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Enhanced Street Lighting System for Optimizing Power Usage With Vehicle Detection

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ABSTRACT: Street lights consumes excessive energy by remaining illuminated constantly, even day time also, resulting in significant energy loss. To address the issue, an autonomous control system is proposed to prevent energy wastage. This project introduces an innovative concept for intelligent street lighting, wherein a logic control circuit is modified to regulate the lights automatically based on vehicle or object movement. Initially, all street lights will automatically turn on during darkness, but they will dim when there is no activity detected. However when vehicle movement is sensed, the lights will brighten gradually, the dynamic lighting system is differ from normal street lighting system.

Keywords: Arduino UNO, Light Emitting Diode, Infrared Sensor, Liquid Crystal Display.

1 INTRODUCTION

Automation is becoming more important in the world economy and daily life. People prefer automatic systems over manual ones. An example of this is “Smart Street Light Sensing.” This means that public street lights are operating according to the presence of pedestrians, cyclists movement and vehicle movement. These smart lights become off when there is no activity detected. If any movement is detected then lights will glow. Using real time data helps us watch and understand how much power is being used. This means we can make decisions quickly and put plans in place to use and save energy better [1]. The research demonstrates that automating streetlights helps save power to some extent. Industrialization, automation goes beyond just using machines; it reduces the need for human effort and thinking. Street lighting is crucial, especially with growing cities and more streets. Designing a good street lighting system involves considering factors like safety at night, cost-effectiveness, reducing crime, and lessening its impact on the environment. Street lights make walking safer by reducing collisions by almost half. Street Light Monitoring & Control is a system that automatically switches street lights on and off at specific times, improving efficiency and accuracy [2].

II. LITERATURE SURVEY

A “Energy Management Analysis on Smart Street Lighting for Smart Cities.”

Authors: G. Sreeramulu Mahesh, J. Chandana, C.M.Nithya, B.S.Preethi & N.Yadhushree

Smart cities, using technology like computers and the internet, have made our lives easier, more efficient, and reliable. Different types of technology have helped smart cities grow a lot, especially by using things like cloud computing. In smart cities, one important goal is to save energy and money on things like street lights. This paper talks about a system called Centralized Control Monitoring Systems (CCMS) that can control LED street lights, track how much energy they use, and predict future energy needs. This system can help make smart cities even better.

B “Automatic Street Light Control by Detecting Vehicle Movement”.

Authors: N Yashaswini, N Raghu, S Yashaswini, G Prathib Kumar

Nowadays, lighting and street lighting consumes a lot of power, even in areas with low vehicle traffic. To save energy, the proposed system switches off lights when no vehicles are present and adjusts brightness based on activity. LED lights, sensors, and a microcontroller like Arduino are used for efficient control.

C “Intelligent Energy Saving Street Lighting System with Vehicle Detection”.

Authors: Logeswaran T, Ranjith Kumar R, Kanishk Haran P, Barathraj A M, Cibiraj B, Kanishka M

The study introduces a smart street light system that saves electricity by dimming lights in the absence of vehicles, utilizing IR sensors to detect vehicle or object movement and adjust LED brightness. Managed by an Arduino microcontroller, the system improves energy efficiency and safety.

D “STREET LIGHT GLOW ON DETECTING VEHICLE MOVEMENT USING SENSOR”.

Authors: S Suganya, R Sindhuja, T Sowmiya

This paper describes a street light control system implemented in India, integrating timers, traffic flow data, photodiodes, LEDs and power transistors. IR sensors detect vehicle movement and modulate LED intensity using pulse width modulation, resulting in energy savings. Additionally, a programmable microcontroller dynamically adjusts intensity levels based on the density of vehicles present in the area, optimizing energy usage.

Sensor-based control: It employs infrared (IR) Sensors to detect vehicle presence, regulating street light brightness accordingly. Light brightens upon vehicle detection and dims in the absence of activity. This automated system optimizes energy usage, enhancing efficiency and reducing wastage. By dynamically adjusting lighting levels based on real-time vehicle presence, it ensures adequate illumination for road users while conserving power during the time of low traffic. Implementing sensor-based control not only improves safety and visibility but also contributes to environmental sustainability by minimizing unnecessary energy consumption [3]. Overall, it offers a smart and efficient solution for managing street lighting in response to varying traffic conditions.

Energy-efficient lighting technologies: The technologies, like LED (Light-Emitting Diode) street lights, offers a solution for reducing power consumption compared to conventional sources like incandescent or fluorescent bulbs. LEDs consume low energy and making them a sustainable choice for street lighting. Their efficient design leads to decreased electricity expenses and diminished environmental impact. By replacing traditional lighting with LEDs, cities can enhance energy efficiency while maintaining adequate illumination levels on streets. The shift to LED technology marks a significant stride in sustainability, in line with worldwide endeavors to combat climate change and lower carbon emissions. Overall, adopting energy-efficient lighting technologies promotes cost savings and environmental conservation in urban areas.

III. PROPOSED WORK

This proposed work involves the development of an innovative power management system for street lights that operates in response to vehicle presence. This system aims to address the inefficiencies of traditional street lighting by implementing intelligent control mechanisms. The key focus is on utilizing sensor technology to detect the movement and presence of vehicles on the streets. Through the integration of advanced sensors such as infrared (IR) sensors, the system will be able to accurately identify the presence of vehicles in real-time. These sensors will be strategically placed along roadways to provide comprehensive coverage and ensure reliable detection of vehicle activity.

Upon detecting the presence of vehicles, the system will automatically adjust the brightness of the street lights to an appropriate level. This dynamic adjustment will ensure that sufficient illumination is provided to enhance visibility and safety for motorists, pedestrians, and cyclists on the road. Conversely, during periods of reduced vehicle activity or inactivity, such as late at night or in less traffic areas, the system will intelligently dim the street lights to conserve energy. By dimming the lights when they are not required at full brightness, significant energy savings can be achieved without compromising on safety or visibility.

This proposed work incorporates energy-efficient lighting technologies, such as Light-Emitting Diode (LED) streets. LED lights consume significantly less energy compared to traditional lighting sources, making them an ideal choice for achieving energy efficiency goals. Overall, the proposed power management system for street lights by vehicles represents a significant advancement in urban lighting infrastructure. The system aims to optimize energy usage,

enhance road safety, and contribute to the overall sustainability of urban environments.

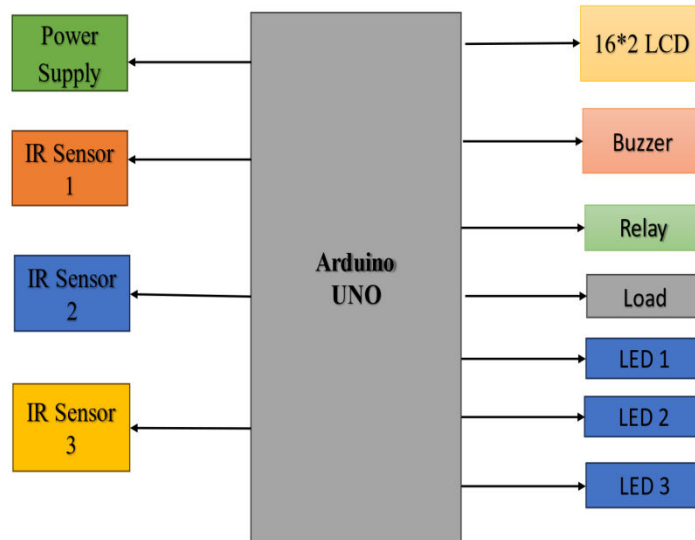


Fig.3.1 Block diagram of Proposed System

4. Results and Discussion

Implementing power management system yielded notable energy efficiencies. By dynamically adjusting lighting intensity in response to passing vehicles, we optimized illumination, enhancing safety and reducing waste. This innovative approach not only minimizes energy usage but also underscores our commitment to sustainable urban development, offering a model for future smart city initiatives aimed at improving both efficiency and safety on our streets. Here's scenario for how it could work.

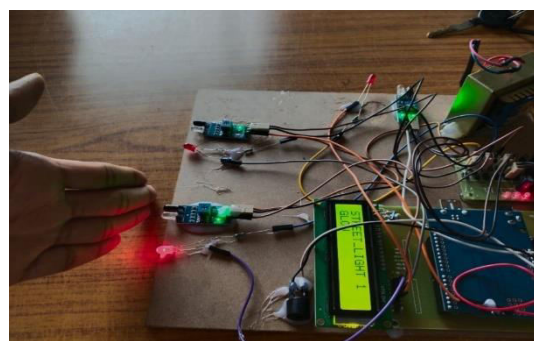
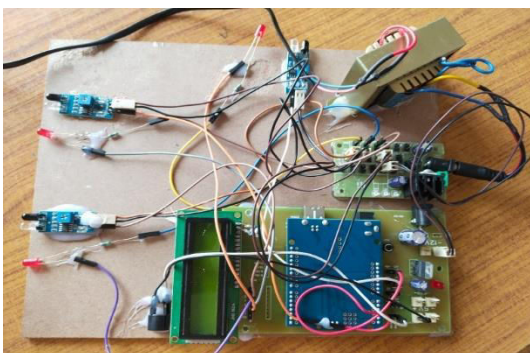


Fig.4.2 Sensor 1 Detected

The Fig.1 shows that how we set up the hardware. Everything is organized so that each part fits with the others. We put the three IR sensors side by side. The Arduino board is to be attached and linked to a power source outside for electricity. We'll connect all three sensors to the Arduino board. The LEDs are linked to the Arduino, which is then installed. After connecting the 5V power supply to the Arduino, thereby finalizing all connections, the circuit will begin operating smoothly.

In Fig.2, when the first sensor detects an object, then the adjacent LED-1 glow. While the remaining LEDs remain in an OFF state. This design ensures focused illumination on the detected object, optimizing visibility while conserving energy by deactivating unnecessary lighting. Such targeted activation enhances efficiency and facilitates a more responsive and sustainable approach to lighting control in the context of object detection.

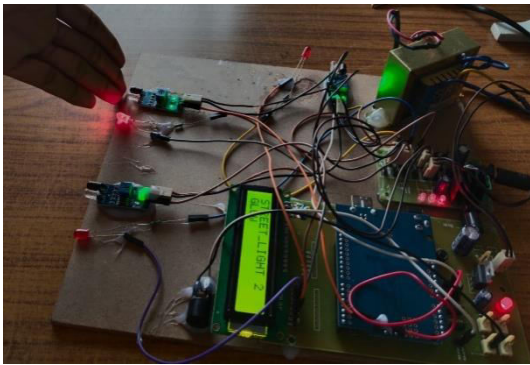


Fig.4.3 IR Sensor 2 Detected

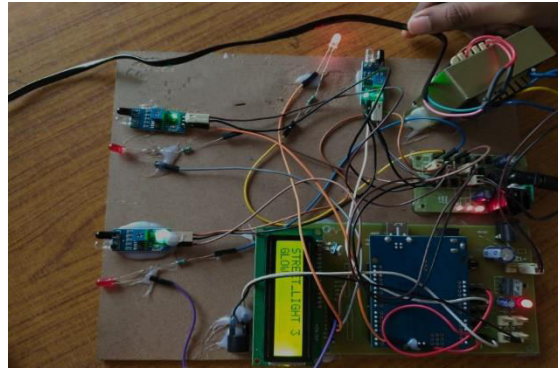
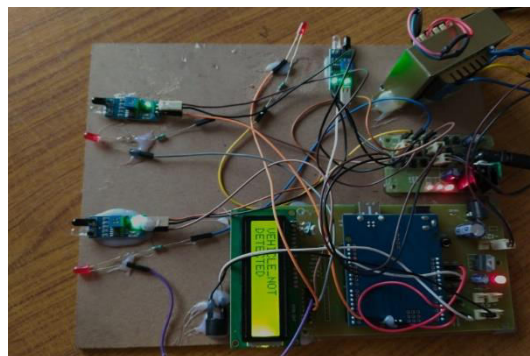


Fig.4.4 IR Sensor 3 Detected

In Fig.3, when the second sensor detects an object movement, then the LED-2 glow, while the rest of LED-1 & LED-3 remains OFF. This selective light ensures that only the necessary area is light up, improving visibility where movement is detected. By keeping the other LEDs OFF, energy is conserved contributing to an efficient and focused lighting system for object detection.

Similarly, the above Fig.4 shows that the third sensor will detect an object, then the LED-3 glow, while the rest of LEDs are in OFF state.



The above Fig.5, depicts that when no object is detected by the sensors then all LEDs remain in OFF position. The 16*2 LCD displays that "Vehicle Not Detected."

V.CONCLUSION

The implementation of power management street light by vehicle detection presents a significant advancement in urban infrastructure. The innovative approach harnesses the capability of vehicle detection sensors to dynamically adjust the intensity of street lighting, thereby optimizing energy usage and enhancing efficiency. The major outcome of this research demonstrates substantial energy savings and improved operational efficiency, as the system responds intelligently to real-time traffic conditions. By illuminating only when vehicles are present, unnecessary energy consumption is minimized, leading to cost savings and environmental benefits. Furthermore, the application of this technology extends beyond energy conservation to encompass enhanced road safety. The targeted illumination provided by the system ensures adequate visibility for drivers and pedestrians, particularly in areas with varying traffic patterns.

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