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Energy Efficient Street Light Supervising and Control System

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Abstract: ***In this proposal, we propose an energy efficient streetlight supervising and control system that can monitor and control streetlight more efficiently and can provide a safe night time environment for all road users including pedestrians. The proposed system uses the ZigBee-based wireless devices which allow more efficient lamp management. It also discusses an intelligent system that takes automatic decisions for ON/OFF/DIMMING considering movement of vehicles or pedestrians and also surrounding light intensity.***
Keywords: ZigBee, energy efficient.

I. INTRODUCTION

In designing lighting systems, the main factor to be considered is energy efficiency. As streetlights consume 40% of the entire city power , a control system that is able to efficiently manage the lighting system is absolutely advisable. For this aim, the traditional lighting systems are not suitable resulting in energy losses, frequent replacement of devices, lack of effective communications, monitoring , automation and fault diagnostic problems.

To address these challenges, many technologies had been utilized in the literature to save energy such as: replacement of metal halide (MH) lamps with Light Emitting Diodes (LED) [1]. But the systems based on these technologies involves complex wiring and need further improvement to increase energy efficiency.

To improve energy efficiency and to simplify the complex wiring, many lighting systems such as: Power Line communication (PLC) [2], USB based protocol [3] have been proposed. But these systems are not suitable for vehicle detection.

To avoid these problems P-BUS technology is introduced [4] in which circuit topology is simpler and has strong interference rejection. But the main drawback is that due to signal attenuation, communication failure occurs.

To overcome this, wireless technology [5] is introduced, where the number of sensors used is reduced. But this results in packet loss which in turn reduces accuracy.

Furthermore, a lighting system based on WiMAX technology [6] which is reliable simple and low cost has been introduced where interference with the existing WiMAX users is the drawback.

In order to fill this research hole, we design the energy efficient streetlight supervising and control system that considers user's requirement and system energy consumption.

II. PROPOSED SYSTEM

In this proposal, we design ZigBee based energy efficient streetlight control system. The streetlights are accompanied by ZigBee module, light sensor, IR sensors. The streetlights continuously monitor the intensity of sunlight by using the sensors connected to it, and based on that intensity, Arduino takes the decision to dim and turn the lamps on or off.

A. Lamp Monitoring System

The lamp monitoring system installed in each streetlight consists of several modules: the light sensor, IR sensors, Arduino (MCU) and ZigBee module as shown in figure.1(a).Sensors are attached to ZigBee to continuously monitor the situation of the lamps. The sensors are used to observe the parameters such as power consumption, and lighting condition of the place. All these data will be transferred to the Arduino which processes the data and automatically sets the appropriate course of action. The detailed discussions related to the main components involved in the lamp monitoring system is given in subsections.

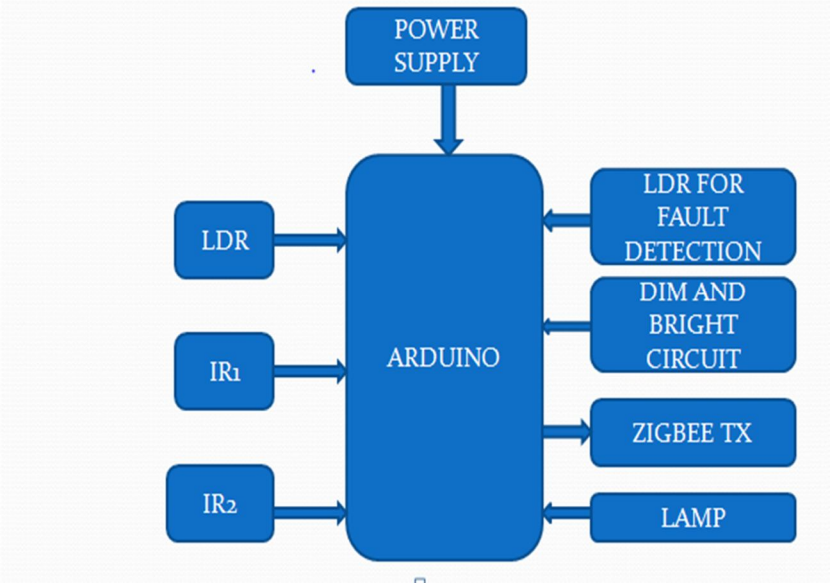
B. Arduino (Uno) Unit

The Arduino controls the operation of the whole system. The sensors gather the information and send it to the Arduino for

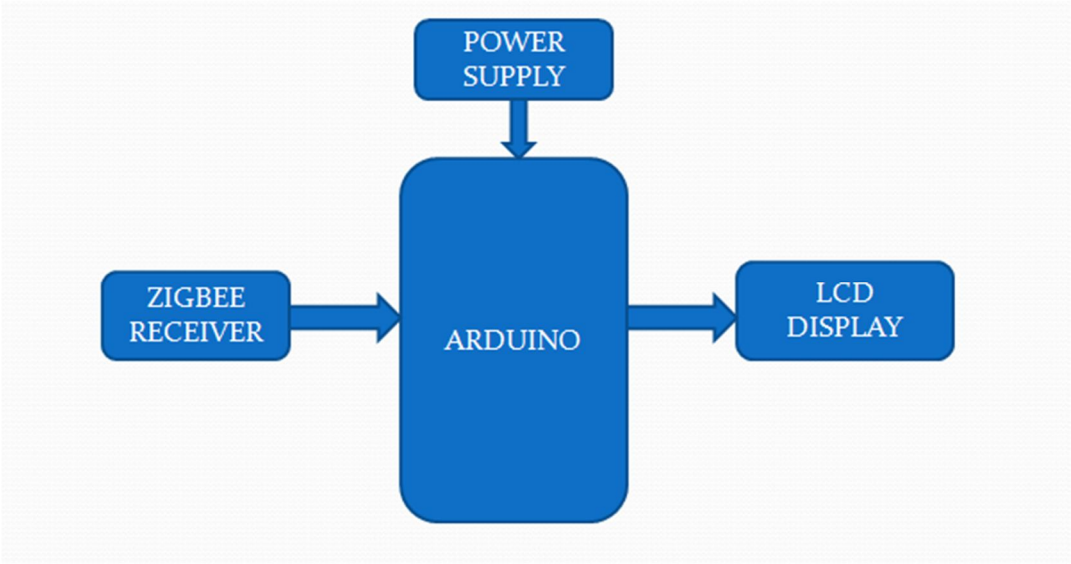
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appropriate actions according to the situation. After the initial settings, the light sensor activates the Arduino if the sunlight is lower the threshold or some person passed through the street. The IR sensors installed at the beginning and middle of the street is used to check the presence of passengers or vehicles passing in the streets. Arduino manages information flow among sensors and is also responsible for generating pulse width modulation (PWM) signal for dimming the LED lamps. It also sends information to the control station about the fault detected in lamps and the power consumed through ZigBee as shown in fig.2. (b).



(a)



(b)

Fig. 1. Proposed LED smart lamp. (a) Transmitter block diagram. (b) Receiver block diagram.

C. Light Sensors

The light sensor used is the LDR (light dependent resistor) measures the brightness of the sunlight and adjusts the light intensity of the lamp accordingly. The purpose of this measurement is to ensure a minimum level of illumination of the streetlights. Based on the intensity of sunlight, the Arduino drives the lamp to maintain a constant level of illumination. Thus, the lamp will be turned on when the sunlight will fall below this illumination level. This action is obviously not required during daylight time.

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D. IR Sensors

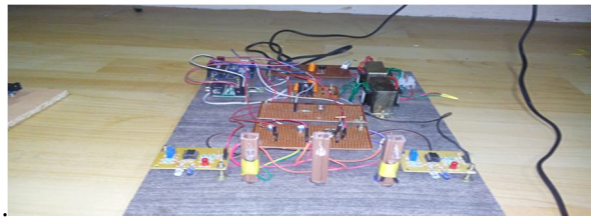
IR sensor is an electronic device, that emits IR rays in order to sense some aspects of the surroundings. An IR sensor can measure the heat of the object as well as detects the motion. Here it is used to detect vehicle and pedestrian movement.

E. Zigbee Module

ZigBee uses the universal synchronous and asynchronous serial receiver and transmitter (USART) interface to connect with Arduino. ZigBee is the low power wireless network standard based on IEEE 802.15.4.It is the main part of the proposed designed system.

III. TEST CASE IMPLEMENTATION AND DISCUSSIONS

The system is designed to modernize the traditional streetlight system with the energy efficient ZigBee-based wireless system.



(a)



(b)

Fig. 2. (a) Streetlight blok. (b) control station. [Day time].

In this system, the sensors (LDR and IR) are interfaced with the streetlight as shown in Fig. 2.(a). Using the LDR sensor two modes of operation are done. The two modes are (i**)** Day mode (ii) Night mode. Using IR sensor vehicle detection is done. During day mode the streetlight will not glow even though IR sensor detects the presence of vehicle as shown in Fig.2.(a)&(b).

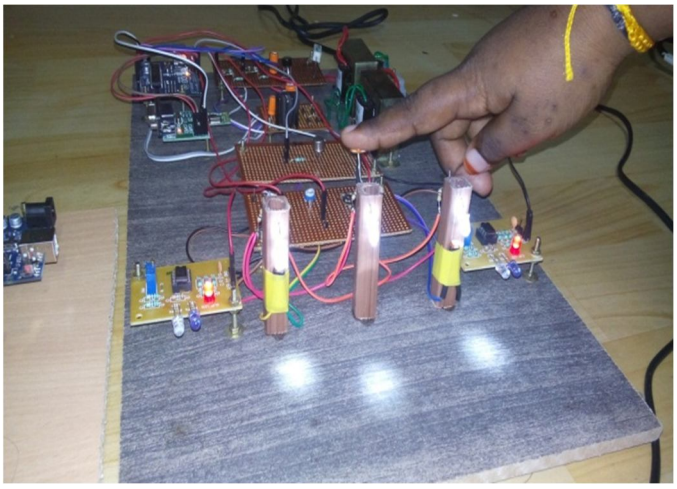


Fig.3.(a) Night mode.

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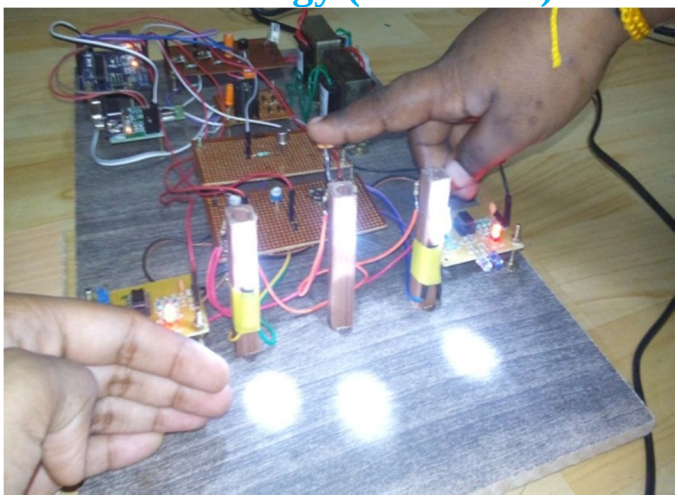


Fig.3.(b) Vehicle detection.

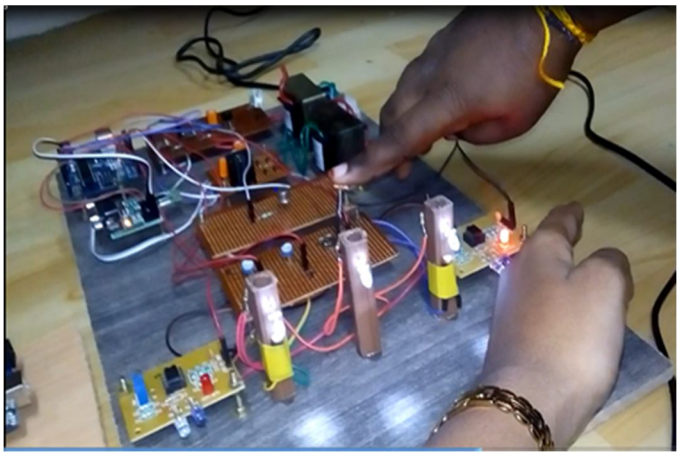


Fig.3.(c) Vehicle exit the street.

During night mode the streetlight turns on but in a dim condition as shown in Fig.3.(a) and when the vehicle is detected by IR sensor(in the entrance of the street) streetlight glows bright as shown in Fig.3.(b) and again turns dim as the vehicle passes the IR sensor at the end of the street as shown in Fig.3.(c). Another important aspect of this design is fault detection which is done using LDR placed in each and every streetlight. The lamp is identified as faulty lamp when it does not turn on even when the LDR senses darkness and displayed in the LCD display through ZigBee module as shown in Fig.4.(a) & (b). Apart from the fault detection voltage and current is also measured and displayed.

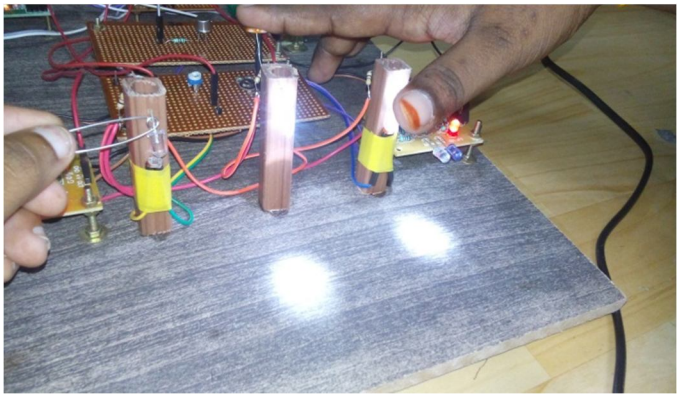


Fig.4.(a) faulty lamp.

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Fig.4.(b) LCD display of fault in control room.

IV. CONCLUSION

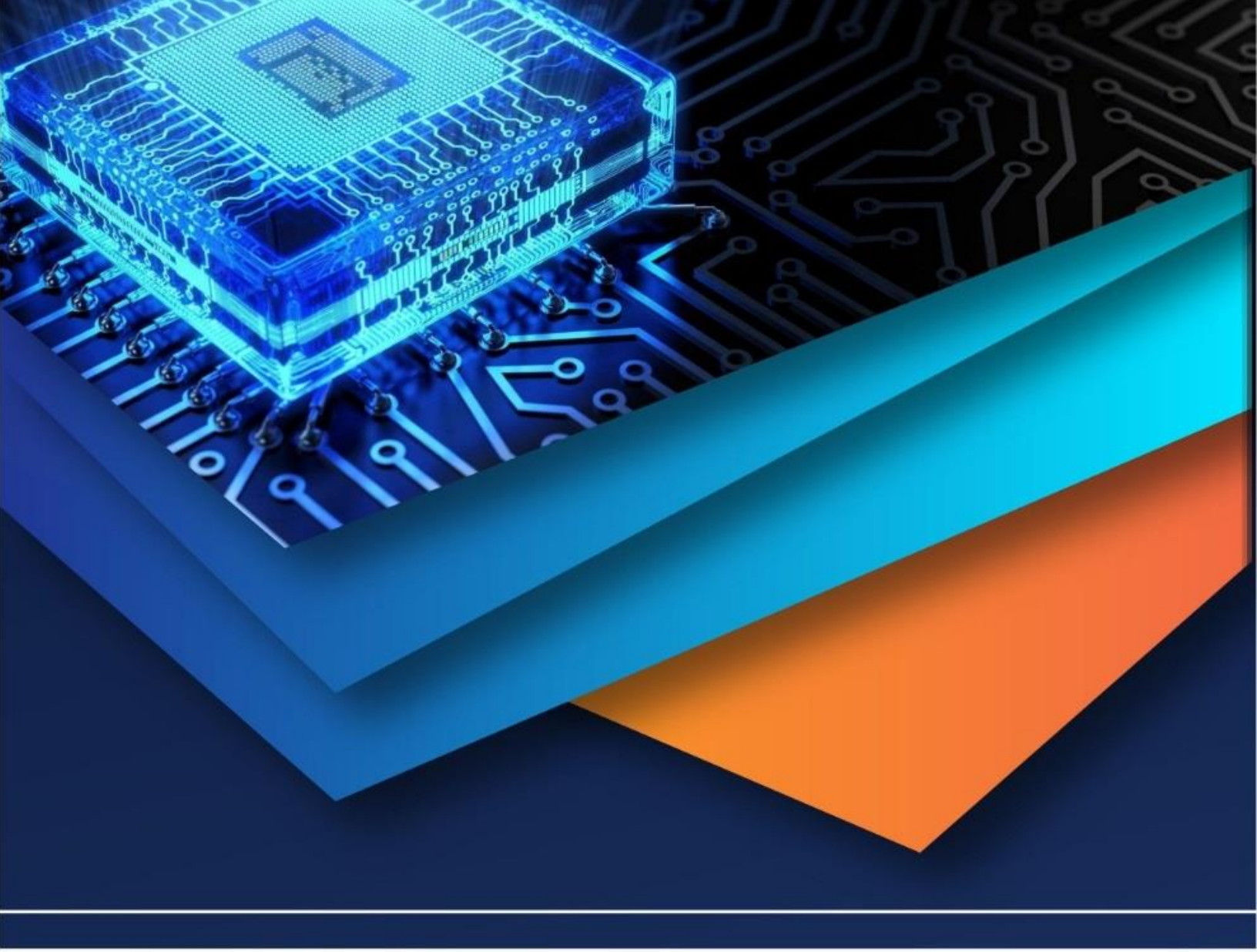
The centralized and smart monitoring of streetlights is the cost effective and energy efficient way of saving precious energy. In this proposal. Smart adjustment of the streetlights according to the sunlight conditions is done. In addition, the designed system can remotely monitor the status of the lights and power consumption.

By using this system the fault identification of streetlight is done in less time and hence recovery can be made immediately, which will save the labor cost for frequently monitoring the system. Furthermore, the proposed system is flexible, extendable, and fully adaptable to the user needs.

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