PIC (16f877A) Microcontroller finds its applications in a huge number of devices. For example, it is used in remote sensors, home automation, security and safety devices, and in many industrial instruments. It has a total number of 40 pins and a CMOS FLASH-based 8-bit. The Pin diagram for the PIC (16f877A) is shown in Figure 2.

LIGHT EMITTING DIODE (LED)

A light-emitting diode (LED) is a semiconductor light emits light when current flows through it. Early LEDs were often used as indicator lamps, replacing small incandescent bulb. LEDs have many advantages over incandescent light sources, including lower energy consumption, smaller size, faster switching, and longer lifetime. LEDs are manufactured in different sizes, colors, and shapes (Boylestad & Nashelsky 2009).

Nowadays, lightening-up of highways is done through high intensity discharge (HID) lamps which are a type of electrical gas-discharge lamps which is based on gas discharge (Singh 2014). However, the energy consumption of these lights is high as well as there is no particular mechanism to turn ON/OFF the lights from sunrise to sunset. Therefore, the light intensity of the HID cannot be controlled by voltage reduction. In addition, HID lamps consume more energy. The proposed system uses LEDs lamps rather than the used HID. LEDs lamps are energy saving because of its high luminous efficiency. LEDs are coupled with relay to be switched ON or OFF.

INFRARED (IR) SENSOR

An infrared sensor is an electronic device used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation (Tambare 2016). The IR sensor consists of IR transmitter and IR receiver. The transmitter emits infrared radiations. This infrared signal is bounces (reflected back) from the surface of an object and the signal is received at the infrared receiver. Figure 3 shows the function of the IR sensor.

LIGHT DEPENDENT RESISTOR (LDR)

A photoresistor or LDR is a light controlled variable resistor. It measures the amount of light; that is, the resistance of the LDR sensor depends on the light intensity. The resistance of an LDR decreases with increasing incident light intensity (intensity of the Sun light). If the light intensity is low, then the value of resistance of the LDR will be high. This value increases as the night gets darker. The resistance value of the LDR reaches its maximum at midnight. As the dawn starts, the resistance of the LDR decreases and the light intensity on the LDR increases. Figure 4 shows a typical LDR resistance versus light intensity.

RELAY MODULE

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. It works as a switch that opens and closes circuits electromechanically or electronically. Relays are useful devices and allow one circuit to switch another while they are completely separated. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage. Relays control one electrical circuit by opening and closing contacts in another circuit. Relays are used where it is necessary to control a circuit where several circuits must be controlled by one signal (Gurevich, 2006). In a basic relay there are three contactors: Normally Open (NO), Normally Closed (NC), and Common (COM). At no input state, the COM is connected to NC. When the operating voltage is applied the relay coil gets energized and the COM changes contact to NO **(**Tambare 2016**)**.

Each LDR is connected directly to the LED bulb through the relay. The system controls the light intensity of the LED bulb based on the light upon the LDR sensor. To represent the switches in real mode, IR sensors were used. The IR sensor module output port was directly connected to the PIC Microcontroller. IR sensor is used to monitor the lights of the streets. It checks the traffic. If it detects a coming vehicle (or any obstacle) in front of the signal, the IR will inform the PIC Microcontroller. The PIC Microcontroller will send a high level output to change the relay state from being normally open to close and turn the LEDs ON. That is, the PIC Microcontroller gives order to turn ON a block of street lights ahead of vehicle. The lights are switched ON for a period of time and (if the IR detects no other vehicles present on road) switched OFF automatically. This period of time is set by the user using the PIC Microcontroller.

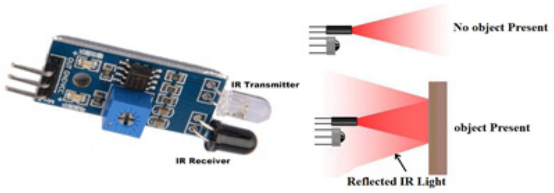

FIGURE 3. Function of the IR sensor

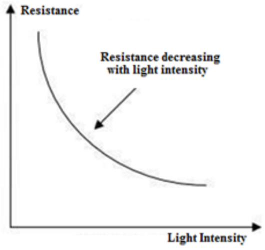

FIGURE 4. Typical LDR resistance versus light intensity

PROTEUS SIMULATION MODEL

The Proteus Software Simulation Circuit is electronic circuit design software which includes a schematic, simulation and Printed Circuit Board (PCB) Layout modules. Proteus is ahead in simulating the circuits containing the Microcontrollers where the circuit can be simulated by uploading the Hex code to the Microcontroller. The Proteus Software Simulation of the proposed system has been done as shown in Figure 5 for each working part of the system. All the components are selected from the component library included in the software itself. The simulation was tested and feasibility is checked before its hardware implementation and real time deployment.

Each LDR is connected directly to an LED bulb through a relay as shown in the proteus circuit. This part of the circuit is shown in Figure 6. The LDR sensor controls the light intensity of the LED bulb based on the Sun light on it. That is, the street lights are switched on based on the intensity of the Sun light upon the LDR sensor. The resistance of the LDR decreases with increasing incident light intensity (intensity of the Sun light). The resistance of the LDR has the following resistances:

$$\text{Daylight} = 50\ \Omega \qquad \text{Dark} = 1\text{M}\ \Omega \tag{1}$$

The voltage across the LRD is represented by V^* on the Proteus Simulation Circuit as shown in Figure 6.

Using Voltage Divider at V^*:

$$V^* = \frac{R_{LDR}}{R_{LDR} + 100}(Vcc) \tag{2}$$

At Night:

$$V^* = \frac{R_{LDR}}{R_{LDR} + 100}(Vcc) = \frac{1M}{1M + 100}(5V) = 4.999\text{V} \tag{3}$$

At Daylight:

$$V^* = \frac{R_{LDR}}{R_{LDR} + 100}(Vcc) = \frac{50}{50 + 100}(5V) = 1.67\text{V} \tag{4}$$

The change in the voltage, V^*, will control the intensity of the LED bulbs. V* is connected to the relay module. The other pin of the relay connected to the LED Bulbs. The relay used is normally open. When the PIC Microcontroller sends 1, the relay closed and LED turns ON with a certain intensity depending on the value of V*. The resistance value of the LDR reaches its maximum at midnight (V* will be

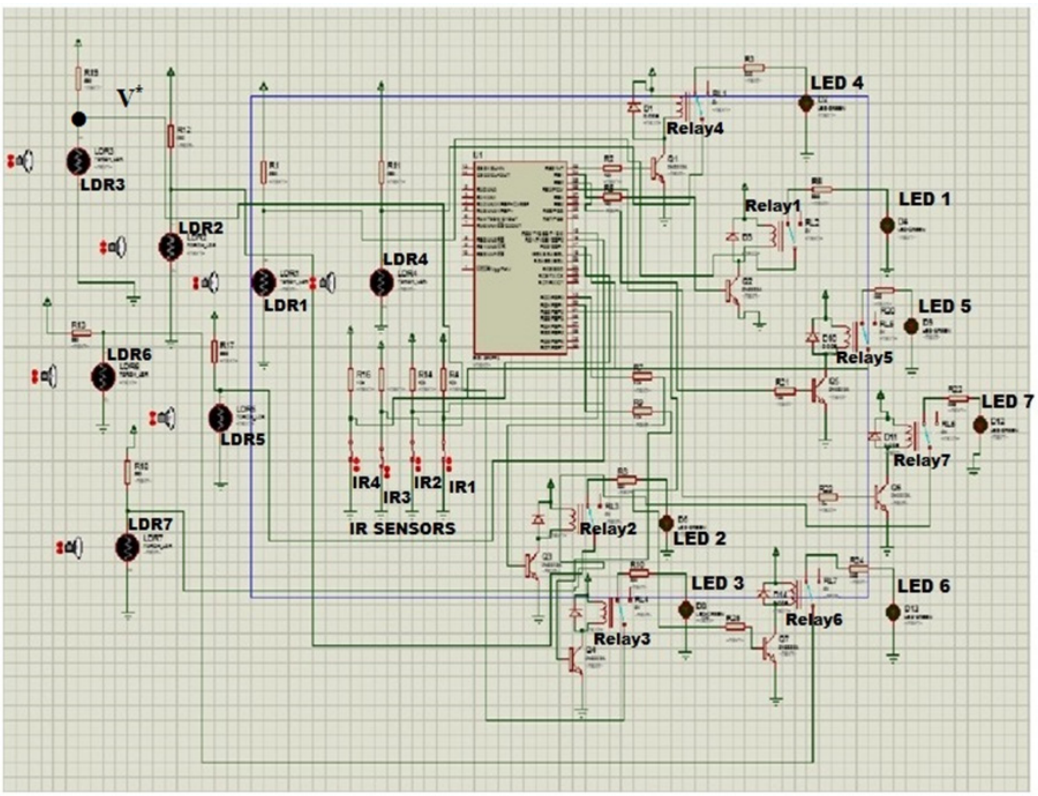

FIGURE 5. Proteus Simulation Circuit for the proposed intelligent street light system

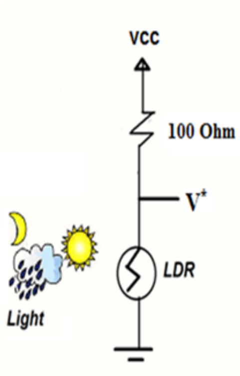

FIGURE 6. The LDR circuit connection

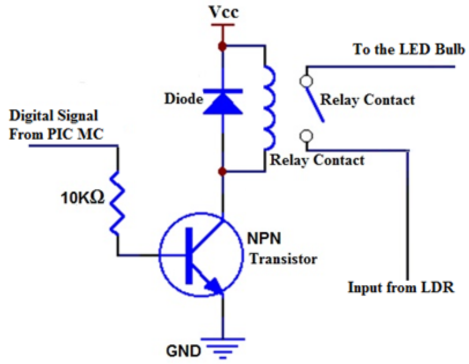

FIGURE 7. Circuit diagram of the relay module

TABLE 1. The connections between the IR sensors and the LEDs through the PIC Microcontroller

Input to the PIC IR Sensor	Output of the PIC LED (Pole)
1	1 & 4
2	5 & 7
3	2 & 3
4	6

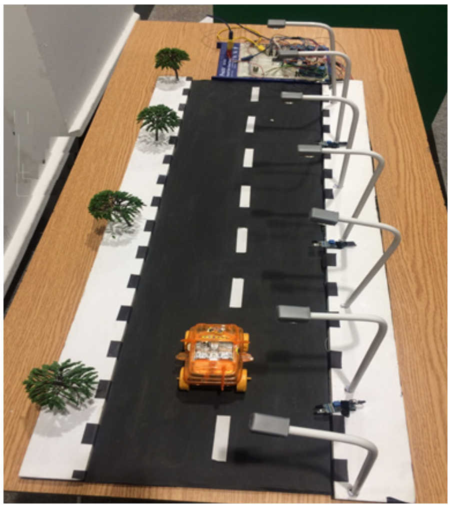

FIGURE 8. A prototype of the proposed intelligent street light system

maximum), street lights will switch ON at full intensity when a vehicle comes by. As the dawn starts, the light intensity upon the LDR increases. Then, the resistance of the LDR decreases. Hence, the intensity of the street lights gradually decreases until it is switched OFF (V* will be minimum).

To represent the switches in real mode, IR sensors were used. The model has 4 IR sensors. Each sensor controls the light of two poles (LED Bulbs). The IR sensor module output port was directly connected to the PIC Microcontroller. IR sensor checks the traffic. If it detects a coming vehicle (or any obstacle) in front of the signal, high level output will be sent by the PIC Microcontroller to change the relay state from being normally open to close and turn the LEDs ON. That is, the PIC Microcontroller gives order to turn ON a block of street lights ahead of vehicle. The lights are switched ON for a period of time and (if the IR detects no other vehicles present on road) switched OFF automatically. This period of time is set by the user using the PIC Microcontroller. Table 1 shows the connections between the IR sensors and the LEDs through the PIC Microcontroller as shown in Figure 5.

In this paper, the PIC Microcontroller is used to analyze vehicle existence on the road and to generate signal that controls an NPN transistor which is part of the relay. The transistor used in the relay module is a 2N2222 NPN bipolar junction transistor. It is used here for switching applications. When transistor is ON, power flows through the coil as shown in Figure 7 (this circuit is part of the proteus circuit in Figure 5). This will generate a magnetic field that attracts a contact and activates the next circuit. When the power is switched OFF, a spring pulls the contact back to its original position, switching the second circuit OFF again. This in

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