



IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY



VOLUME : 7 ISSUE : 02 Print / Issue Publication Date: 05-Aug-2022



ISSN : 2455-2143



DOI : 10.33564/IJEAST.2022.v07i02.066

Indexed In



WWW.IJEAST.COM

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THE USE OF “SMART” TECHNOLOGIES IN THE ECONOMY OF ELECTRICITY

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Abstract: Smart Street light is an automated system which automates the street. The main aim of Smart Street light is to reduce the power consumption when there are no vehicle movements on the road. The Smart street light will glow with high intensity when there are vehicles on the road otherwise the lights will remain dim.

Keywords: Arduino, automation, energy, IR LED, IR sensor, LDR, photodiode, pin, Smart Street light, vehicle

I. INTRODUCTION

With advancement of technology, things are becoming simpler and easier for everyone in the world today. Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization, whereas mechanization provided human operators with machinery to assist the users with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Automation plays an increasingly important role in the world economy and in daily experience. Automatic systems are being preferred over manual system. The research work shows automatic control of streetlights as a result of which power is saved to an extent. The Smart street light provides a solution for energy saving which is achieved by sensing an approaching vehicle using the IR sensors and then switching ON a block of street lights ahead of the vehicle with high intensity. As the vehicle passes by, the trailing lights turn dim automatically. Thus, we save a lot of energy. So when there are no vehicles on the highway, then all the lights will remain dim.

Smart Street light is an automated system which automates the street. The main aim of Smart Street light is to reduce the power consumption when there are no vehicle movements on the road. Intelligent street lighting, also referred to as adaptive street lighting, dims when no activity is detected, but brightens when movement is detected. This type of lighting is different from traditional, stationary and illumination, or dimmable street lighting that dims at pre-determined times.

II. METHODOLOGY

2.1 Analysis of smart home lighting platforms

Arduino is an open-source, prototyping platform and its simplicity makes it ideal for hobbyists or novice to use as well as professionals. The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

The Arduino Uno R3 uses an ATmega16U2 instead of the 8U2 found on the Uno (or the FTDI found on previous generations). This allows for faster transfer rates and more memory. No drivers needed for Linux or Mac (in file for Windows is needed and included in the Arduino IDE), and the ability to have the Uno show up as a keyboard, mouse, joystick, etc. The Arduino Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 microcontroller chip programmed as a USB-to-serial converter.

The Uno R3 also adds SDA and SCL pins next to the AREF. In addition, there are two new pins placed near the RESET pin. One is the IOREF that allow the shields to adapt to the voltage provided from the board. The other is a not connected and is reserved for future purposes. The Uno R3 works with all existing shields but can adapt to new shields which use these additional pins.



Figure 1. Arduino Board

Features of the Arduino UNO:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-18V

- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by boot loader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

2.2 Features of smart lighting components

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion as well as the presence of an object due to intervention or interruption. These type of sensors measure only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.

2.3 Working mechanism

An IR sensor is basically a device which consists of a pair of an IR LED and a photodiode which are collectively called a photo-coupler or an opto-coupler. The IR LED emits IR radiation, reception and/or intensity of reception of which by the photodiode dictates the output of the sensor. Now, there are so many ways by which the radiation may or may not be able to reach the photodiode.

We may hold the IR LED directly in front of the photodiode, such that almost all the radiation emitted, reaches the photodiode. This creates an invisible line of IR radiation between the IR LED and the photodiode. Now, if an opaque object is placed obstructing this line, the radiation will not reach the photodiode and will get either reflected or absorbed by the obstructing object. This mechanism is used in object counters and burglar alarms.

Physics taught us that black color absorbs all radiation, and the color white reflects all radiation. We use this very knowledge to build our IR sensor. If we place the IR LED and the photodiode side by side, close together, the radiation from the IR LED will get emitted straight in the direction to which the IR LED is pointing towards, and so is the photodiode, and hence there will be no incidence of the radiation on the photodiode. Please refer to the right part of the illustration given below for better understanding. But, if we place an opaque object in front the two, two cases occur:

Reflective Surface. If the object is reflective, (White or some other light color), then most of the radiation will get reflected by it, and will get incident on the photodiode. For further understanding, please refer to the left part of the illustration below.

Non-reflective Surface. If the object is non-reflective, (Black or some other dark color), then most of the radiation will get absorbed by it, and will not become incident on the photodiode. It is similar to there being no surface (object) at all, for the sensor, as in both the cases, it does not receive any radiation.

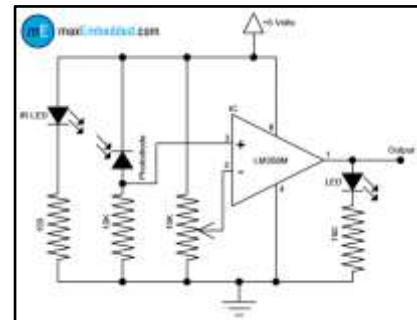


Figure 2. Circuit Diagram of IR Sensor



Figure 3. IR Sensor

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000000 ohms, but when they are illuminated with light resistance drops dramatically. Electronic onto sensors are the devices that alter their electrical characteristics, in the presences of visible or invisible light. The best-known devices of this type are the light dependent resistor (LDR), the photo diode and the phototransistors. Light dependent resistor as the name suggests depends on light for the variation of resistance. LDR are made by depositing a film of cadmium sulphide or cadmium selenide on a substrate of ceramic containing no or very few free electrons when not illuminated .The longer the strip the more the value of resistance. When light falls on the strip, the resistance decreases. In the absence of light the resistance can be in the order of 10K ohm to 15K ohm and is called the dark resistance. Depending on the exposure of light the resistance

can fall down to value of 500 ohms. The power ratings are usually smaller and are in the range 50mw to .5w. Though very sensitive to light, the switching time is very high and hence cannot be used for high frequency applications. They are used in chopper amplifiers. Light dependent resistors are available as discs 0.5cm to 2.5cm. The resistance rises to several Mega ohms under dark conditions.

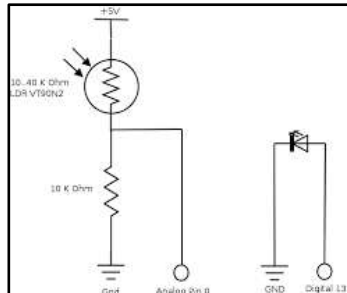


Figure 4. LDR Circuit



Figure 5. Light Dependant Resistor

A light-emitting diode (LED) is a two-lead semiconductor light source. It is p-n junction diode that emits light when activated. The long terminal is positive and the short terminal is negative. When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. LEDs are typically small (less than 1 mm²) and integrated optical components may be used to shape the radiation pattern.

LEDs produce a focused light source and extra care should be used for your eyes, though intensity is not very high. While testing the LEDs a resistance must be applied to it. Also, being a semiconductor device, they are sensitive to static charges.

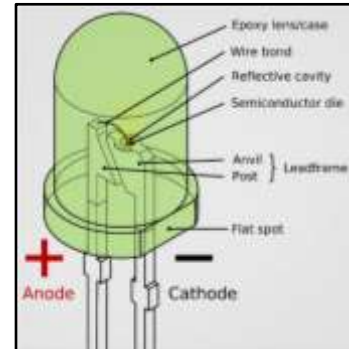


Figure 6. LED Structure



Figure 7. LED

III. RESULTS AND DISCUSSION

3.1 Connection of devices on arduino board and results

The construction of smart street lights is carried out in the following sequence (All studies were performed in a laboratory environment and the results were obtained):

- 1) Output of the LDR pin is connected to A0 (analog) port of Arduino Uno board.
- 2) Connect all output of the IR sensors to port numbers A1, A2, A3, A4 and A5 respectively (analog) which is the input signal to the Arduino board.
- 3) Connect the ground of all the IR sensors to GND port.
- 4) The output signals from LED are connected to port number 5, 6, 9, 10 and 11 respectively.
- 5) Again connect all the negative terminals of LED's to GND port.
- 6) Power is passed to the Arduino (7-12V).

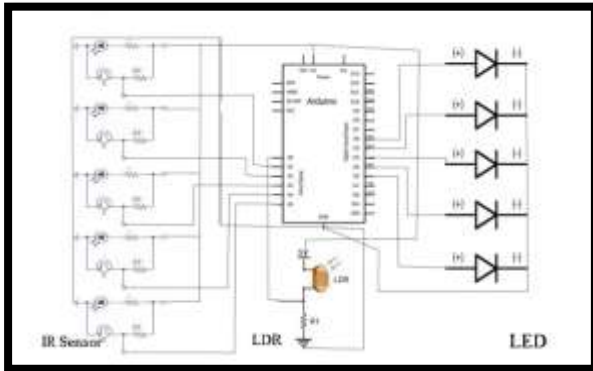


Figure 8. Circuit diagram for Smart street light using IR sensors



Figure 9. Initial Setup Phase 1

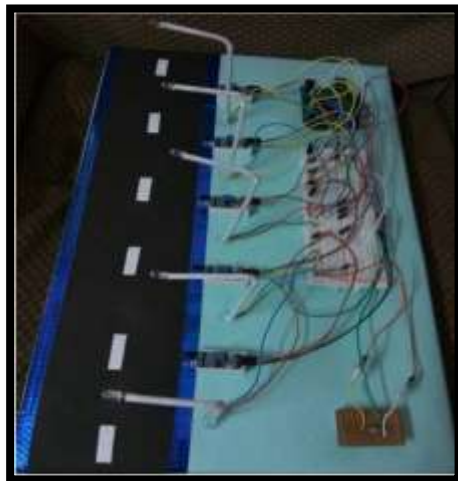


Figure 10. Initial Setup Phase 2

The Figure 9 depicts the initial setup of the hardware. All the components are in accordance to every other component. The five IR sensors are placed next to each other. The Arduino board is about to be mounted and connected to the external power supply for the flow of current. All the five

IR sensors are going to be connected to the Arduino board. All the wirings with the breadboard are installed. The Figure 10 depicts the second phase where all the LEDs are connected with the Arduino and Arduino is mounted. All the connections are completed, as soon as the 5V power supply is fed to the input Arduino, circuit will start to work perfectly.

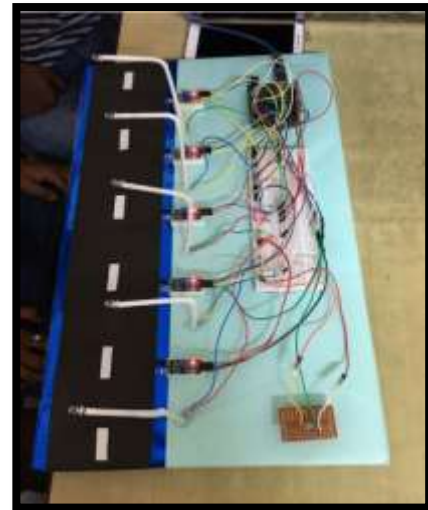


Figure 11. Operation Phase 1

The Figure 11 shows the initial operation when power is supplied to the Arduino at the natural lighting condition. Thus, LDR circuit detects light and LDR works as an insulator, does not allow the current to pass through the circuit. Hence, LEDs are remained turn off.

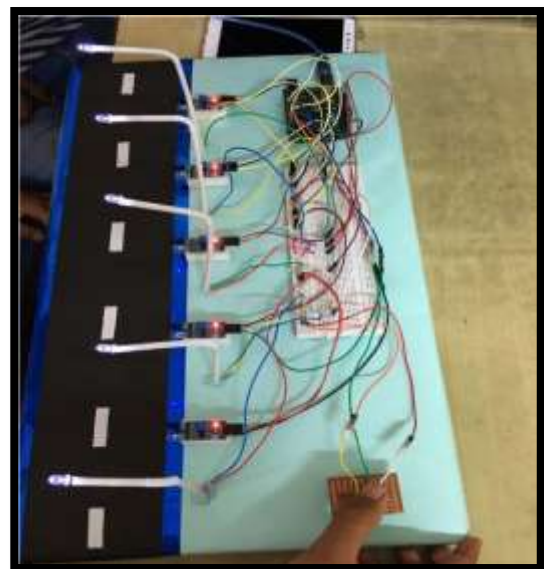


Figure 12. Operation Phase 2

In Figure 12, LDR is hidden by finger tip, to create natural dark condition. Due to no light, the resistance of LDR

becomes very low, allowing current to pass through the LDR circuit. Thus, LEDs glow dimly.

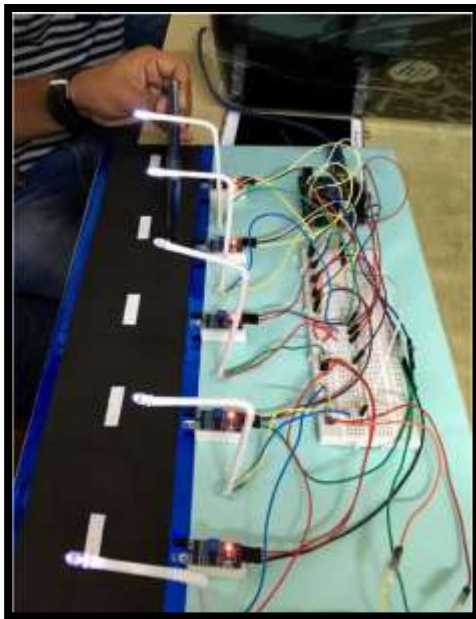


Figure 13. Operation Phase 3

Figure 13 depicts when any object is detected by the first sensor first two adjacent LEDs glow with its full intensity keeping rest of the LEDs lit dimly.

Figure 14 shows that fourth IR sensor detects the object and glows the corresponding LED and the successive LED with full intensity keeping rest of LEDs lit dimly.

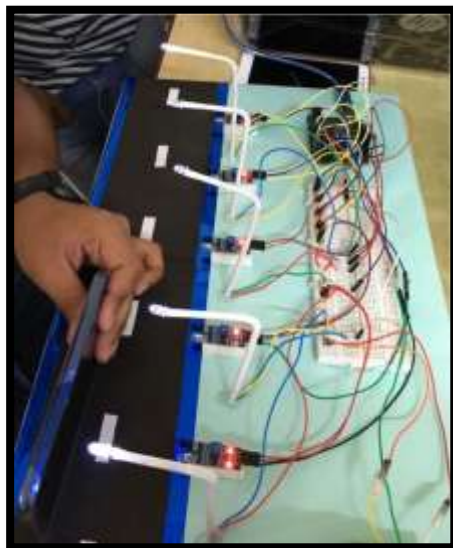


Figure 14. Operation Phase 4

IV. CONCLUSION

By using Smart Street light, one can save surplus amount of energy which is done by replacing sodium vapor lamps by

LED and adding an additional feature for security purposes. It prevents unnecessary wastage of electricity, caused due to manual switching of streetlights when it's not required. It provides an efficient and smart automatic streetlight control system with the help of IR sensors. It can reduce the energy consumption and maintains the cost. The system is versatile, extendable and totally adjustable to user needs.

- The system is now used only for One way traffic in highways.
- Continuous uses of LDR and IR sensors even in day time.
- Not switched on before the sunset.

The Smart light system can be further extended to make the current system in two-way traffic, making the system more flexible in case of rainy days and introduction of ways to control the lights through GSM based service.

The installed system has the following advantages:

- The street light control circuit can be used in normal roads, highways, express ways etc.
- The project can also be used in parking areas of malls, hotels, industrial lighting, etc.
- If the lighting system implements all LED lights, the cost of the maintenance can be reduced as the life span and durability of LEDs is higher than Neon based lights which are normally used as street lights.
- As the lights are automatically turned ON or OFF, huge amount of energy can be saved.
- This system less costly, less installation and maintenance cost and more efficient as compared to the others system.

However, the system is not without its disadvantages:

- This system can be used for only one way traffic. A highway might be covered by this system on dual system installation on both side.
- The system does not have any automatic fault detector.
- Pole damage detection with the addition of suitable sensor can be implemented.

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