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Design of Solar Street Light With Auto Intensity Control Using Arduino

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Abstract: The purpose of solar street light project is to design a system that do not consume huge amount of electricity, maintaining maximum utilization and minimum loss of energy. Solar is a non-conventional energy source and electricity can be captured by solar panel and stored into battery by using charge controller. The function of charge controller is to control the charging of the battery. This stored energy is used to glow the street lights during the whole night. Solar streetlight is designed based on microcontroller (Arduino Uno) as a controller to read the inputs of light on a sensor and turn it into an output. This project will be using two sensors which are LDR (light dependent resistor) sensor and IR (infra-red) sensor. LDR sensor is a light sensor which is used to measure intensity of light. Then IR sensor is a combination of infrared transmitter and receiver will use to detect the motion of vehicles, human, or anything that pass through it. Street light will switch ON at the dusk and switched OFF at the dawn automatically, emits low intensity light when there is no movement and emits high intensity lighting when it detect a movement of either vehicle or people passing through.

Keywords: Solar Panel, Charge Controller, Arduino Uno, LDR Sensor, IR Sensor

1. Introduction

Automation system are being preferred because of the striving hard to save electrical energy from wasted. Street lighting is one of the most important parts in a city's infrastructure where the main function is to illuminate the city's street during the dark hours of the day [1]. As we know that, controlling the street light is a time taking during the evening times when it switched ON and a significant waste of energy is done at morning because it could not be turned OFF together at once. During midnight wastage also is done which the light will glow at full intensity even though there is

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not much vehicle and traffic. Solar street lighting system is an effective way to reduce power on consumption.

1.1 Problem Statement

The main problem of the street light that consists of manual controls which need constant monitoring and maintenance. The manual control of this systems will consume the wastage of electricity. This street lights would be a lot time taking during evening times when it supposed to be switched ON. As we can notice that the street lights are still ON when it is not necessary. Thus a significant waste of energy is done at morning because of the street light could not be turned OFF together at once. At midnights, the street light still glows at full intensity even though there is not much traffic.

2. Methodology

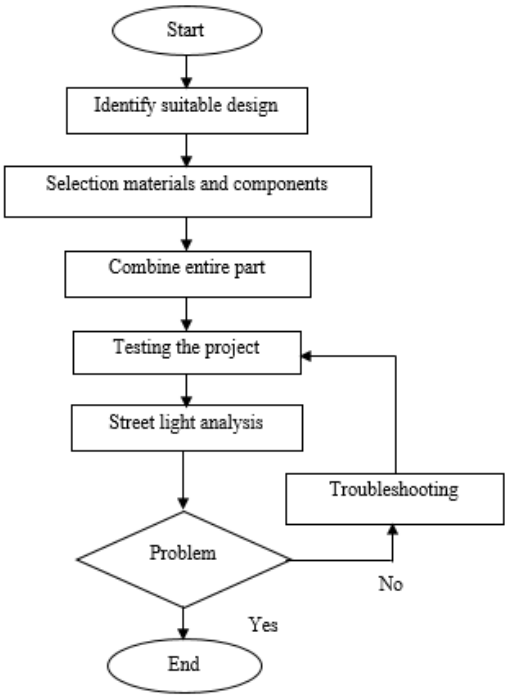

Figure 1: Project Planning Flow Process

2.1 Project Architecture

A block diagram is used to represent the system layout and structure that involved in this project. In this subchapter, the architecture of the project would be explained and illustrated. The flowchart of the project is shown in Figure 1.

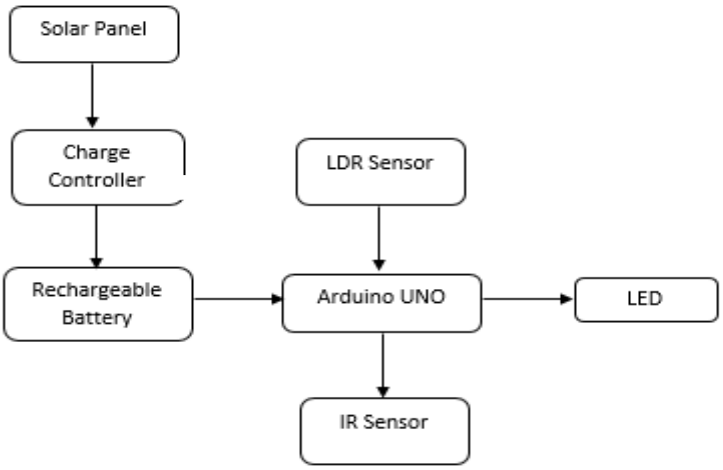

Figure 2: Block diagram of the project

2.1.1 Block Diagram of Project

Figure 2 shows the block diagram for the project, which is using Arduino Uno as a controller to interface the hardware component and software. This controller will control the intensity of light at different time slots [2] and [3]. The IR sensor consist of an infrared-transmitter, an infrared-receiver and a potentiometer for adjusting the distance [3]-[5]. This sensor detects the vehicle passes on the road to give feedback to the controller during the night time. LDR sensor used to detect the darkness of the surrounding light level or to measure the light intensity. During the night time, the resistance is very high but during the day time resistance will drops dramatically which depends on the light intensity [6] – [9].

Rechargeable battery is an energy storage device which is can be charged again after being discharged [10]. This battery stores the electricity from the solar panel during the day and this energy will be used during the night time. The solar panel in this project will convert the solar energy into electrical energy which is used to power the equipment or to recharge a battery. LED is the output that used to emit the visible light when it is activated.

2.2 Project Features

There are three main components in this Solar Street Light Project which is hardware component, software component and programming development method.

2.2.1 Hardware Components

Table 1 shows the list of the component for electrical parts and mechanical parts.

Table 1: List of Component

Component	Item	Description
Electrical Component	Solar panel	12V
	Arduino	Arduino Uno
	IR sensor	Operating voltage: DC 3.3V-5V
	Rechargeable battery	9V 800mAH
	LDR sensor	Input voltage: DC 3.3V-5V
	LED	White
	Resistor	10k Ohm

2.2.2 Software Component

The software development is required to be a part of the collecting data and information for this project. The software that are used in this project are Arduino software (IDE) and Proteus software. The Arduino IDE is used as a platform to construct and design the coding of the programming code and Proteus software used to do the simulation circuit project.

2.2.2.1 Proteus Software

This software used to implement the simulation by using Proteus professional design software. Proteus in Figure 3 is an electronic circuit design software that includes a schematic capture, simulation and PCB (Printed Circuit Board). The tools in this software provide with a powerful, integrated and easy to use for the beginner.

Figure 3: Proteus Software Application

2.2.2.2 Arduino Software IDE

The programming coding for this project was developed by using Arduino IDE software in Figure 4. Programmer able to make simulation the coding and upload the coding to the Arduino controller board. The operating system of this software are Windows, macOS and Linux. The open source this software makes it easy to write the code and uploads the program to Arduino compatible boards.

Figure 4: Arduino IDE software

2.2.3 Programming Development Method

In this subtopic, the initial step used is flowchart to arrange the process flow of the required operation function of each part of the project. This flowchart in Figure 5 is important to solve the solution with the step–by-step procedure before beginning with the code. By using this programming method, it was able to show the process flow and instruction for the programmed code to solve the problem.

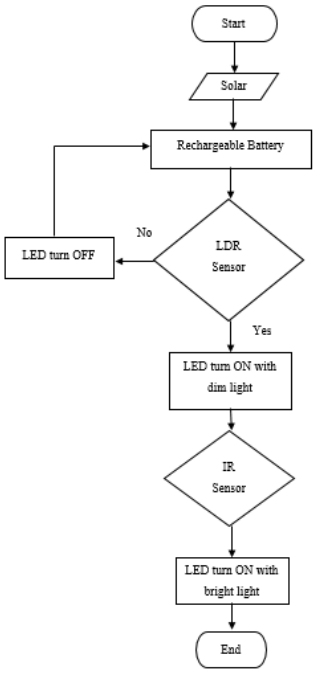

Figure 5: Flowchart for overall project

3. Results

The results of this project in Figure 6 and Figure 7 show when its dark the LDR sensor will switch ON the LED 1, LED 3 and LED 5 with dim light and when any vehicle is detected by IR sensor the respected LED will glow with full brightness for 10 seconds. During the day time, LDR sensor will switch OFF all of the LED. Solar panel convert energy from the sun into a flow of electrons by the photovoltaic effect. This energy will store in a rechargeable battery 12 V and supplied to the luminary when it is required to glow.

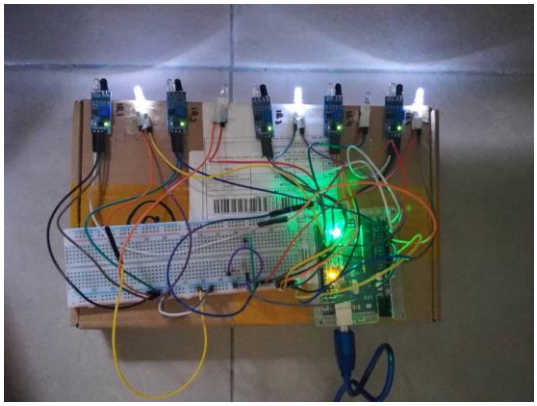

Figure 6: LED switch ON during the night time

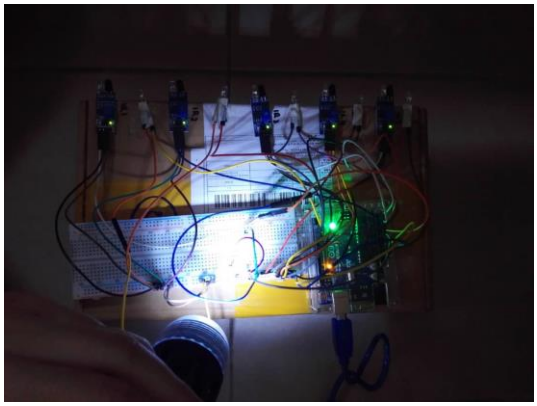

Figure 7: LED switch OFF during the day time

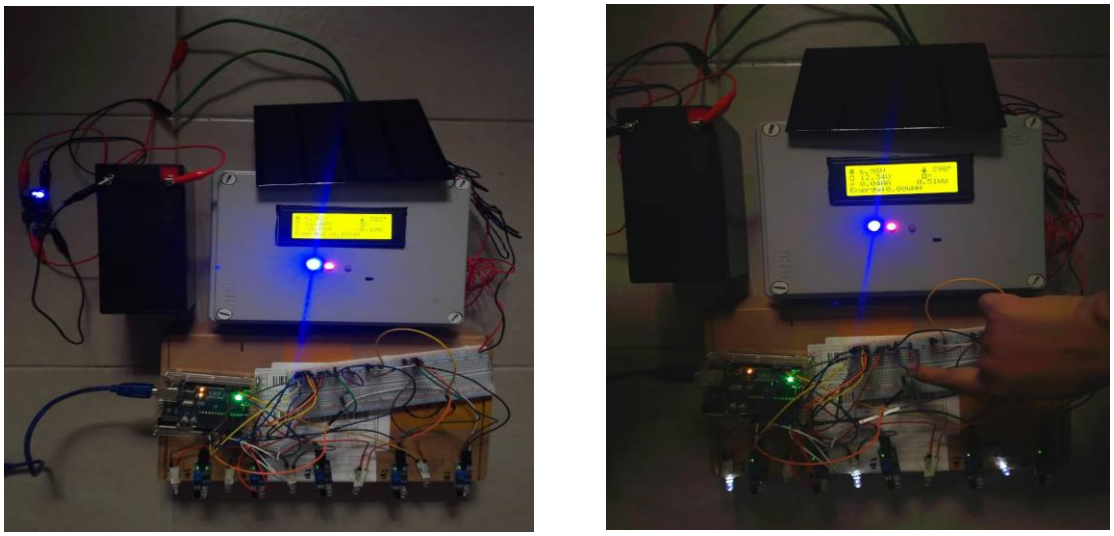

Figure 8: Displaying the reading on LCD

Based on the Figure 8, LCD display the reading of voltage, current, power, energy and temperature of solar panel and battery. Battery status in Table 2. for this solar panel will be evaluated based on led battery indicator. RGB led on the solar charge controller will show three condition of the battery which is healthy, full charge and low voltage. Load status in Table 3 for this solar panel will be evaluated based on load indicator.

Table 2: Battery status on led indicator

	Battery Status		
Condition	Red	Green	Blue
Battery voltage healthy	×	/	×
Battery voltage full charged	×	×	/
Battery voltage low	/	×	×

Table 3: Load status on led indicator

Condition	Load Status	
	Red	Green
Load connected	×	/
Load disconnected	/	×

3.1 Solar panel output reading

The performance of each system in solar street light is able to work and function as expected in Table 4. The controller of this system which is Arduino Uno able to perform well for each operation. Observation have been observing and the data have been collected for this system. Street light function as expected which is during the day time LED will switch OFF and only the midnight time LED will switch ON. The IR sensor function well by detect the vehicle that passing by on the road and LDR sensor also function as expected to indicate the present of light.

Table 4: Continuous outcomes using 12 V 3Watt solar panel

Time	Output	
	Output Voltage, V	Current, A
11:00 AM	7.12	0.23
11:30 AM	7.89	0.35
12:00 PM	8.54	0.38
12:30 PM	7.23	0.41
1:00 PM	9.34	0.33
1:30 PM	9.77	0.44
2:00 PM	10.51	0.44
2.30 PM	11.01	0.46
3:00 PM	11.69	0.50
3:30 PM	12.34	0.55

4. Conclusion

The objectives to design and develop solar street light had been achieve. This system is a cost effective, practical and safest way to save energy. Solar energy is a one of the important and major renewable sources of energy. It can solve the problems that worlds is facing today, saving energy and also disposal of incandescent lamps very efficiently.

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