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Arduino Based Smart Lighting

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Abstract: The use of Light Dependent Resistors (LDRs) for smart lighting systems has gained considerable attention due to their low cost and eases of implementation. LDRs can be used to sense the ambient light levels and adjust the brightness of the lighting system accordingly, resulting in energy savings and improved user comfort. In this paper, we will talk about the working principles of LDR and discuss some of its application in providing solutions for smart lighting systems. We discuss various applications of LDRs in smart lighting systems and the advantages they offer. We also highlight some of the challenges associated with LDR-based smart lighting systems, such as their sensitivity to changes in the ambient environment and the need for calibration. Finally, we conclude with some recommendations for the implementation of LDR-based smart lighting systems, including the use of advanced algorithms and techniques for data processing and calibration.

Keywords: Light Dependent Resistor, Arduino, Light Emitting diode, Smart Lighting, Sensor

I. INTRODUCTION

In today's world where people are very busy with their daily schedules, automation is a prevalent trend, from household appliances like coffee machines to window shades. Automation has made everything more efficient and has become the hallmark of next-generation technology. However, lighting systems have yet to catch up to this trend. In Kolkata, India, where I live I have seen that the street lights are not automated a fellow man of the area, does the job of switching on the lights one by one, and as current flows through the lights all day long fossil fuels and energy gets wasted for no reason. So this project aims to implement an auto-intensity control of LED lights based on Light Dependent Resistors (LDRs) that are interfaced with an Arduino board. This system will switch on the lights during dusk and gradually increase the light intensity until midnight. Then, the intensity will decrease until dawn, and the lights will turn off automatically. This process will repeat daily, saving energy and reducing costs. This system can be applied in many areas such as park lights, street lights, headlights in automobiles, and more. To provide isolation between the Arduino and 220-volt AC supply, a relay is used. The primary objective of this project is to reduce energy consumption and associated costs, making it a cost-effective and sustainable solution. In conclusion, the proposed system uses LDRs and an Arduino board to implement an automated lighting system that saves energy and reduces costs. This technology has significant potential in various areas and can contribute to building a more sustainable future.

II. MATERIALS

Light Dependent Resistor: Light-Dependent Resistors (LDRs) are electronic components that change their resistance according to the light they receive. The materials used for LDRs are usually semiconductors made from a combination of elements such as cadmium sulfide (CdS), lead sulfide (PbS), and indium antimonide (InSb). These materials are chosen because they exhibit photoconductivity, which means their conductivity changes when exposed to light. When light falls on the LDR, the material's resistance decreases, and when there is no light, the resistance increases (Fig.1).

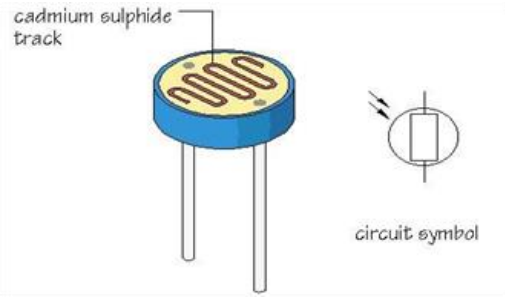

Fig. 1 LDR

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Arduino is a device that is widely used in electronics projects. It is designed to use a programming language and a range of input and output pins that can be used to connect to various sensors and devices. Arduino boards are made using a variety of materials, including printed circuit boards (PCBs), microcontrollers, and other electronic components (Fig.2).

Fig. 2 Arduino

Light Emitting Diode: LED (light-emitting diode) lights are a type of energy-efficient lighting technology that produces light by passing an electrical current through a semiconductor material. They consume significantly less energy than traditional incandescent bulbs and have a longer lifespan. LED lights come in various shapes and sizes and are commonly used for general lighting, as well as in electronic devices such as TVs, smartphones, and computer monitors. Another advantage of LED lights is their longer lifespan. LED lights can last up to 50,000 hours, which is significantly longer than traditional incandescent bulbs, which typically last only 1,000 hours. This makes LED lights a more cost-effective option in the long run, as they need to be replaced less frequently. In addition to their energy efficiency and longer lifespan, LED lights also offer several other benefits. They are highly durable and can withstand shock, vibration, and extreme temperatures, making them ideal for use in harsh environments. LED lights also emit less heat than traditional bulbs, making them safer to use and reducing the risk of fire. In conclusion, LED lights are a revolutionary lighting technology that offers numerous advantages over traditional incandescent bulbs (Fig.3).

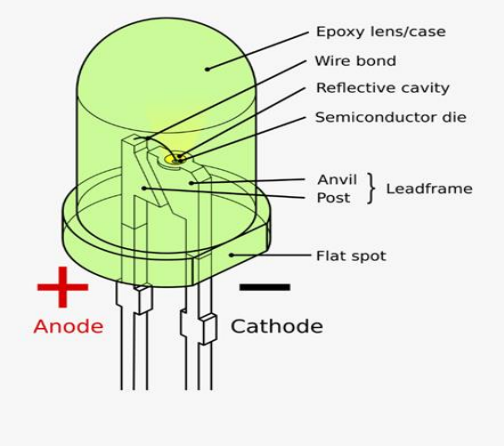

Fig. 3 LED

IR Sensor: An infrared (IR) sensor is a sophisticated device designed to detect the presence of infrared radiation. This technology works by detecting the radiation emitted by an object when it obstructs the path of the infrared beam. The sensor then sends a signal to a processing unit, which interprets the data and makes a decision based on the information received. IR sensors are widely used in various applications, ranging from remote controls and temperature sensors to smart lighting systems. Due to their exceptional performance characteristics, these sensors are highly valued in the industry.

Their low power consumption, high sensitivity, and rapid response times make them valuable components in many settings.One of the most common uses of IR sensors is in remote controls, where they are used to transmit signals from a remote-control unit to an electronic device. The sensor detects the infrared signals emitted by the remote control, allowing users to operate their electronic devices from a distance. Smart lighting systems also rely on IR sensors to detect the presence of people in a room. When someone enters a room, the sensor detects their presence and activates the lights. This feature helps to save energy by only lighting up a room when it is occupied (Fig.4).

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Fig. 4 IR Sensor

III. DISCUSSIONS

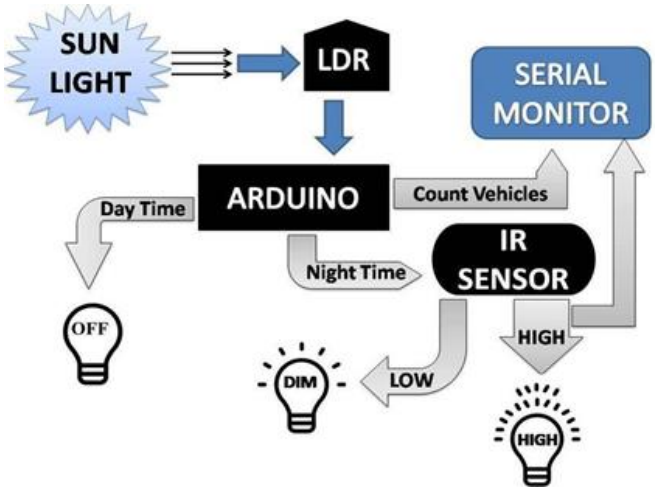

Fig. 5 Proposed System (sketch)

Working Principle

Sensing Light: A Light Dependent Resistor (LDR) is a sensor that changes its resistance in response to the intensity of light that falls upon it. When placed in a room or area where light needs to be controlled, the LDR detects the ambient light in the room and its resistance changes accordingly. In low light conditions, the resistance of the LDR is high, and it decreases as the intensity of light increases. The mechanism behind this is the semiconductive material used to make LDRs, which contains impurities. When photons of light fall on the LDR, they excite the electrons in the material, causing them to move from the valence band to the conduction band, resulting in a decrease in resistance. Conversely, when there is little or no light falling on the LDR, there are fewer photons to excite the electrons, and the resistance of the LDR increases. The change in resistance of the LDR can be measured using a simple circuit, and the output can be used to control the light in the room. For example, a decrease in resistance can be used to turn on lights or increase their brightness, while an increase in resistance can turn off lights or decrease their brightness [1,2].

Reading LDR Signal: An LDR is typically connected to an analog input pin on an Arduino board. These pins can read analog signals from sensors, including LDRs. Analog signals are continuous signals that can take on any value within a specific range, while digital signals can only take on two values: 0 or 1. To convert the analog signal from the LDR into a digital signal that the Arduino board can process, an inbuilt Analog Digital Converter (ADC) is used. The ADC samples the analog signal from the LDR at a specific frequency and assigns a digital value to the call based on its voltage level. The resolution of the ADC determines the number of digital values that can be assigned to the analog signal. For example, a 10-bit resolution ADC can give 1024 digital values to the analog signal, ranging from 0 to 1023. Once the ADC converts the analog signal into a digital signal, the value is stored in the memory of the Arduino board. With the converted digital signal, the Arduino board will control other components such as LEDs, or other output devices based on the changes in the ambient light level detected by the LDR. This allows the Arduino board to respond to changes in the light level and adjust the output devices accordingly.

Determining Threshold: The threshold value is a pre-determined value that represents a specific level of light intensity in the room. This value is set by the programmer and can be adjusted based on the desired level of light in the room. When the light intensity in

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the room reaches this threshold value, the Arduino board will trigger a signal to turn the light on or off. To implement this functionality, the Arduino board would typically be connected to a light sensor such as a photoresistor or LDR (light-dependent resistor). The light sensor detects the amount of light in the room and sends this information to the Arduino board. The Arduino board then compares this value to the pre-set threshold value. If the light intensity is above the threshold value, the Arduino board will turn the light off. If the light intensity is below the threshold value, the Arduino board will turn the light on.The threshold value can be adjusted based on the user's preference. For example, if the user wants more light in the room, they can set a higher threshold value. If the user wants less light in the room, they can set a lower threshold value.In conclusion, the threshold value programmed into the Arduino board is an important factor in controlling lights based on the level of light in a room. By adjusting this value, users can achieve their desired level of lighting in the room.

Lighting Control: When the analog signal from the LDR falls below the threshold value, the Arduino board sends a signal to turn the light on. Similarly, when the analog signal from the LDR rises above the threshold value, the Arduino board sends a signal to turn the light off. The light sensor (LDR) is connected to an analog input pin on the Arduino board. The analog input pin reads the voltage level from the LDR, which varies depending on the amount of light in the room. The analog input pin on the Arduino board converts the voltage level from the LDR into a digital value that can be processed by the microcontroller. The digital value from the analog input pin is compared to the threshold value programmed into the Arduino board. If the digital value is below the threshold value, it means that the light level in the room is too low, and the Arduino board sends a signal to turn the light on. If the digital value from the analog input pin is above the threshold value, it means that the light level in the room is sufficient, and the Arduino board sends a signal to turn the light off. The signal sent by the Arduino board is typically a digital output signal that can be used to control a relay, transistor, or other switching device that controls the power supply to the light. Once the light is turned on or off, the process repeats, with the analog input pin continuously reading the voltage level from the LDR and comparing it to the threshold value to determine whether to turn the light on or off.

Programming Options: Additional programming can be done to add more features to the smart light system. In addition to the basic functionality, we can add more features to the system, such as scheduling, remote control, and integration with other smart home devices. A timer can be added to the Arduino code to turn the light off after a specific amount of time has elapsed. This is useful for situations where you may forget to turn off the light, such as when leaving the room in a hurry. The Arduino board can be integrated with other smart home devices, such as a voice assistant or smart thermostat. This allows you to control the light using voice commands or to set up automation rules, such as turning the light off when you leave the house. A motion sensor can be added to the Arduino board to detect movement in the room. This allows the light to be turned on automatically when someone enters the room and turned off when they leave. This is particularly useful for areas that are frequently used, such as a hallway or bathroom. Instead of just turning the light on or off, the Arduino board can be programmed to adjust the light intensity based on the level of ambient light in the room. This is useful for situations where you want to set a specific mood or create a more relaxing atmosphere. The Arduino board can be connected to a WiFi or Bluetooth module, which allows you to remotely control the light from your smartphone or another device (Fig.5, Fig.6).

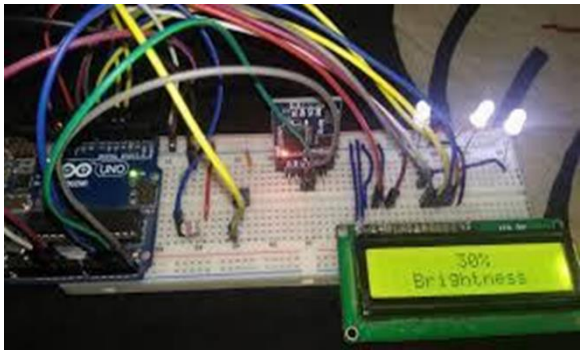

Fig. 6 Proposed System

IV. CURRENT REVIEWS

Many users find that LDRs are easy to use with Arduino boards, as the sensors can be quickly connected to the analog input pins and can provide data in a matter of seconds. The simplicity of the Arduino platform also makes it easy to program the board to respond to changes in light intensity.

In another paper LDRs are generally considered to be accurate sensors for measuring light intensity, although the accuracy can be affected by factors such as the quality of the LDR, the calibration of the sensor, and the environmental conditions. In general, however, users find that LDRs provide reliable and consistent data.

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According to another paper LDRs can be used in a wide range of applications, from simple light detectors to more complex systems that use the sensors to control other devices. This flexibility makes LDRs a popular choice for Arduino projects, as they can be adapted to suit a variety of needs.

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V. INDIAN SCENARIO

In India, there are street lights almost everywhere whether it is highways or just pedestrian streets, or cycling lanes. But they waste a large amount of energy every day as most street lights are not automated and it requires people to turn on all the lights manually one by one or just turn on one light that is connected to the others and this way others also light up. So the lights get turned on at a certain time in the evening and then stay on for the rest of the night till morning and then they get turned off. But in this process, a large amount of electricity is wasted as we don't need the same amount of light intensity at the time of dusk and night or dawn. So if we use LDRs with an Arduino and implement them into street lights they will automatically detect the natural light levels and get turned on when needed and also automatically adjust their intensity at the time of dusk to night to dawn by detecting the amount of natural light by LDR. Then signal coming from LDR goes to Arduino it checks if the natural light intensity is less than a certain amount it increases the intensity of the street lights and if the natural light intensity is higher than a certain amount then it decreases the intensity of the street light. Using that method we can save a large amount of energy that is being wasted every day [3, 4, 5].

VI. CONCLUSIONS

This system is a promising technology that can provide an efficient and reliable lighting control mechanism for both residential and commercial applications. The system operates by sensing the ambient light intensity using the LDR and automatically adjusting the lighting accordingly. One of the major advantages of the Arduino-based smart lighting system is its energy efficiency. By automatically adjusting the lighting based on the ambient light levels, the system can save a considerable amount of energy compared to traditional lighting systems. This not only reduces energy costs but also helps in reducing the carbon footprint. Another advantage of the system is it's easy to use. The Arduino platform provides an easy-to-use interface for programming and controlling the lighting system. The LDR sensor is also readily available and easy to install, making the system accessible to both DIY enthusiasts and professional installers. Furthermore, the system can be customized to suit the specific needs of different users. With the use of additional sensors, the system can be programmed to turn on or off lights based on factors such as occupancy, movement, and time of day. This makes the system versatile and adaptable to different situations. However, there are also some limitations to the Arduino-based smart lighting system using LDR. One of the main limitations is its reliance on ambient light levels. The system may not work effectively in situations where there is no natural light or when there are sudden changes in light levels due to weather conditions. In conclusion, the Arduino-based smart lighting system using LDR is a promising technology that can provide energy-efficient and reliable lighting control for both residential and commercial applications. While the system has some limitations, its ease of use, versatility, and customizability make it a promising solution for smart lighting.

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