



Research Paper for Smart Street Light Using Vehicle Movement for Scientific Research and Engineering Development

Guide :- Prof. Monica Ugale

Sakshi Dhakane*, Abhishek Kumbharde, Vishal Sagare***, Sushant Sanap******

*(Mechanical Engineering, DYPCOE, and Pune
Email: sakshidhakane16@gmail.com)

** (Mechanical Engineering, DYPCOE, and Pune
Email: abhishekkumbharde00762@gmail.com)

*** (Mechanical Engineering, DYPCOE, and Pune
Email: vishalnani333@gmail.com)

**** (Mechanical Engineering, DYPCOE, and Pune
Email: sushantsanap8@gmail.com)

Abstract:

This research paper presents a smart street light system using Arduino, which offers an efficient and sustainable approach for urban lighting. The proposed system incorporates motion sensing, ambient light sensing, and remote monitoring and control features to improve energy efficiency, reduce maintenance costs, and enhance sustainability. Arduino-based microcontrollers are used to control LED lights, and motion sensors detect the presence of pedestrians or vehicles, adjusting the light intensity accordingly. Ambient light sensors measure natural light levels, and the system dynamically adjusts the street light brightness. Remote monitoring and control allow for real-time performance monitoring and adjustments. Experimental results demonstrate significant energy savings and reduced maintenance costs compared to traditional street lighting systems, contributing to sustainability by reducing carbon footprint and minimizing light pollution. This research provides insights into the development of smart street lighting systems and their potential benefits for urban environments, paving the way for more sustainable and smart cities in the future. As the traffic decreases slowly during late night hours, the intensity gets reduced rapidly till morning to save energy and so, the street lights switch on at the dusk and then switch off at the dawn, automatically. The process repeats every day. White Light Emitting Diodes (LED) replaces old conventional HID lamps in street lighting system to include dimming feature. The intensity is not possible to be controlled by the high intensity discharge (HID) lamp which is generally used in street lights. LED lights are the best for lighting, because of their low energy consumption and long life. LED lights are fast replacing conventional lights because intensity control is possible by the pulse width modulation. This proposed system uses an Arduino board and a rectified power supply. String of LED are interfaced to the Arduino board with a MOSFET device. The intensity control of the LED light is possible by varying duty cycle from a DC source. A programmed Arduino board is engaged to provide different intensities at different times of the night using PWM technique. This project is also enhanced by integrating the LDR to follow the switching operation precisely.-----

INTRODUCTION

Street lighting is an essential factor of city infrastructure, presenting protection and security to pedestrians and motorists at some point of nighttime. However, conventional avenue lights systems regularly eat excessive energy and make contributions to light pollutants. To deal with those problems, clever street lighting structures have emerged as a promising answer, leveraging superior

technology including network of things (IoT), sensors, and microcontrollers for efficient and sustainable lights control. On this study's paper, we present a smart avenue mild challenge that employs Arduino microcontroller and sensors for controlling the depth of road lights. Arduino is an open-supply microcontroller platform that lets in for clean prototyping and improvement of various electronic projects. By integrating sensors with Arduino, the proposed challenge can dynamically modify the

depth of road lighting environmental situations which include ambient light and weather Degrees, movement detection, conditions. The project ambitions to reduce electricity intake, Optimize operational charges, and make contributions to the Sustainability of city lighting fixtures structures. The main concerns inside the subject of clever street Lights are automation, strength intake, and Value effectiveness. Automation aims to reduce Manpower by way of the usage of fixtures primarily based On actual-time wise structures, whilst power Saving is essential due to the diminishing assets of energy. The goal of this studies is to shop electric Electricity in road lighting routinely the usage of strength saving Elements like LDR (light-based resistor), Resulting in fee effectiveness. The saved electricity can be Utilized in other programs along with irrigation, Villages, and cities. This research proposes the usage of Arduino, an open-supply microcontroller, to govern The depth of avenue lighting.

Background:

Road lighting fixtures is a important concern for public Authorities in developing international locations due to its Strategic significance for financial and social balance. Inefficient lighting wastes considerable financial Sources and terrible lights can cause accidents. Energy Efficient technologies, along with LED (mild-emitting Diode) lighting fixtures, can considerably reduce the value of street Lights and improve performance.

Techniques used in Arduino:

sorts of sensors, LDR and photoelectric Sensor, may be used on this studies. The LDR senses The quantity of mild falling on its surface and provides An indication of whether it is day or night. The Photoelectric sensor detects movement and might be Activated most effective throughout the night time. The Arduino board Gets commands from those sensors and Controls the road lighting fixtures as a consequence. The MOSFET Switch acts as an ON/OFF relay to govern the lighting.

Concealed Lamp:

High-intensity discharge (concealed) lamps are a type of Electrical gasoline-discharge lamp that produces light Through an electric arc between tungsten Electrodes. These lamps are packed with noble fuel and Steel salts, which growth the intensity of visible mild Produced. However, concealed lamps have limitations Which includes deterioration of lumen output over time and Fragility.

Want of the gadget:

The conventional implementation and enterprise Of road lighting have boundaries in phrases of Enhancing and developing similarly. With dynamic changes in Economic system, strength materials, and ecological worries, There's a want for automated and modernized avenue Lights structures which are flexible, computerized, and Adaptable. This will make certain secure traffic Conditions even as decreasing energy intake and Operational expenses, thinking of the converting parameters Of the surroundings.

Operation of LDR Sensor:

The LDR (mild based Resistor) sensor Includes a couple of metal movie contacts separated by A track of cadmium sulphide film. This film is designed to Offer maximum touch location with the metal movies. The LDR sensor is housed in a clean plastic or Resin case, permitting external mild to freely access it. Realistic LDRs are available in numerous sizes and Package deal patterns, with the most popular size having a Face diameter of around 10mm. (a practical LDR Is proven in the accompanying discern.) An LED lamp is a sort of electric powered light bulb that Makes use of light-emitting diodes (LEDs) to provide light. LED lamps are recognised for their long lifespan and high Electric performance, making them extra energy efficient Than incandescent lamps and maximum fluorescent Lamps. The LED lamp marketplace is anticipated to develop Drastically, with projections showing a twelve-fold Increase from \$2 billion in 2014 to \$25 billion in 2023, with A compound annual boom charge (CAGR) of 25%. LEDs use most effective approximately 10% of the energy

required by means of Incandescent lamps. Unlike fluorescent lamps, LEDs do not require Warm-up time and come to full brightness Right now. Common switching on and rancid does not lessen the Lifespan of LEDs, in contrast to fluorescent lighting. However, the preliminary cost of LED lamps is commonly better As compared to conventional bulbs. Through the years, the light output of LEDs may additionally degrade Due to the degradation of LED dye and packaging Substances. A few LED lamps are designed to be Direct replacements for incandescent or fluorescent Lamps, with packaging indicating the lumen output, Power intake, color temperature, operating Temperature variety, and from time to time the equivalent Wattage of an incandescent lamp with comparable Brightness. LED lamps are electric powered lighting that use light emitting diodes (LEDs) to provide light. They may be Greater electricity-efficient and feature an extended lifespan In comparison to incandescent and fluorescent lamps. LEDs may be directional or omnidirectional, and their mild Output is usually lower than other types of lamps. LED lamps require a DC strength source, so they want an LED motive force to convert AC strength to the regulated DC Power that LEDs require. Thermal management is Vital for high-electricity LEDs to prevent Premature failure and reduce warmth. Efficiency slump is a Decrease in luminous efficacy as present day will increase, Which can be addressed with the aid of the usage of multiple LEDs in a single Lamp. LED lamps may also include warmth dissipation Elements like warmness sinks and cooling fans for excessive energy programs.

Calculation and graphs

Conventional light consumption= 250 W on average.

$$\begin{aligned} \text{Energy consumed(kWh)} &= \text{power in kW} * \text{hours} \\ &= 250 * 10^{-3} * 12 \\ &= 3 \text{ kWh or units} \end{aligned}$$

LED light consumes = 60W on an average

$$\begin{aligned} \text{Energy consumed(kWh)} &= \text{Power in kW} * \text{hours} \\ &= 60 * 10^{-3} * 12 \\ &= 0.72 \text{ kWh or units} \end{aligned}$$

For adaptive intensity light will consume:

Here, we will be using LED light which will be consuming 60 watts on an average

Case I) vehicle runs throughout the night on the street.

$$\begin{aligned} \text{Energy consumed(kWh)} &= \text{Power in kW} * \text{hours} \\ &= 60 * 10^{-3} * 12 \\ &= 0.72 \text{ kWh or units} \end{aligned}$$

Case II) when vehicle runs from 6 PM to 12 AM after that there is a drop of 25% in traffic.

$$\begin{aligned} \text{Energy consumed(kWh)} &= \text{Power in kW} * \text{hours} \\ &= (60 * 10^{-3} * 6) + (60 * 10^{-3} * 4.5) \\ &= 0.63 \text{ kWh or units} \end{aligned}$$

Case III) The same situation like above but the traffic drop is 50%

$$\begin{aligned} \text{Energy consumed(kWh)} &= \text{Power in kW} * \text{hours} \\ &= (60 * 10^{-3} * 6) + \\ &+ (60 * 10^{-3} * 3) \\ &= 0.54 \text{ kWh or units} \end{aligned}$$

Case IV) The same situation like 1st case but the traffic drops 75%

$$\begin{aligned} \text{Energy consumed(kWh)} &= \text{Power in kW} * \text{hours} \\ &= (60 * 10^{-3} * 6) + (60 * 10^{-3} * 1.5) \\ &= 0.37 \text{ kWh or units} \end{aligned}$$

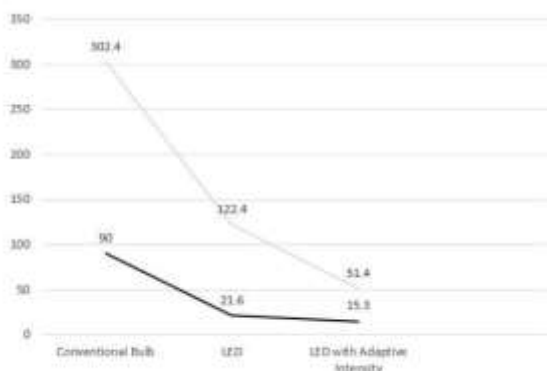
We can take the average of the above 3 results to get the final estimation

$$\begin{aligned} &= (0.63 + 0.54 + 0.37) / 3 \\ &= 0.51 \text{ kWh or Units.} \end{aligned}$$

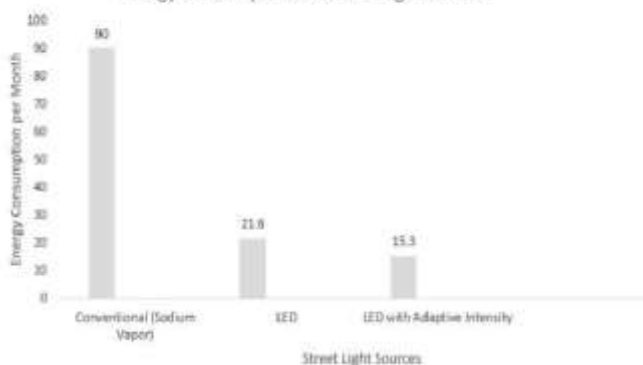
As the obtained result 0.51 kWh is significantly less than 0.72 kWh the energy consumption is observed.

Result

	Conventional (Sodium Vapor)	LED	LED with adaptive intensity (Average)
Energy Consumption per day (kWh or Unit)	3	0.72	0.51
Energy Consumption per month (kWh or Unit)	90	21.6	15.3
Cost or Electricity Bill (INR)	302	122.4	51.4



Graphical Representation of Energy Consumption VS Street Light Sources



CONCLUSIONS

In conclusion, the implementation of a smart Street light gadget the use of Arduino Uno has Demonstrated to be a a hit and innovative Approach to decorate the efficiency and Functionality of conventional avenue lighting fixtures. The Use of Arduino Uno, a versatile and without problems Programmable microcontroller, has allowed for The development of a smart avenue light system That includes diverse superior features such As automated brightness manage, movement Detection, and remote tracking. The smart Avenue mild device has established huge Advantages, consisting of progressed strength performance Through automated brightness adjustment based On ambient mild conditions and motion Detection, ensuing in reduced energy Consumption and fee savings. The device's Far off monitoring skills have furnished Actual-time statistics on the popularity and performance of Avenue lighting fixtures, taking into consideration proactive protection And troubleshooting, thereby lowering downtime And improving standard machine reliability. Moreover, the clever avenue mild device has Contributed to expanded protection and security in The illuminated areas through motion detection, Which could locate any uncommon activity or Potential dangers. This has ended in improved Public protection and reduced crime charges, making The system a treasured addition to city Infrastructure. Universal, the implementation of Clever avenue light device using Arduino Uno has Proven the ability of leveraging Advanced technology to optimize avenue lights Operations, enhance power performance, improve Safety and safety, and provide value-powerful Solutions for cutting-edge city environments. In addition research and improvement on this place Have the ability to yield even extra advanced And sophisticated smart avenue mild structures, Reaping rewards communities and towns global.

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