Automatic Street Light Dimmer Circuit Using Arduino

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Abstract

We will be exploring the methodology of sensing the vehicle or human being without false detection which may occur due to animals and also the protocol for dimming light without wasting energy. Street lights help the vehicles to guide along the road, but during late night hours, most of the roads will be empty and still all the street lights illuminate till morning. Due to the illumination of street lights all night even when the road is empty, it is not worth to light the street lamps and the cost due to energy consumption directly affect the local government. To overcome this issue in smart way, we can reduce the brightness of the street lamps to desire level and only illuminate in full brightness when vehicles or human being pass by. This may help the government to reduce expenditure on power and also save lot of energy which could be used for other energy demanding purposes. The proposed idea to detect activity on the road, utilizes ultrasonic sensor which can measure the distance between the sensor and the obstacle, in this case the obstacles are vehicles or human beings. When a vehicle comes into the range of the sensor, it does some mathematical calculations to determine the distance between the vehicles and sensor, if the vehicle is confirmed to be below the pre-determined range; the on-board microcontroller will light the street lamp at maximum brightness. The street light will illuminate at maximum brightness for a pre-determined amount of time and reduce its brightness if no vehicles or human beings are detected further.

Keywords: *dimming light, street light, Arduino, illumination*

1. Introduction

The 21st century is striving hard to save electrical energy. Street lights are essential, but expensive, therefore there is need to optimize the system in a way that it is affordable and efficiently conserves energy. Manually controlling the street lights is a time taking and tedious process. Working in such manner could sometimes result in large disasters and destructions. The main problem that manual controls on the street lights face is that there would be a lot time taking during evening times when they are to be switched ON and a significant waste of energy is done at morning at all could not be turned OFF together at once. Another way in which the wastage is done is that at midnights lights glow at full intensity although there is not much traffic. Therefore, there is a need to come up with a system which overcomes the problems of existing systems. This could be done by using low power, robust and efficient components.

We will be exploring the methodology of sensing the vehicle or human being without false detection which may occur due to animals and also the protocol for dimming light without wasting energy. Street lights help the vehicles to guide along the road, but during late night hours, most of the roads will be empty and still all the street lights illuminate till morning.

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When a vehicle comes into the range of the sensor, it does some mathematical calculations to determine the distance between the vehicles and sensor, if the vehicle is confirmed to be below the pre-determined range; the on-board microcontroller will light the street lamp at maximum brightness.

The street light will illuminate at maximum brightness for a pre-determined amount of time and reduce its brightness if no vehicles or human beings are detected further. By now the objective of this project would have cleared. Let's dive into circuitry of the proposed setup.

2. Proposed system

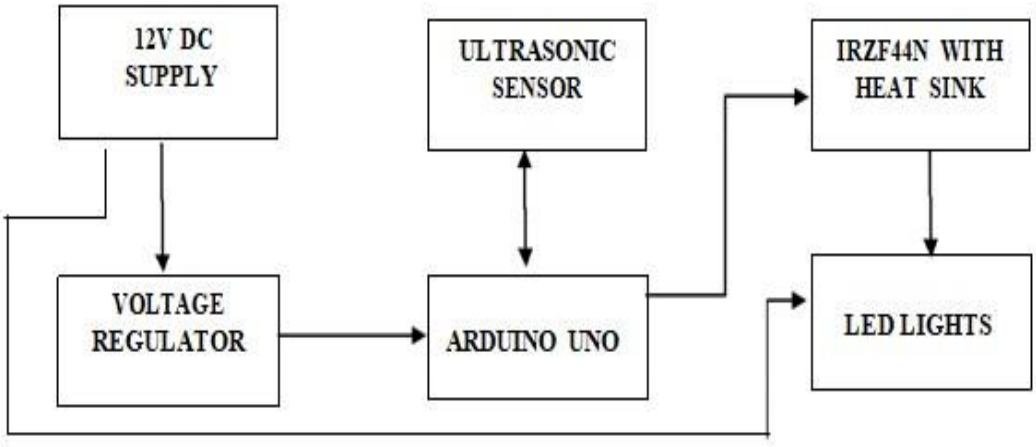

Fig 1 Block Diagram of Automatic Street Light Dimmer Circuit

In the proposed system the 12v of dc supply is given to the voltage regulator, the voltage regulator regulates up to 9v and it gives supply to the Arduino. Arduino gives the supply to the ultrasonic sensor and IRFZ44N MOSFET. The ultrasonic sensor detects the vehicles and sends the signals to the Arduino. Based on the signal given by Arduino the

MOSFET control the voltage and current flow between the source and the drain. The 12V DC supply is directly given to the LED modules

3. Harware implementation

3.1 Arduino Uno:

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 programmed as a USB-to-serial converter.

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

Revision 3 of the board has the following new features:

- 1.0pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, which is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.0

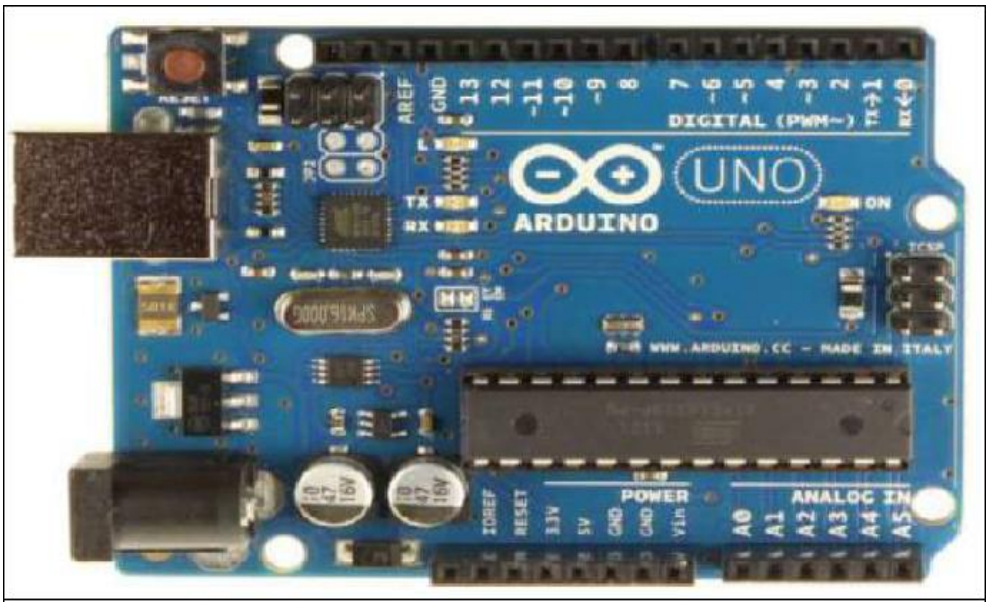

Fig. 2 Arduino uno board

3.2 Ultra Sonic Sensors:

Ultrasonic Ranging Module HC - SR04

Product features: Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The Basic principle of work:

- Using IO trigger for at least 10us high level signal.
- The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
- If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning. Test distance = (high level time×velocity of sound (340M/S) / 2.

Fig. 3 Ultrasonic Sensor

3.3 Timing Diagram:

The Timing diagram is shown below. You only need to supply a short 10uS pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion .You can calculate the range through the time interval between sending trigger signal and receiving echo signal. Formula: uS / 58 = centimeters or uS / 148 =inch; or: the range = high level time * velocity (340M/S) / 2; we suggest to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.

Attention: The module is not suggested to connect directly to electric, if connected electric, the GND terminal should be connected the module first, otherwise, it will affect the normal work of the module. When tested objects, the range of area is not less than 0.5 square meters and the plane requests as smooth as possible, otherwise ,it will affect the results of measuring.

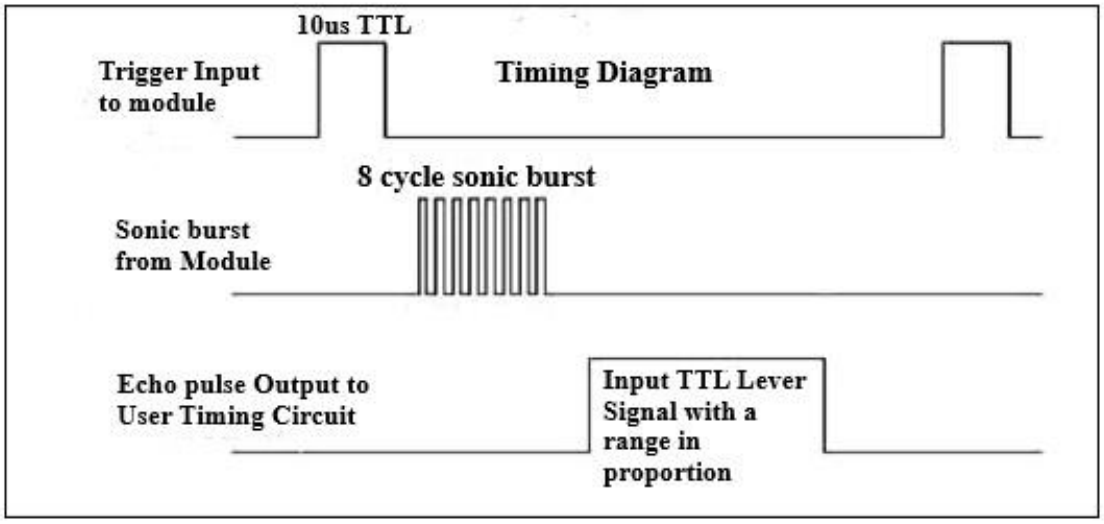

Fig. 4 Timing Diagram of Ultrasonic Sensor

4. Working and operation

The automatic street light dimmer circuit consists of Arduino which is the brain of the project, an ultrasonic sensor for detecting vehicles or human beings. A 9V regulator is provided for powering the arduino microcontroller board and a MOSFET for driving the LEDs which consumes few amperes at peak brightness.

The LED module and power supply for the setup must be selected carefully so that there will be adequate power available for the whole circuit and does not overload the power supply.

The LED module can be homemade one which is shown in schematic or may be purchased for market, but before constructing or getting one form market make sure to calculate the voltage and current requirements for the power supply.

The power supply may be an SMPS or constructed using transformer, rectifier and voltage regulator. The LED reduces its brightness by using PWM. The PWM is square wave; it turns on and off supply to LED rapidly with well determined on and off width in a single cycle.

The width of the on and off time determine the brightness of the LED. When the street light switches to full brightness the supply to LED will have no pulses and steady DC will be supplied.

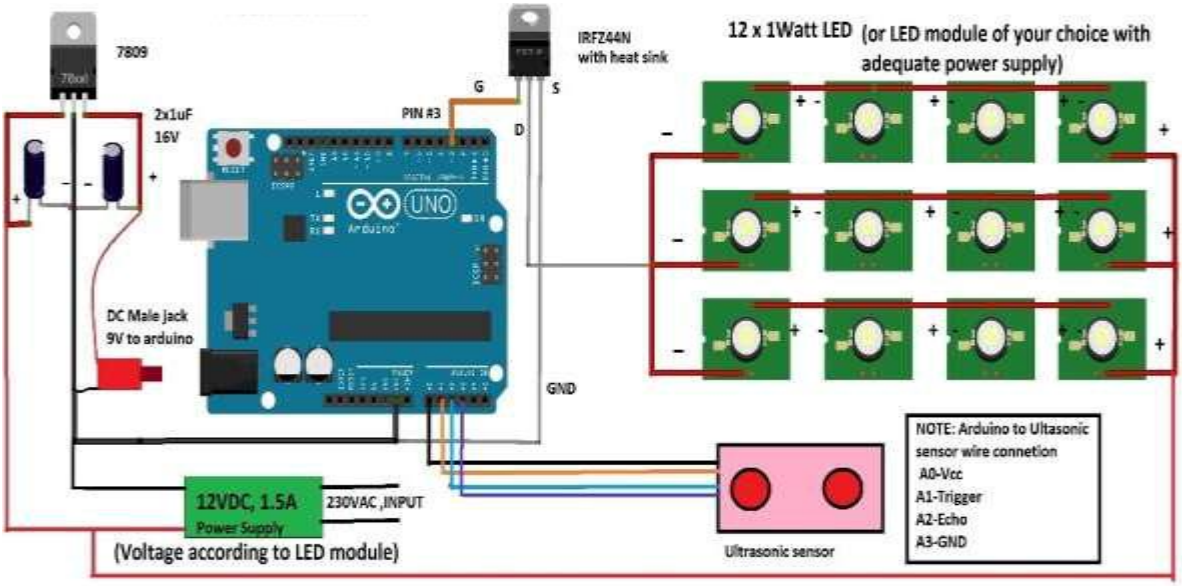

Fig. 5 Schematic Diagram of Automatic Street Light Dimmer Circuit Using Arduino

5. Results

The automatic street light dimmer circuit using arduino shown in the figure. During the initial conditions at the beginning the street lights are in bright position for 15seconds. And then after the lights are dimmer positions when there is no passage of vehicles on the road as shown in the figure 6.

When the vehicle passes, the ultrasonic sensor detects the vehicle then the lights glow in bright as shown in the figure. The ultrasonic sensor is elevated around 3.5ft to 4ft above the ground, this is done so that it only detects vehicles and human beings, since their average height is around the same and when dogs or cats or any other animals which usually roam around the city will not trigger the street light to maximum brightness. The animals which live and roam around the city are below 3.5ft tall. The sensor height may be adjusted to operate at optimum level as described in the pictures. The threshold distance can be controlled in the program. When the Arduino detects the obstacle detected below pre-determined distance the LED lights go peak brightness.

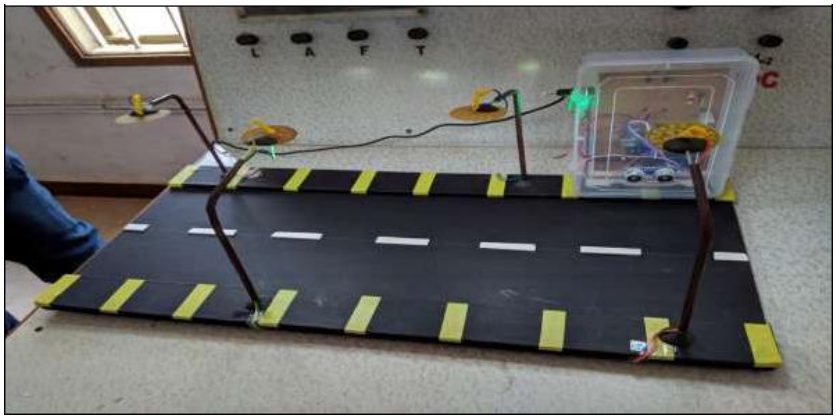

Fig. 6 Automatic Street Light Dimmer Circuit using Arduino when there is no vehicle or person on the Road & the Lights will glow lightly)

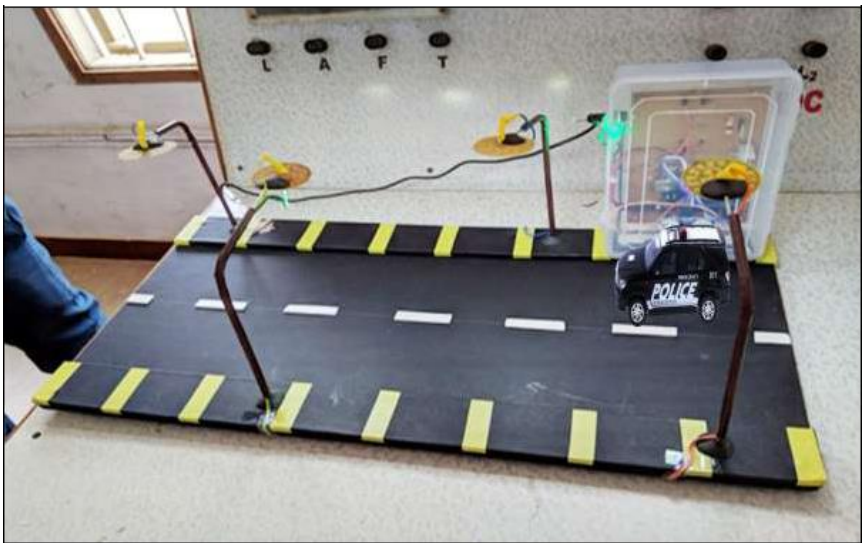

Fig.7 Prototype Model of Automatic Street Light Dimmer Circuit using Arduino when vehicles or person on the Road & the Lights will glow brightly

6. CONCLUSION

The proposed streetlight automation system is a cost effective and the safest way to reduce power consumption. It helps us to get rid of today's world problems of manual switching and most importantly, primary cost and maintenance can be decreased easily. The LED consumes less energy with cool-white light emission and has a better life than high energy consuming lamps. This presented work has more advantages which can overcome the present limitations. Keep in mind that these long-term benefits; the starting cost would never be a problem because the return time of investment is very less. This system can be easily implemented in street lights, smart cities.

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