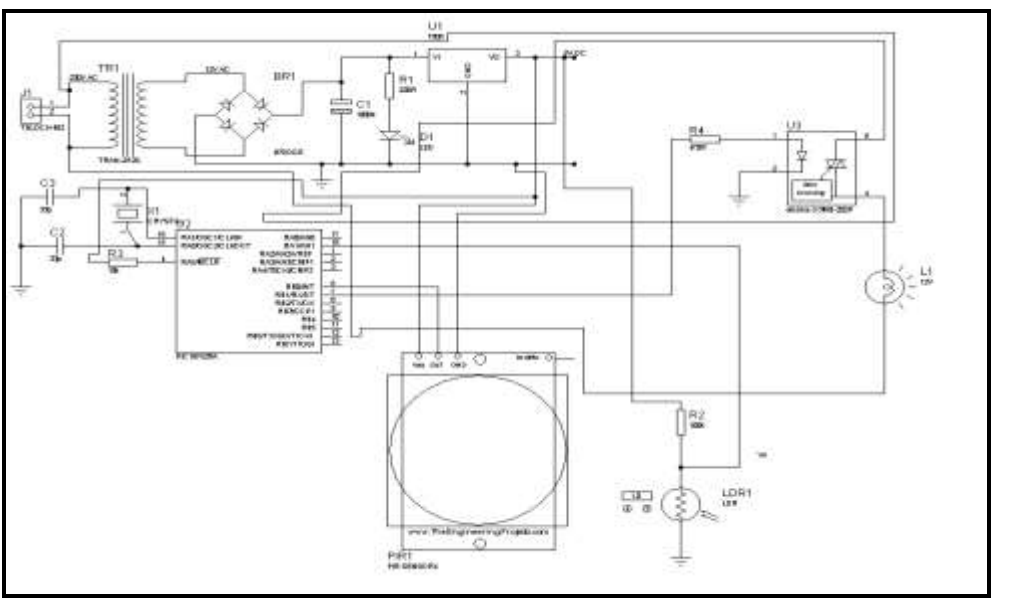

Figure 8: Mode of operation: Complete circuit diagram

From Figure 8 above, the PIR sensor is connected to pin 6 of the controller while the output from the LDR is read by the controller too. If human presence is sensed, the controller will first check the status of the environment if it is day or night. If it is day, it will ignore and the lamp will remain OFF. If it senses it night it will then turn on the lamp.

III. Results and Discussions

The system was built on a Vero-board; the controller was programmed via the use of top win programmer. Afterwards, it was tested and the results are presented in Table1.

Table 1: Experimental Result

S/N	PIR	LDR	SSR
1.	0	0	0
2.	0	1	0
3.	1	0	0
4/	1	1	1

Key: PIR: 1- Presence of Human Being; 0 – Absence of Human Being
LDR: 0- Day Time; 1 – Night Time
SSR: 1- On; 0 – Off

When PIR senses human presence the logic is 1 and if not logic is 0. Also for the LDR if day is sensed, the logic is 0 while at night the logic is 1. Furthermore, SSR is on when it is logic 1 and off when it is logic 0. From Table 1, the SSR is always off except when the human presence is sensed and when it is night.

Furthermore the risk of carbonized contact in electromagnetic relays is eliminated via the use of SSR. This also makes it noiseless.

IV. Conclusion

Automatic switch is necessary for the purpose of energy conservation especially at homes. The system was developed via SSR so as to avoid failure as a result of carbonized contacts which occurs in electromagnetic relays. Furthermore, the system was able to detect day and night effective utilization and energy conservation.

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