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Movement Based Automatic Intensity Control of Street Light

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Abstract— We introduce an automation system for controlling lighting using sun radiation and object recognition, based on Arduino. In order to accomplish the needed operations—which no longer require laborious manual streetlight switching—we intend to design a variety of technologies. An Arduino microcontroller, an infrared sensor, and a light-dependent resistor (LDR) are used in the suggested task. However, this paper presents two primary contributions. First, we demonstrate how streetlight control is possible based on night vision and object identification. This causes the streetlights to automatically switch to a DIM state at night and a HIGH state when detecting an object; the streetlights stay off during the day. Second, the automatic method that is being suggested is expanded to bypass the DIM situation at night and merely activate streetlights in response to object detection. The suggested systems are created as lab-scale prototypes in order to verify their effectiveness, dependability, and affordability through experimentation. We note that the suggested solutions are amenable to easy testing and large-scale implementation in real-world settings in the near future, which will be helpful for applications involving automation systems and smart homes in the future.

Index Terms— streetlights, smart houses, sensors, open source, microcontroller, Arduino, automation, energy consumption, cheap cost.

I. INTRODUCTION

A key component of the effort to develop more intelligent and sustainable urban landscapes is the incorporation of cutting-edge technology. One such potentially very useful innovation is the use of movement-based automatic intensity control for street lighting. Traditional street lighting systems, which run continuously regardless of the weather, have problems with energy economy, economic efficacy, and adaptability to shifting usage patterns. Changing the street lights' brightness in reaction to movement is an intriguing solution to these problems. By using sensors and sophisticated control systems, we can create an adaptable and energy-efficient infrastructure that enhances security and safety and supports bigger projects to reduce energy use and diminish environmental impact. This study examines the objectives, benefits, and specifics of movement-based automatic intensity management for street lighting. This technique may save energy and operating costs while simultaneously enhancing safety and adaptability to changing circumstances, making it a significant step towards the creation of efficient and ecologically friendly smart cities. By investigating the subtleties of this technology, we seek to shed light on how urban environments might be transformed, resulting in intelligent, bright spaces that can change to meet the requirements of the people they serve.

A. Literature Review

The authors of paper [1] examine the operation of LDRs, illuminating its capabilities and potential uses. Engineers and hobbyists can use LDRs to create effective and responsive electronic devices by learning how they react to variations in ambient light levels. This article explores the nuances of LDR functioning through incisive explanations and useful examples, providing insightful knowledge for both beginning and seasoned electronics practitioners.

In this paper [2], Louis explores the basic operation of Arduino microcontrollers and how they can be used as flexible teaching and research tools. The paper clarifies Arduino's importance as a platform for practical learning and experimental study in the domains of control, automation, and communication systems by an extensive examination of its operating principles, capabilities, and programming approaches. This paper serves as an invaluable resource for educators, students, and researchers who wish to harness the innovative and exploratory potential of Arduino by offering practical insights into its hardware and software components and examples of its uses across a range of areas.

The study conducted by Salvi et al. showcases a creative use of Arduino Uno microcontrollers in the creation of a smart street lighting system. This paper [3] describes the system's design, implementation, and evaluation. The system makes use of Arduino's real-time data processing and control capabilities. The smart street light system uses an Arduino Uno to integrate sensors, such as motion detectors and Light Dependent Resistors (LDRs), to dynamically modify light intensity based on detected movement and ambient conditions. Salvi et al. show the efficacy and efficiency of the suggested method in maximizing energy consumption and boosting safety in urban contexts through empirical analysis and field testing.

With Arduino microcontrollers, Cynthia et al. offer a novel method of power-saving automatic street light control based on vehicle identification. The paper [4] looks at the planning, execution, and assessment of a system that dynamically modifies the brightness of street lights in response to the presence of a car. The suggested system ensures proper illumination for road users while achieving effective energy use through the integration of sensors, such as infrared (IR) detectors, and Arduino-based control algorithms. Cynthia et al. show how the system optimizes power consumption and improves safety on urban roadways with efficaciousness and dependability through empirical analysis and field testing.

A cutting-edge Automatic Street Light Control and Fault Detection System with cloud storage capabilities is presented by Gowdhaman and Scholar. The research paper [5] presents a comprehensive solution that integrates cloud-based data storage, real-time problem detection, and autonomous street light control. The system tracks street light performance, identifies malfunctions, and saves pertinent data on distant servers for study and maintenance by utilizing cloud computing and Arduino microcontroller technology. Gowdhaman and Scholar show how the suggested approach can improve operating efficiency, decrease downtime, and streamline maintenance procedures for urban street lighting infrastructure through empirical study and field testing.

The use of a passive infrared (PIR) sensor in an automated system for street lighting is presented by Ramli et al. The goal of this research [6] is to improve street lighting systems' efficacy and efficiency by integrating PIR sensors, which can identify movement and human presence. The research demonstrates how street lights may dynamically modify their intensity based on detected activity, optimizing energy usage and improving safety in urban contexts. This is accomplished by integrating Arduino microcontrollers and PIR sensors into the automation system. The use of PIR sensors in street lighting automation is shown to be feasible and advantageous by Ramli et al. through empirical research and field testing, opening the door to more responsive and sustainable urban lighting infrastructure.

By designing and implementing a dimmer-based solution utilizing a Raspberry Pi and Internet of Things technologies, Sravani, Malarvezhi, and Dayana present a fresh approach to smart street lighting systems. This paper [7] proposes a system that allows street light intensity to be dynamically controlled, allowing for adaptable lighting according to user preferences and environmental conditions. The system provides remote monitoring and management capabilities, improving operational efficiency and maintenance capabilities, by utilizing the Raspberry Pi's processing power and IoT connectivity. The viability and efficacy of Sravani et al.'s dimmer-based smart street lighting system are demonstrated, along with its potential to enhance energy efficiency and urban livability, through empirical validation and practical implementation.

II. EXISTING SYSTEM

Most street lighting systems in use today rely on static control mechanisms, which switch lights on or off in accordance with pre-established schedules or ambient light thresholds. These traditional methods are not very adaptive to dynamic environmental elements like changing levels of traffic and pedestrian activity or variations in the amount of ambient light throughout the day.
In order to turn lights on and off at specific periods or light levels, traditional street lighting systems frequently use photocells or timers. These are rather easy and affordable solutions, but they are not smart enough to adapt to changes in lighting needs in real time. Thus, they can result in insufficient lighting during times of high utilization or energy waste during times of low activity. Certain sophisticated street lighting systems use motion sensors to identify movement and turn on the lights. Unfortunately, these systems frequently lack the intelligence necessary to dynamically change the intensity of the light in response to detected movement and ambient light levels. Because of their rudimentary control methods, they might also have problems with dependability and restricted scalability. Furthermore, existing street lighting systems sometimes involve custom development and labor-intensive integration of many components, such as IR sensors, microcontrollers, and LDR modules, raising the complexity and cost of installation. All things considered, the street lighting systems that are now in place are not very flexible, intelligent, or energy-efficient. In order to offer dynamic and responsive lighting control, they fall short of utilizing the full capabilities of contemporary sensor technologies and microcontroller platforms. Innovative approaches that can solve these issues and provide more effective, long-lasting, and user-focused street lighting infrastructure are becoming more and more necessary as urban environments continue to change.
By incorporating LDR modules, IR sensors, an Arduino microcontroller, and other parts, the suggested movement-based intensity control system seeks to get around these restrictions by enabling dynamic street light intensity modification depending on observed movement and surrounding light conditions. By improving comfort, safety, and energy efficiency in urban settings, this creative strategy could pave the road for smarter, more sustainable cities.

III. PROPOSED SYSTEM

The suggested movement-based intensity control system for street lights represents a major advancement in urban lighting infrastructure with its dynamic and responsive control mechanisms that maximize energy usage and enhance safety. Figure 1 This system uses an Arduino microcontroller, jumper wires, a breadboard, light-dependent resistor (LDR) modules, infrared (IR) sensors, and a USB cable to achieve its objectives. At the core of the system is the Arduino microcontroller, which serves as the central processing unit responsible for data collection, analysis, and control. For

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continuous ambient light level measurement, LDR modules are utilized, and for motion detection close to street lights, infrared sensors are introduced. After analyzing these sensor readings, the Arduino dynamically adjusts the street light level based on detected movement and ambient light. Smooth scaling and deployment are encouraged by the system's adaptable architecture and modular design, which also make it easy to integrate with the existing street lighting infrastructure. By dynamically adjusting street light intensity, the proposed method improves safety and visibility for automobiles and pedestrians while also increasing energy economy. Furthermore, the system's real-time monitoring tools enable preventive maintenance and troubleshooting, ensuring dependable operation and reducing downtime. When everything is taken into account, the recommended solution represents a significant advancement toward more ecologically conscious and intelligent urban lighting systems.

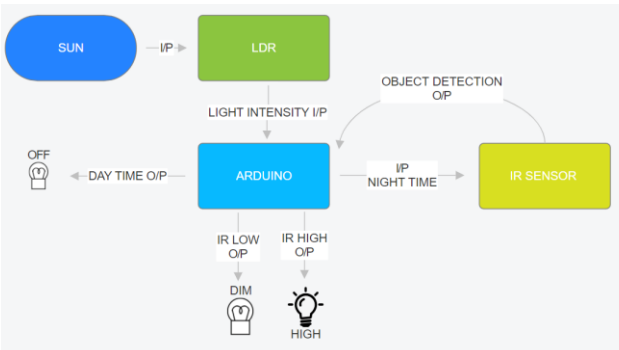

Fig. 1. Architecture diagram of the movement based intensity control of street lights

IV. MODULES DESCRIPTION

Hardware Requirements:

- Light Dependent Resistor (LDR) Modules
- Infrared (IR) Sensors
- Arduino Microcontroller
- Mini Breadboard
- Jumper Wires
- 10mm Ready LED's

Software Requirements:

- Arduino Integrated Development Environment (Arduino IDE)

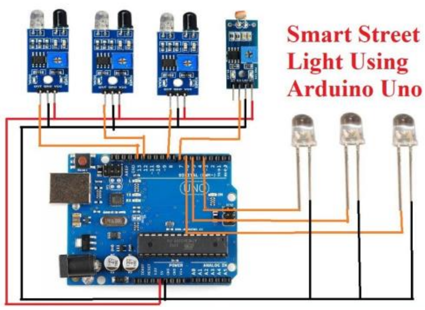

Fig. 2. Circuit Diagram of movement based intensity control of street lights

V. DESIGN

A. Working:

The new movement-based intensity control system for street lights dynamically adjusts street light intensity in response to observed movement and ambient light conditions by utilizing a range of integrated components. It functions as follows:

1. Light Dependent Resistors (LDRs): LDR modules continuously monitor the amount of ambient light. The resistance of the LDR varies with the intensity of light.
2. Infrared (IR) Sensors: Based on infrared light, these sensors detect movement near street lights. When an object or person moves, the IR sensor reacts.
3. Arduino Microcontroller: This is the central processing unit. After processing and applying control algorithms to the data received from the IR sensors and LDR modules, the output is produced.
4. Breadboard and Jumper Wires: The breadboard acts as a platform for component connections, and jumper wires are used to connect the Arduino, sensors, and other peripherals to each other.
5. USB connection: To power and program the Arduino, a USB connection is made between it and a computer. It allows for the setting of microcontrollers and the transfer of data.

When these components function as a unit as shown in fig 3, the system may dynamically adjust the street light's intensity based on the movement that is being watched and the environment. The Arduino microcontroller analyzes sensor data to determine the optimal illumination settings. When the system detects activity, it activates the street lights to preserve visibility and safety. On the other hand, when ambient light levels are sufficient, the system reduces intensity to conserve energy. This adaptive control system optimizes energy use while improving visibility and safety in metropolitan areas.

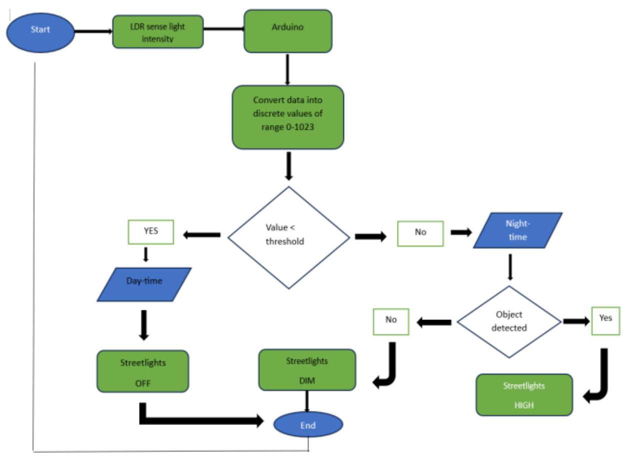

Fig. 3. The flow diagram of automatic intensity control of street light

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B. Connections:

As shown in Fig 2 Connect the positive (+) and negative (-) terminals of a power source (such as a battery or USB cable) to the power rails on the breadboard. This completes the power supply connections. Make sure the polarity is correct to prevent harming the parts. The ground (GND) pin of every IR sensor should be connected to the ground rail of the breadboard. Attach the VCC (power) pin of every IR sensor to the positive power rail on the breadboard. Assign the digital input pins on the Arduino board to each IR sensor's output (OUT) pin. For LDR Module Connections attach one leg of the LDR module to the ground rail of the breadboard. Link the opposite leg of the LDR module to the positive power rail on the breadboard. Attach the LDR module's output (middle pin) to an analog input pin on the Arduino board. The cathode, or negative terminal, of every LED should be connected to the ground rail of the breadboard. The anode, or positive terminal, of every LED should be connected to a different digital output pin on the Arduino board. Connect the ground (GND) pin of the Arduino board to the ground rail of the breadboard. This completes the setup of the Arduino. The Arduino board's 5V pin should be connected to the positive power rail of the breadboard. As shown by the supplied circuit schematic, connect the components using jumpers. Make sure all connections are tight and stay away from crossed wires to avoid short circuits. Users can construct a working smart street light system that automatically modifies light intensity in response to sensor inputs and Arduino programming by making the following connections.

VI. RESULTS AND DISCUSSIONS

The IR obstacle avoidance sensor was originally set to LOW. Consequently, the IR transmitter continued to send out IR rays even in the absence of an item in front of the sensor. When an automobile or any other item blocks an IR obstacle avoidance sensor, the rays that are released will reflect back to the IR receiver upon impact, and the microcontroller will register this as motion. In other words, the microcontroller will cause the associated LEDs to change from OFF to HIGH (5 V) when an object passes in front of the first IR obstacle avoidance sensor. The next three LEDs will change from OFF to HIGH as soon as the object advances ahead and blocks the next IR obstacle avoidance sensor the LEDs from the previous set will then change from HIGH to OFF. This procedure is followed by all of the IR obstacle avoidance sensors and LEDs in the set.

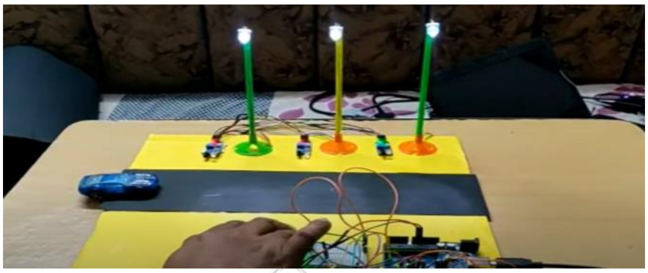

Fig. 4. As we covered the LDR module with our hand the system thinks its night and the street lights started to glow in dim light as no vehicle is passing by

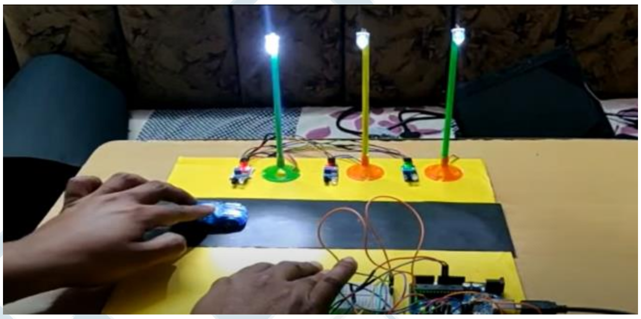

Fig. 5. As the car passes the intensity of the street lights increases immediately

Fig. 6. As the car passes through the second LED the intensity of LED 2 increases and the intensity of LED 1 decreases

VII. CONCLUSION

To sum up, the movement-based intensity control system for street lights is a noteworthy development in the infrastructure of urban lighting, providing flexible and responsive control mechanisms to maximize energy efficiency and improve safety. The system delivers a comprehensive approach to street light management by combining Infrared (IR) sensors and Light Dependent Resistor (LDR) modules with an Arduino microcontroller.

The system can efficiently adjust street light intensity to natural lighting circumstances thanks to the LDR modules' vital data on ambient light levels. In the meantime, the system may instantly change the illumination in response to movement sensed by the IR sensors, which identify the presence of moving objects.

The Arduino microcontroller dynamically changes street light intensity by coordinating the processing of various inputs, resulting in the best possible visibility while consuming the least amount of energy. By providing sufficient illumination where and when it is most required, this strategy not only increases energy efficiency but also increases safety for both drivers and pedestrians.

All things considered, the movement-based intensity control system shows how sensor technology and microcontroller-based control systems can be used to produce more intelligent and environmentally friendly urban lighting options. The system provides an all-encompassing solution for managing street lights, enhancing safety and reducing energy consumption in urban areas by utilizing insights from both ambient illumination and motion detection.

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