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Automatic Street Light Controller by Using Arduino

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Abstract

This paper describes an advanced automatic street light control system this project is made to replace the conventional use of manual street lights with the energy saving automated street lights without interference from human in the system with utilization of LDR, PIR and a relay module the lightning may be controlled based on the favourable condition in environment automates the brightness of light as the light stay on only under low light conditions and is switched off during daylight the conventional street lights are substituted by automated street lights as they are no more efficient street lights. energy consumption is largely minimized The system employs a Passive Infrared (PIR) motion sensor and a Light Dependent Resistor (LDR) that is the dual sensors sensor to turn street lights automatically on or off depending on the presence of human beings and light levels in the environment. Arduino is employed to control the LEDs output and handle the dual sensors here relay module is also utilized which acts as a switch for the system. The automatic street light system can be implemented in various area like the smart cities in urban region also in industries like smoke detecting industry, park lighting. In urban and rural region street lights play a very crucial role to ensure the safety and security of each individual necessity leads to over use of the street lights the excessive usage of street light leads to wastage of energy the paper suggests automatic street light control system using the Arduino UNO and various other components like the LDR sensor, PIR sensor, a relay module and a 5V battery these will primarily work on the basis of the LDR and PIR sensors the light will be illuminated only in the dark and also when motion will be detected this will assist in reducing the excessive energy usage of the street lights when not needed the aim is to run project on low cost, less man power requirement and save energy.

Keywords: Arduino UNO, PIR sensor, LDR sensor, led, Relay module, resistors, energy efficiency, smart lightning, light control.

1. Introduction

Street lights are one of the basic necessity which creates slight illumination of light which helps vehicle reduce accidents and also improves survivals of pedestrians, and makes life better for every individual living in urban and rural areas of the country, but the necessity of street lights leads to over consumption of energy which needs to be saved for further future use of street lights apparently the saving of energy will lead to ecological conservation of resources initially when street light where initiated in urban areas in the year of 2001 it was dominated by high pressure sodium lamp (HPS) faced a lot of criticism due to unnecessary energy consumption and light pollution though it was widely used by people but huge consumption on the (HPS) was replaced by light emitting diode (led) the evolution from high pleasure sodium lamp to led technology has given a lots of benefits such as the ecological conservation by energy saving even after huge consumption, higher efficiency and greater longevity the programmes such as the LED street lightning national programme made by the government leads to the installation over 10.3 millions street light it helped not only for the energy conservation but also reduced the CO2 emissions further SLNP aims to install 13.6millions LED till march 2020 and also smart LEDs replaced by conventional street lights major goal is to reduce the electricity demand the next aim of India is to integrate internet of things (IoT) cost efficient streamline maintenance process, achieve cost saving and enhance the safety and security also referred in Md. Sazol Ahmmed [1]. usually we observe street lights remained switched on even after sunrise thus leads to lots of energy consumption so then we use light detecting resistor will act in the way that the light will be turned on/off and adjusted according light energy intensity in environment and in human being presence at the time In rapidly changing technologically advanced world, the role of automation in day-to-day life has turned surprisingly more essential, energy efficiency, and sustainability.

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Illumination systems, which are an integral part of residential, commercial, and industrial environments. This dual-sensor solution not only maximizes energy consumption but also improves user convenience through the removal of manual intervention. The LDR sensor, which responds to the level of ambient light, allows the system to sense when artificial lighting is required, while the PIR sensor detects human presence, ensuring lights are switched on only when the area is dark and occupied. With the rapidly changing technology times today, the use of automation in day-to-day life is becoming more common, with goals to improve convenience, power savings, and sustainability. Lighting systems are an essential component of residential, commercial, and industrial surroundings Traditional lighting systems rely on manual control, which might lead to wasted energy since lights remain on in UNO occupied spaces or even during the day. To describe these inefficiently, this project suggests an Automatic Light System with a combination of (LDR) and (PIR) sensor. We have already observed how both the dual sensors operate accordingly to facilitate approach for minimizing the manual intervention, and maximize optimal energy but in our project we have also utilized another significant device i.e. the relay modules which provide low power signal from the Arduino and collectively the application of both the dual sensors and the relay modules facilitates electrical wastage.

2. Literature Review

O. Urfaliglu et al [4]. the paper explains about the PIR (passive infrared sensor) and its operation the paper describes how the PIR sensor senses the human movement and adjusts its light accordingly in the respective environment and also gives brief about different type of movement that PIR sensor can categorize distinguishing different types of movement contributing the respective research.

Michael Mango [5]. The whole research focuses on the energy of solar powered street lights reports about the net positive energy consumed and balanced throughout the year its total concentration is towards the the consumption of power and takes the optimized decision about the electrical energy purchased and sold throughout the year This research explores the design of a solar-powered street lighting system for having a net positive energy balance throughout the year.

Deepak Kumar Rath [3]. Research paper explains in detail about applications and benefit that the automated street light system gives regardless of manual influence at a low cost and by effectively using the energy these project is highly useful in terms of today's world usage which also works towards keeping the environment safe the automation of also provides public safety.

3. System Components

An automatic street light control system contains Arduino, LED, LDR sensor, PIR (motion detector) sensor, resistors, breadboard, jumper wires, and 9v battery for external power and relay module as shown in Table 1.

Table 1: List of Components

Sr.no	Components	Specifications
1.	Arduino UNO	microcontroller controls dual sensor and relay module
2.	LDR sensor	DC 3-5V, 5mm
3.	PIR motion sensor	Voltage: 4.5V to Angle: 110
4.	Resistor	220ohm, 1kohm
5.	Led	5mm, operating voltage 5V
6.	Battery 9V	9V voltage
7.	Connecting wires	Jumper wires
8.	USB cable	Type – B
9.	Relay module	5v Relay

Arduino UNO

Arduino is microcontroller board which consists of an IDE (Integrated Development Environment) and the ATmega32 series controller employed for writing and uploading codes to the Arduino also referred in Gaurang Tandon [2]. It operates at an operating voltage of 5 volts and input voltage 7 to 20 volts. includes (USB) cable for the loading purpose and to draw power from a computer. The microcontroller includes 14 digital Inputs/Output pins, out of which 14 pins six pins are PWM output capable, six analog I/O pins from A0 to A5 shown in Figure 1, USB connection jack, 16 MHz ceramic resonators, 9v external power supply jack, and In-Circuit Serial Programmer (ICSP) header. The Arduino receives the input from the dual sensor which are PIR and LDR then provides output to LED.

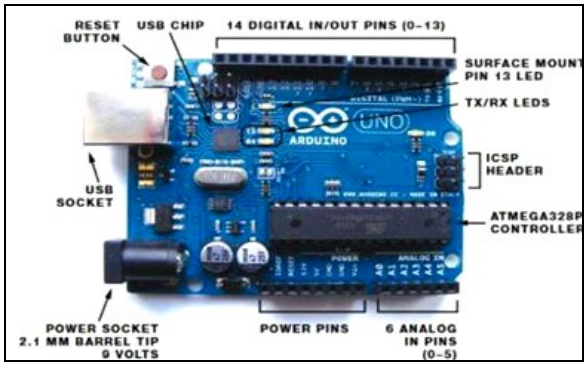


Fig 1: Arduino UNO

PIR Sensor

PIR sensor is also referred as Passive Infrared sensor it is a motion sensor that checks the motion of human or animal. PIR is an open source hardware as shown in Figure 2 utilized in numerous projects. PIR sensor is also utilized to check for different kinds of movements it collects infrared radiation from human or an animal body and thereby helps in switching light ON/OFF if the human being is within the range of light the it will set LED HIGH and if human being is outside its range then LED is in LOW.

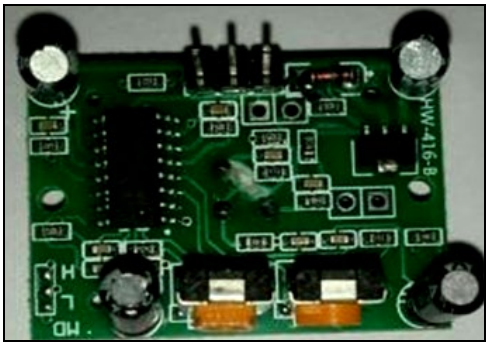


Fig 2: Passive Infrared Sensor Relay module:

Relay modules as shown in figure 3 are interface devices that facilitate the exchange of signals and information between various devices or systems relay module is bridge between low powered devices such as Arduino and Raspberry Pi and high powered devices such as motors to control them.

Fig 3: Relay Module LDR sensor:

LDRs referred to as photoresistors, LDR is a light sensing devices which is inversely proportional to the intensity of light falling on it. As resistance is high if the intensity of light is low as shown in figure 4.

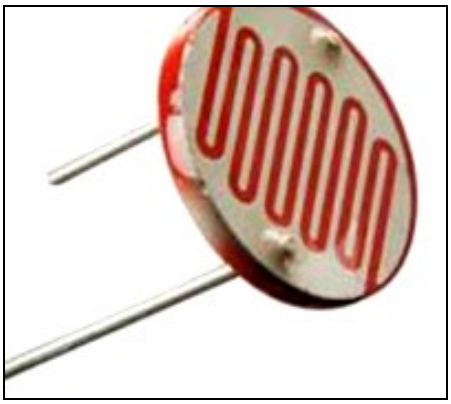


Fig 4: Light Dependent Resistor Cost analysis:

In our paper we will be studying the cost of electricity and the consumption of power based on Indian parameters, i.e., reasonable assumptions, calculations and achievable savings for example let's assume a small town with 1, 000 street lights with 220W led lights, average running time taken is as 12 hours per day, rate of electricity with 5.43 rupees per Kilo Watt hour which is the average commercial rate of India and finally the number of days are considered as 60 days.

Unit = P*T/1000 60*12/1000 0.72 Unit per day per lamp

Average price of electricity per unit in India is 5.43 rupees than the entire cost per month is computed as *5.43*30 equals to 117.28 rupees per month per light.
The total amount for light in 1 kilometer is 117.28*100 finally the total amount for all 1, 000 street light over one Kilometers is 11728 rupees.by employing the dual sensors the street lights will be turned ON/OFF based on the luminous energy and by motion detection it saves a lot of electricity, minimizes electricity bill and is environmentally friendly.

4. Methodology

In automatic street light control system PIR and LDR sensors are employed for controlling light according to ambient light conditions and movement detection the dual nature of sensor assists in energy efficiency and ensuring when light is turned on especially in locations where manual control of lightning is impractical or inefficient. which are operated on Arduino (microcontroller) by connecting on breadboard by uploading code in Arduino with the help of Arduino ide and then connect it with USB cable or here power supply can be used instead of USB cable for operating and a relay module work as switch used to on and off light lastly a battery is used for backup power consumption by connecting all the components in a suitable way the led or the bulb will be turn according to the functionality of sensors. Here, in this project block diagram, we can take PIR and LDR motion sensor as inputs and lead or street light as output of the project. The sensor may receive data from the external world and provide it to the microcontroller here we used Arduino UNO as a microcontroller. The microcontroller moves the data which are received from the sensor and act according to the input data as shown in figure 5. Arduino UNO can control light and sensor. A Light Dependent Resistor, is a resistor whose resistance is reduced with increasing light. When light hits the LDR, within the LDR, the resistance is altered. When in low light or darkness, the sensor's resistance is higher, and when in bright light, the resistance is lower. The resistance of the Light Dependent Resistor varies greatly with different light intensities.

Block Diagram

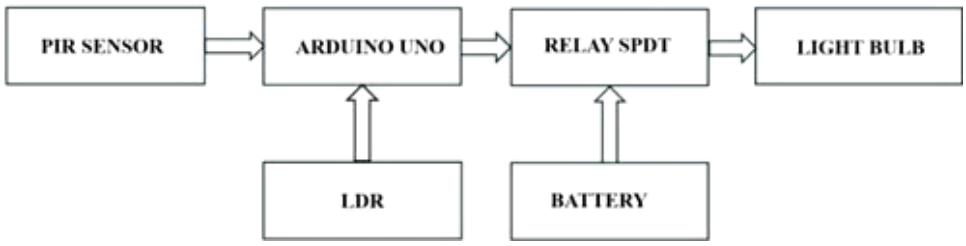


Fig 5: Procedure

Components and Their Connections

Table 2: explanation of components and their connections Code:

Components	Connections with Arduino
LDR Sensor	A0, other leg to GND (with a resistor to GND)
1KΩ Resistor	Connects LDR to GND
Relay module	VCC to 5V, GND to GND, IN to Digital Pin7
PIR sensor	VCC to 5V, GND to GND, OUT to Digital Pin 3
Led	Connected to relay's NO (Normally Open) & COM (Common) terminals
9V Battery	Positive to Vin (Arduino), negative to GND

Code:

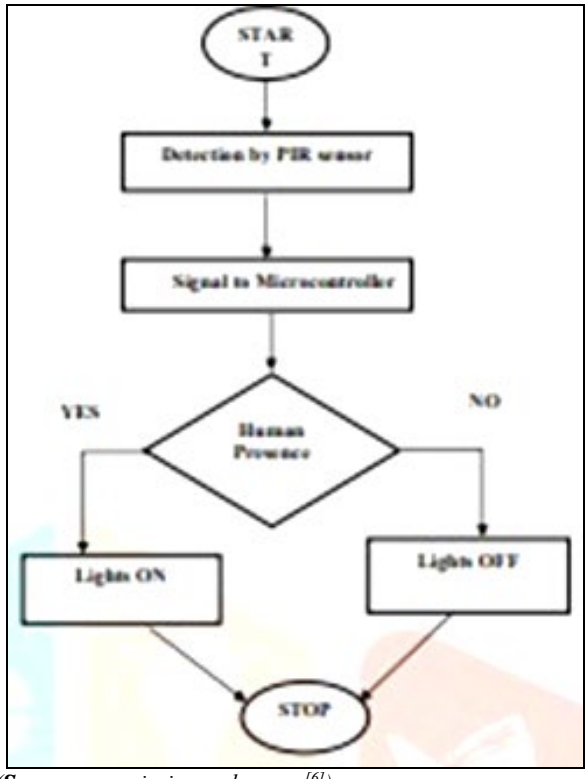
This code reads the LDR (light dependant resistor) and PIR sensor (motion sensor) to switch on/off the street light.

How it Works

- Darkness is detected by LDR → System gets activated.
- Motion is detected by the PIR sensor → Light switches ON.
- Motion is absent for a period of time → Light switches OFF.
- Daytime → Light stays OFF irrespective of motion..

Object Detection

- PIR sensor working processor where the process is first initiated as shown in figure 6. Then if anyone comes in front of the PIR sensor, it detects the individual and transmits the value of PIR sensor to the microcontroller and the microcontroller activates the light and if the individual does not display the light is OFF, Lastly the process is terminated.



*(**Source:** www.irejournals.com. [6])*

Fig 6: Flow chart explaining working of PIR sensor

Light Detection

In these LDR flow chart as shown in Figure 7 first, the process is LDR sensor detects the light and the information is passed on to the microcontroller if the intensity of light matches with the value given to the microcontroller then the lights turn ON, if the LDR sensor value doesn't match with the intensity of light then the lights turn OFF then finally, the process is terminated..

*(**Source:** www.irejournals.com.[6])*

Fig 7: Flow chart explaining working of LDR sensor

5. Results and Discussions

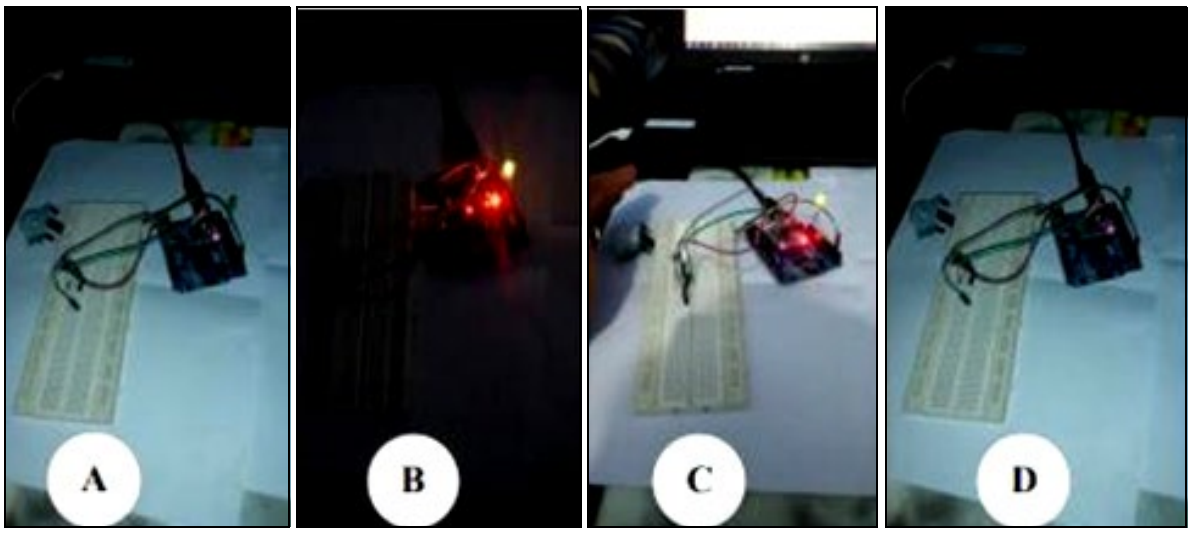


Fig 8: Hardware of the Results

Figure 8: (A). At first, PIR value is low because of no motion is detected and the LDR value is high even though the LED is OFF. (B).LED is on because LDR value is lower than the set value. (C).LED is ON because of motion is detected by PIR sensor. (D). LED is OFF because no motion is detected.

Table for Interpretation of Results

Table 3: Interpretation of Result

Sr.no	Components	Input Data	Result	Remarks
1.	Microcontroller Testing	Digital signal	LED ON/OFF on dual sensors	Component is correct
2.	LDR Sensors	Outside environment intensity Values	HIGH/LOW LED According to light intensity.	Components work accurately
3.	PIR Sensors	Object detection such as humans	LED is high when it detects motion	Object detection is accurate

6. Future Scope

The suggested automated system control focuses especially on the dual sensors LDR and PIR which controls the led operation while the relay module concentrates on regulating the AC since the system was only able to regulate 5mm led in the future the automated system may significantly contribute for the solar based system and can also regulate 5 watt relay module this system is also capable of being interfaced with Bluetooth module for its operation using smartphones..

7. Conclusion

In this automated street light system, we can attempt to minimize manual operation to OFF and ON switches. The system itself identifies if there is any need of light or not. It detects the darkness in the environment and sense if person is there or not. The system is not only budget friendly but also saves tons of electricity. It assists us to eliminate the world issues of manual switching today. Most importantly, the basic cost and maintenance cost can be reduced with ease. It decreases unnecessary usage of electricity. It offers a

cost-effective and intelligent automatic streetlight control system with the aid of PIR and LDR sensors. It is able to reduce energy usage and keeps the cost. It is highly flexible, expandable, and user adjustable. We do not need to switch on and off these road lights manually since they switch on and off by themselves based on the intensity of the surrounding's light. The primary aim of this project is to avoid unnecessary loss of electricity during the day and in the absence of any individual reduces unnecessary use of electricity

8. Acknowledgment

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