ES 116 – Principles and Application of Electrical Engineering

Dynamic Street Light Control System

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Abstract – The aim of this project is to design a street light control system which can dynamically adjust its brightness during night according to the real-time traffic conditions to save electricity. The system utilizes ultrasonic sensors to detect the coming vehicles from far and LEDs to replicate the streetlights. The procedure involved programing the Arduino to interact with the inputs from the sensors and give output accordingly.

I. Aim

To develop a street light system which can adjust its brightness dynamically according to the real-time traffic conditions.

II. Theory

A. Ultrasonic Sensors:

Ultrasonic sensing is based on the ultrasonic sound waves i.e. sound waves out of range of human hearing. The sensor sends ultrasonic waves which bounce back on hitting any obstacle and return to the sensor. The distance of the object from sensor is calculated from the time taken for wave to return. The ultrasonic sensor has four pins: VCC, TRIG Pin, ECHO Pin, GND. VCC is the positive voltage supply, GND is the ground. The trig pin receives voltage from Arduino to send an ultrasonic pulse of a few microseconds. The Echo Pin detects the time duration of returning of the pulse. The distance (in cm) is calculated as:

$$d = \frac{t * 0.034}{2}$$

Where d is the distance of the obstacle and t is elapsed between sending and receiving of the signals.

III. Instruments Required

The following instruments were used in developing the project:

- 3 Ultrasonic Sensor
- 2 Breadboards
- 1 Arduino Uno Board
- 6 LEDs
- 6 Straws
- 6 Resistors (1k ohm)
- Cardboard
- Paper
- Jumper wires
- Power Supply

Figure1: Ultrasonic Sensor

Figure2: Arduino Uno Board

IV. Circuit Discription

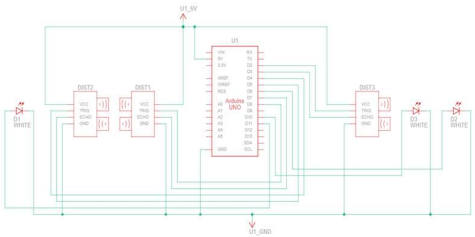

Figure 3: Circuit Diagram

We have used an Arduino board and two breadboards for making the connections. The circuit diagram can be shown in the figure above. We have made the two bus strips of the breadboard to +5V potential and Ground respectively by interconnecting them. Then, the VCC pins of all the ultrasonic sensors are connected to the bus strip of breadboard at +5V potential and the GND pins of the ultrasonic sensors are connected to the bus strip of breadboard at ground. The TRIG and ECHO pins of the ultrasonic sensors are connected at different terminal strips

of the breadboard and then connected to the Arduino via jumper wires. The TRIG pins are connected at the pins 8,4 and 2 of the Arduino UNO and ECHO pins are connected at the pins 7,5 and 3 of the Arduino. Similarly, all the negative pins of the LEDs are connected the grounded bus strip and the positive are connected to the Arduino via a 1kΩ resistor to the 9,10, and 11 PWM pins of the Arduino to give analog output.

V. Procedure

The lights in the normal state at night are dimmed. The ultrasonic sensors continuously monitors if any obstacle is approaching. The sensors are placed at an angle such that it can sense the far objects coming on the line of the road. So, when the first sensor detects the object, the first four lights change their state to brighten up and the last two still remain dimmed. As the vehicle crosses the first sensor, the first two lights are dimmed and the next two are brightened. Similarly, the other sensors also work in the same manner. When the object crosses all the sensors, a countdown (currently set at 5 seconds) is run to ensure proper clarity to the driver and then all lights are dimmed again.

VI. Results

The intended objectives of the project were largely met. The sensors were able to detect the objects from the distance only and could handle the lights appropriately so that there is enough visibility to the driver.

Fig. 4 Vehicle approaching from far

Fig. 5 Vehicle crossed sensor 1

Fig. 6 Vehicle crossed sensor 2

Fig. 7 Vehicle crossed the last sensor

VII. Discussion and conclusion

The ultrasonic sensors are highly sensitive, that even a small change in angle of the sensors, resulted in different values than expected. Therefore, we must assure that the sensors are fixed firmly. Moreover, the angles of the sensors have to be adjusted carefully so that they can properly sense the objects coming in the line of the road. There is still scope for a more robust design with integrating other sensor like piezoelectric and moreover, an additional feature of controlling the lights according to the sunlight can be added by adding a light-dependent resistor. Yet, this project is in itself capable of performing the functionalities committed. This project showed how intricate the sensors are how minimal error in their setup can cause a large effect on the results.

VIII. Refrences

[1] “What is Ultrasonic Sensor: Working Principles and Application”, [Online], Available: https://robocraze.com/blogs/post/what-is-ultrasonic-sensor [Accessed. Apr. 19 2024]

IX. Acknowledgements

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