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Automatic Smart Street Light

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Abstract : Automatic Smart Street Light using solar is an efficient way of lowering energy consumption since there are some street lights that do not work well where it is often observed that even after sunrise, the street lights are still ON and causing a major waste of electricity. The objective of this project is to develop a prototype of an Automatic Smart Street Light system using a light-emitting diode (LED) powered by solar energy. This project of Smart Street Light used solar panel to save the electricity consumption and work when there is precense of vehicles or pedestrians. It requires solar panel, rechargeable battery, Nodemcu Lolin Baseboard WIFI Development Board ESP 8266 Serial Port modem controller, relay module, LDR sensor and IR sensor. Each of this component will performing specific operations such as manage the street light system, also detect motion of vehicles or pedestrians and the power consumption analysis. This intelligent system shows that it is suitable for both urban or rural area that helps cost savings to be an energy saving era and give advantages in humanity.

Keywords: Automatic Smart Street Light System, Solar Street Light, Energy Saving

1. Introduction

Currently, in our country has been experiencing a crisis of resources for a long time. Street lights consume a lot of energy especially in urban areas. There are times where the streetlight is not turned ON and OFF in a suitable time. The streetlights are ON even during daytime and sometimes the streetlights will not be turned ON at night. This kind of situation directly will be increasing the street lighting cost. The use of street lights is not limited to urban areas only but also in the rural areas. This project focuses more on urban areas as it consume more energy and electricity than in the rural areas. Nowadays with the population growing and energy demand, renewable option has been taken as energy source. Providing street lighting is one of the most parts of infrastructure either in a urban or rural areas [1]. The electricity cost and power consumption of the street lights can be reduced by applying the energy efficient technologies and design mechanism. In managing the street light system, there are several control strategies and methods to ensure that it use less energy and low cost in terms of resources

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and use. The twenty-first century tries hard to conserve electrical energy [2]. Streetlights are important, but costly, so the system needs to be optimized in a way that is economical and conserves energy effectively [2].

Therefore, this project aims to develop an Automatic Smart Street Light system using LDR and Relay powered by solar that can work well and able to save lot of energy without wastage. This saved power can be used in some other cases especially in facing the increasing demand for power consumption in large urban areas. So this report showcases a new and innovative approach to effectively manage street light systems that can be used in all places whether urban or rural residential areas. The development of Automatic Smart Street Light system is studied during day time where there are some street lights still switched ON and there is a major waste of electricity. So, with this system, the street light will only turn ON when it detect movement of vehicles or pedestrians. The street light system is powered by solar which is one of an efficient way in lowering energy consumption and CO2 that will affect the environment by preserving road safety standards [3]. In addition, electric street lights absorbs 114 TW hours a year, resulting in 69 million tons of CO2 emissions [4]. The important element in this solar street light project is the use of variety of electrical and electronic components to ensure automatic, effective and efficient street light control. Two sensors, light-dependent resistor (LDR) sensor and infra-red (IR) sensor, have been selected for this project. The LDR sensor is a type of light sensor used to measure light intensity. Then the IR sensor is a combination of an infrared transmitter and a receiver being used to track the movement of vehicles moving through it.

The solar panel is the central feature used in this project. This is because sunlight is one of the major energy resources in Malaysia, 70 % of the year because of its hot weather [5]. Ultimately, solar panel have been used as a component to convert the solar energy to electrical energy without using any other electrical sources. Solar panel is a photovoltaic panel which designed to absorb the light from sun and then the electricity or heating will be produced. Photovoltaic panel also can be used for charging batteries. The amount of electricity of a solar panel can produced are depending on the size of solar panel, efficiency of the solar cells inside and the amount of sunlight the panel gets to absorb. In this project, Nodemcu Lolin Baseboard WIFI Development Board ESP 8266 Serial Port modem use as a controller to read input light on a sensor and then turn it into an output. The Nodemcu Lolin Baseboard WIFI Development Board ESP 8266 Serial Port modem will activate switch to turn on the LEDs, 4 channel 5 V relay module, LDR sensor and IR sensor. Then, using the Arduino IDE, the development of the programming software is required to control the whole process of the Nodemcu Lolin Baseboard WIFI Development Board ESP 8266 Serial Port modem. At the end of this project, this intelligent system was expexted to showcases a new and innovative approach that effectively can manage street light systems powered by solar that can be used in all places whether in urban or rual residential areas. And the street light was expected to reduce the electrical wastage and cost while operating the streetlight. As the system comes with a different situation, which is the street light will turn ON only if there is a vehicle passing through it, so the electrical wastage can be reduced.

2. Materials and Methods

There are several methods that need to be adopted to perform this task successfully. This Smart Street Lighting System is designed to detect user vehicles on the road at night or during rainy season where road users will experience blurred vision at that time.

2.1 Materials

Based on **Table 1**, there are several material and component that is required in developing the prototype of an Automatic Smart Street Light System.

Table 1: List of Materials and Component

NO	ITEM NAME	QUANTITY	DESCRIPTION
1	ESP8266 WIFI with CH340C NODEMCU-V3	1	Processing data
2	NODEMCU Baseboard	1	Baseboard for NODEMCU
3	ACS712 Current Sensor 20A	1	Read the current value
4	Infrared Obstacle Avoidance Sensor Module (IR)	2	Detect the object
5	Light Dependent Resistor (LDR)	1	Detect the light
6	LED (White)	10	Brightness
7	Resistor 220 Ω	10	Resistance for LED
8	Resistor 1k Ω	1	Resistance for LDR
9	Solar Panel	2	Absorb the energy
10	Solar Charger Controller	1	Process the voltage
11	Sealed Lead Acid Battery	1	Save the voltage

2.2 Methods

Based on the block diagram in **Figure 1**, it operates in accordance with the changing levels of sunlight. When there is sufficient sunlight in the area, the LDR provides a high resistance and operates as an insulator. However, when there is no sunlight, the LDR functions as a low resistance path that allows electric current to flow. This LDR is powered by IR sensors that are responded under low lighting conditions and are controlled via a NodeMCU microcontroller, all fundamental electrical circuits run at a regulated 5 VDC. When a vehicle or humans comes inside the radius of the infrared sensors, the IR LED produces radiation and reflects it to the infrared photodiode. As a result, a vehicle or humans is detected. In **Figure 2**, the current sensor is used to read the current value and the data will send to database which is in Google Sheet.

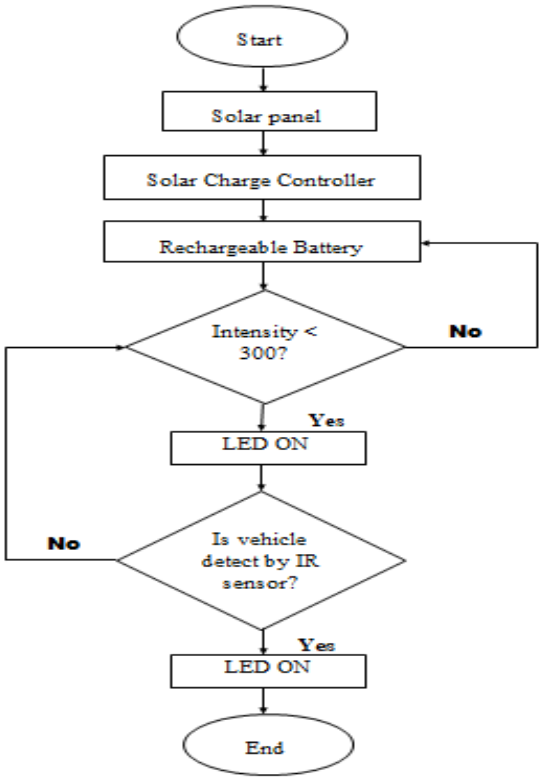


Figure 1: Automatic Smart Street Light Flowchart

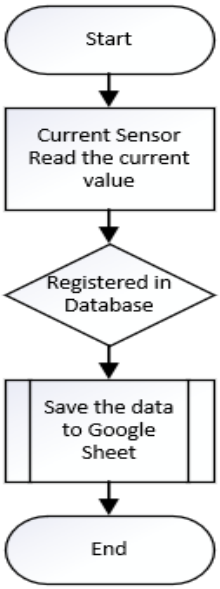


Figure 2 : Process FLow of the Data

3. Results and Discussion

3.1 Results

Table 2: Result Of Overall Prototype Condition

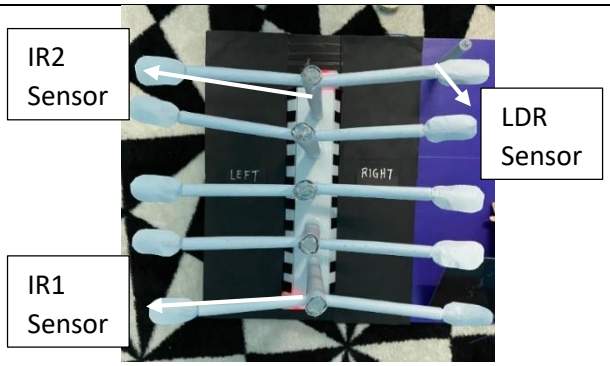
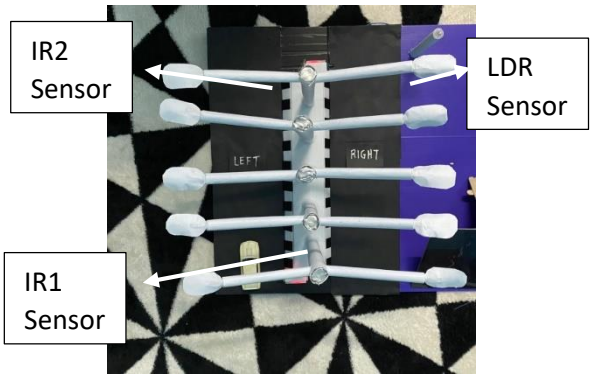
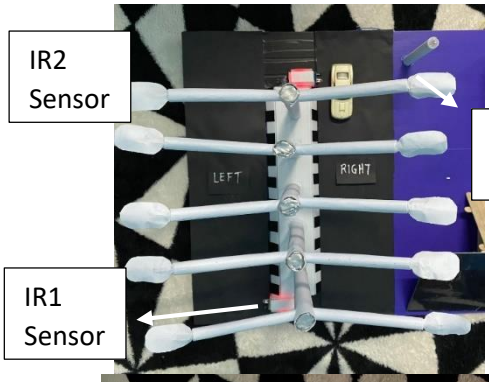
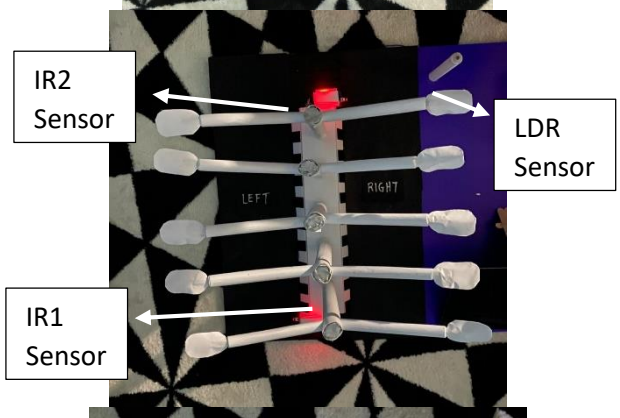
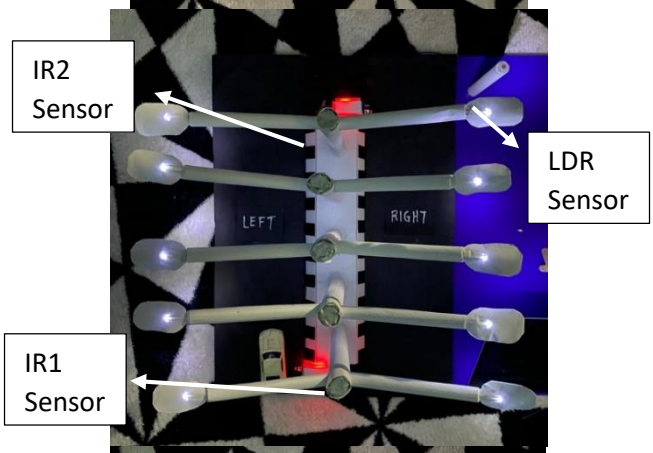
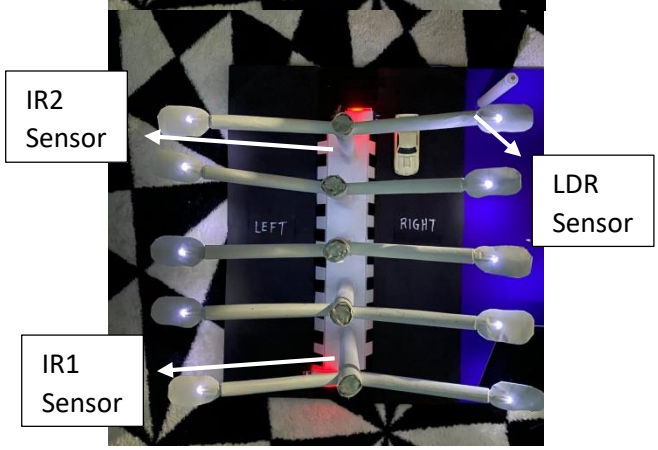
CONDITION	RESULTS
CONDITION 1 Light time and no precense of motion from vehicles or pedestrians at both IR1 and IR2 sensor.	
CONDITION 2 Light time and there is no precense of motion from vehicles or pedestrians at IR1 sensor.	

Table 2: Result Of Overall Prototype Condition (continue)

CONDITION 3 Light time and there is precense of motion from vehicles or pedestrians at IR2 sensor.	
CONDITION 4 Dark time and no precense of motion from vehicles or pedestrians at both IR1 and IR2 sensor.	
CONDITION 5 Dark time and there is precense of motion from vehicles or pedestrians at IR1 sensor.	
CONDITION 6 Dark time and there is precense of motion from vehicles or pedestrians at IR2 sensor.	

3.2 Discussions

Condition 1 until condition 3 shows when the LDR sensor detected light, whether IR1 or 1R2 sensor detects the movement of any vehicle, all LEDs remains turned OFF.

Condition 4 shows when the LDR sensor detected dark, and no presence of motion from vehicle. All LED remains turned OFF until the IR1 or 1R2 sensor detects the movement of any vehicle.

Condition 5 shows when the IR1 sensor detects the presence of motion from the vehicle at the left side of the road. In this stage, IR1 sensor ready to activate and all the LED at the right and left side of the road turns from OFF to ON. At this time all LED in the right and left side are in ON condition. All the LED start turns ON after any vehicle attaches to the IR1 sensor. After 10 seconds, all the LEDs will turn OFF.

Condition 6 shows when the IR2s sensor detects the presence of motion from the vehicle at the right side of the road. In this stage, IR2 sensor ready to activate and all the LEDs at the right and left side of the road turns from OFF to ON. At this time all LEDs in the right and left side are in ON condition. All the LED start turns ON after any vehicle attaches to the IR2 sensor. After 10 seconds, all the LEDs will turn OFF.

3.3 Current Results

Table 3: Current Value of Overall Prototype Condition

CONDITION	CURRENT VALUE
Light time and there is no precense of motion from vehicles or pedestrians.	15.05A
	15.05A
	15.05A
	15.05A
	15.05A
Light time and there is precense of motion from vehicles or pedestrians.	16.38A
	16.37A
	16.37A
	16.37A
	16.37A
Dark time and there is no precense of motion from vehicles or pedestrians.	15.46A
	16.93A
	15.88A
	15.67A
	15.31A
Dark time and there is precense of motion from vehicles or pedestrians.	17.14A
	16.93A
	17.30A
	16.90A
	18.22A

4. Conclusion

The development of this Automatic Smart Street Light using the Arduino IDE and Fritzing app has been successfully produced. The street light hardware had been completed using a Nodemcu Lolin Baseboard WIFI Development Board ESP 8266 Serial Port modem. Based on the development process, the first objective of this project was achieved which is to develop a prototype model of an Automatic

Smart Street Light system powered by solar energy using a Nodemcu Lolin Baseboard WIFI Development Board ESP 8266 Serial Port modem. The second objective is to study the energy savings between Automatic Smart Street Light systems and the ordinary street light systems in order to reduce waste and electricity costs while operating the street light. The software requirements for this project are investigate and characterize by implementing the usage of the Arduino IDE platform. The coding programming has been uploaded to the Nodemcu Lolin Baseboard WIFI Development Board ESP 8266 Serial Port modem.

The first recommendation is suggestion to improve the street light system are to expand the use of IR sensor with a suitable distance for the vehicle to pass through because the radius of the IR sensor module can be set. Secondly, design the conditions to set the LED to turn ON in dim or bright light whether in day or night. Also, the delay should be longer depending on the developed design. Thirdly, make an improvement on the battery technology to store electricity more efficiently to power the street light by doing some calculations before selecting the suitable rating of solar panel and battery. Next, place an IR sensor in each street light so that the LED will only light up when there is a car going through it and will turn off again when the car has passed away. Lastly, for the solar battery charging process, take the data for 24 hours until the time when the peak voltage is detected to know the time that the solar battery charging process can be done more quickly in a short time.

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