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Review of Controller - Based Smart Street Lighting Systems

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Abstract: This paper proposes energy efficient smart automatic street lighting system. The main objective is to design an energy efficient microcontroller based system which gets turned on and off automatically depending on the ambient lighting. This system consists of LDR, light sensor, and a set of the Light Emitting Diode (LED) module. The system was programmed to automatically turn off during the hours of daylight and only operate during the night and heavy raining or bad weather. Several numbers of tests have been conducted to test and validate the proposed prototype in the different environment. As conclusion, around 77%-81% reduction in power consumption can be achieved through this proposed automatic street lighting system for energy efficiency system design. Also, a demonstration with a real-time proto type model involving costs and implementation procedure has been developed using Internet of Things (IoT) to visualize the real time updates of street processing and notifying the changes occur.

Keywords: LDR, Energy Efficiency, Light Sensor, Automatic Lighting, Microcontroller, IoT

I. INTRODUCTION

Street lighting is one of the important parts of a city's infrastructure where the main function is to illuminate the city's streets during dark hours of the day. Previously, the number of streets in the town and city is very small. Therefore, the street lamps are relatively simple but with the development of urbanization, the number of streets increases rapidly with high traffic density. There are several factors need to be considered in order to design a good street lighting system such as night-time safety for community members and road users, provide public lighting at cost effective, the reduction of crime and minimizing it is effect on the environment. At the beginning, street lamps were controlled by manual control where a control switch is set in each of the street lamps. It is called first generation of the original street light. After that, another method that has been used was optical-control method. This method uses high pressure sodium lamp in their system. It can be seen that this method is widely used in the country nowadays. This method operates by setting up an optical control circuit, changes the resistance by using of light sensitive device to control street lamps lights. Therefore, this paper highlights the energy efficient street lighting design using LED lamps through intelligent sensor interface for automatic switching. Section II surveys current techniques and technology trends in smart street lighting. Section III describes the proposed system. Section IV concludes the paper with a discussion on the scope for further research in this domain.

II. LITERATURE SURVEY

Controller-based street lighting systems have been investigated in detail by researchers in recent years. Such systems offer multi-pronged advantages and can also be combined with other systems (such as solar cell based systems) to provide a greater than standard energy benefit while reducing energy costs simultaneously [1]. Researchers have concluded such street lighting systems to be essential in the design of smart cities for optimization of power consumption, especially in the domain of public systems [2].

Intelligent street light control offers simultaneous benefits in terms of reduction of energy consumption and balancing energy generation costs, when coupled with renewable energy based systems such as solar cells [3][4]. It has also been observed by researchers that switching of streetlights based on real-time data minimizes the chance of accidents while maximizing energy benefits in a given situation [5]. Research has also been conducted on image recognition for augmenting the efficiency of such controller-based systems [6]. Finally, the type of streetlight used also affects the switching process in terms of the voltage and power required to switch on the devices, since these parameters become crucial in case frequent switching takes place [7]. The current paper thus proposes a simple IoT (Internet of Things) based controller system for conditional toggling of streetlights.

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III. PROPOSED SYSTEM

The main objective of this project is to implement an IoT based Automatic Street Lighting System. As the traffic decreases slowly during late-night hours, the intensity gets reduced progressively till morning to save energy and thus, 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 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 urban streetlights. LED lights are the future of 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. Strings of LED are interfaced to the Arduino board. A programmed Arduino board is engaged to provide different intensities at different times of the night. This project is enhanced by integrating the LDR to follow the switching operation precisely and IoT to display the status of street on web browser and help in controlling it.

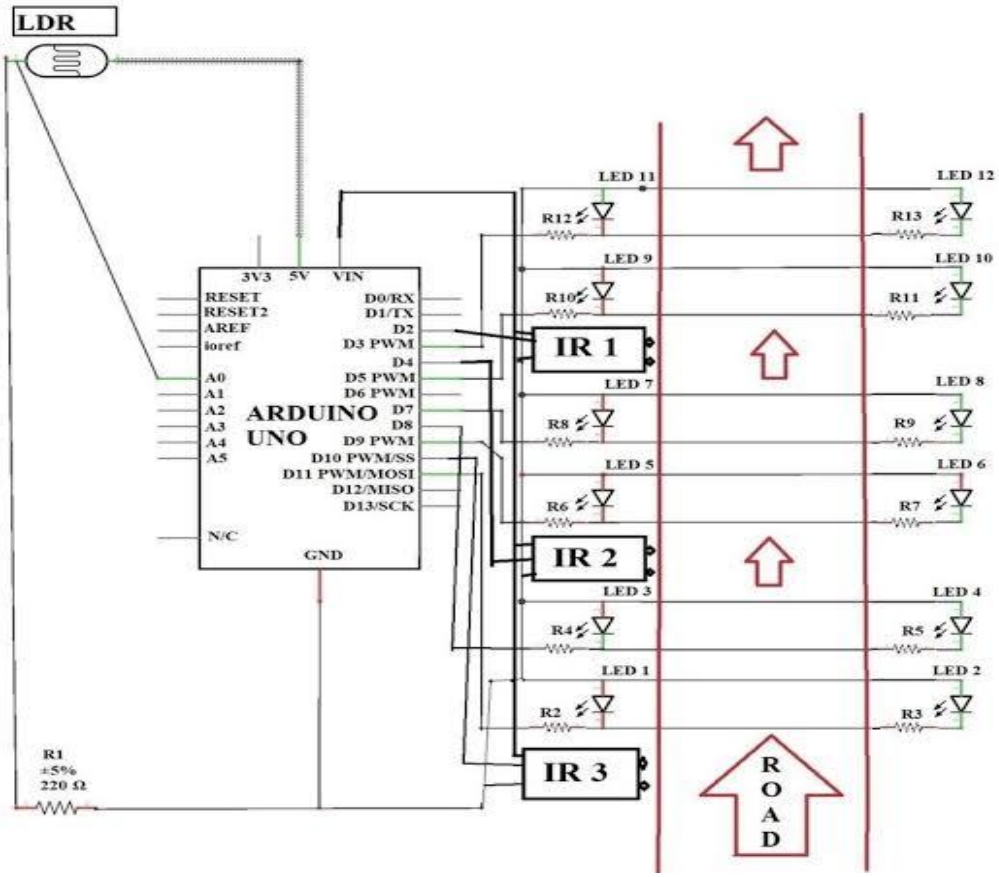

Figure 1: Proposed System

The list of components are shown in table 1 below.

Table 1. List of components

SL.NO	NAME OF THE COMPONENT	QUANTITY
1	Light dependent resistor(LDR)	1
2	Transistor	2
3	Resistors	2 (10kΩ -1 no.)
4	Light Emitting Diode(LED)	5
5	Wires	As per requirements
6	Arduino	1
7	IR sensors	5
8	Jumper wires	as per requirement

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The block diagram of the System is shown in Figure 2 below.

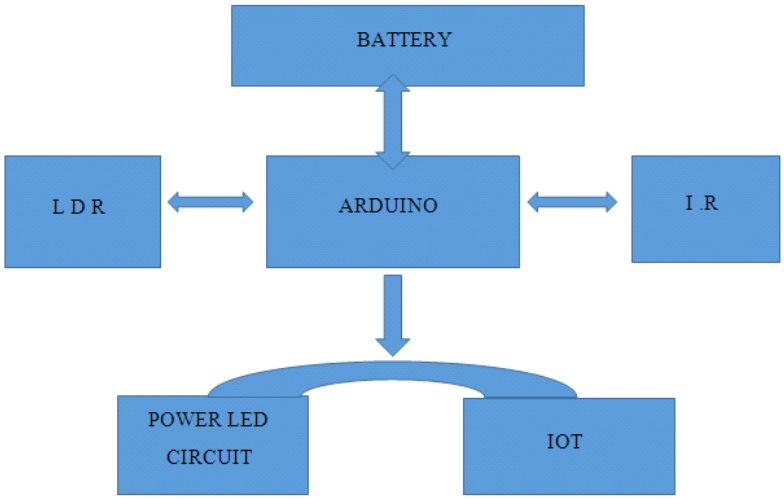

Figure 2: Block Diagram of System

The proposed system is expected to reduce energy consumption significantly, considering variation in traffic. An advantage of this system is the fact that the system performance increases with increase in randomness of traffic density for the road on which this system is installed.

IV. CONCLUSION

The current work accomplished in this paper comprised the comparison of different techniques currently under research in the domain of smart street lighting. After review, the authors have proposed a system for betterment of energy performance of street lighting systems. The authors plan to implement the proposed system in the near future and augment the standard algorithm using machine learning to accurately predict traffic patterns and prevent spurious switching.

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