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AUTOMATIC STREET LIGHT CONTROL SYSTEM USING LDR AND MICROCONTROLLER

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ABSTRACT

This paper aims at designing and executing the advanced development in embedded systems for energy saving of street lights. Nowadays, human has become too busy, and is unable to find time even to switch the lights wherever not necessary. The present system is like, the street lights will be switched on in the evening before the sun sets and they are switched off the next day morning after there is sufficient light on the roads. This paper gives the best solution for electrical power wastage. Also the manual operation of the lighting system is completely eliminated. In this paper the two sensors are used which are Light Dependent Resistor LDR sensor to indicate a day/night time and the photoelectric sensors to detect the movement on the street. The microcontroller PIC16F877A is used as brain to control the street light system, where the programming language used for developing the software to the microcontroller is C-language. Finally, the system has been successfully designed and implemented as prototype system.

KEYWORDS: Introduction-block diagram, Sections-required hardware/ software, circuit diagram and proposed model, advantages, applications, future aspects, Conclusions.

INTRODUCTION

The idea of designing a new system for the street light that do not consume huge amount of electricity and illuminate large areas with the highest intensity of light is concerning each engineer working in this field. Providing street lighting is one of the most important and expensive responsibilities of a city. Lighting can account for 10-38% of the total energy bill in typical cities worldwide[1]. Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for economic and social stability. Inefficient lighting wastes significant financial resources every year, and poor lighting creates unsafe conditions. Energy efficient technologies and design mechanism can reduce cost of the street lighting drastically.

Manual control is prone to errors and leads to energy wastages and manually dimming during mid night is impracticable. Also, dynamically tracking the light level is manually impracticable. The current trend is the introduction of automation and remote management solutions to control street lighting[2].

There are various numbers of control strategy and methods in controlling the street light system such as design and implementation of CPLD based solar power saving system for street lights and automatic traffic controller[1], design and fabrication of automatic street light control system[3], automatic street light intensity control and road safety module using embedded system[4], automatic street light control system[5], Intelligent Street Lighting System Using Gsm[6], energy consumption saving solutions based on intelligent street lighting control system[7] and A Novel Design of an Automatic Lighting Control System for a Wireless Sensor Network with Increased Sensor Lifetime and Reduced Sensor Numbers[8].

In this paper two kinds of sensors will be used which are light sensor and photoelectric sensor. The light sensor will detect darkness to activate the ON/OFF switch, so the streetlights will be ready to turn on and the photoelectric sensor will detect movement to activate the streetlights. LDR, which varies according to the amount of light falling on its surface, this gives an inductions for whether it is a day-night time, the photoelectric sensors are placed on the side of the road, which can be controlled by microcontroller PIC16f877A. The photoelectric will be activated only on the night time. If any object crosses the photoelectric beam, a particular light will be automatically ON. By using this as a basic principle, the intelligent system can be designed for the perfect usage of streetlights in any place.

The block diagram of street light system as shown in Fig. 1 consists of microcontroller, LDR, and photoelectric sensor. By using the LDR we can operate the lights, i.e. when the light is available then it will be in the OFF state and when it is dark the light will be in ON state, it means LDR is inversely proportional to light. When the light falls on the LDR it sends the commands to the microcontroller that it should be in the OFF state then it switch OFF the light, the photoelectric sensor will be used to turn ON or OFF the light according to the presence or absent of the object. All these commands are sent to the controller then according to that the device operates. We use a relay to act as an ON/OFF switch.

Street lights are the major requirement in today's life of transportation for safety purposes and avoiding accidents during night. Despite that in today's busy life no one bothers to switch it off/on when not required. The project introduced here gives solution to this by eliminating manpower and reducing power consumption.

This requires three basic components i.e. LDR, Sensors and microcontroller. During daytime there is no requirement of street lights so the LDR keeps the street light off until the light level is low or the frequency of light is low the resistance of the LDR is high. This prevents current from flowing to the base of the transistors. Thus the street lights do not glow. As soon as the light level goes high or if light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance. Now the circuitry goes in on condition and the block diagram represented here starts working.

BLOCK DIAGRAM

When LDR allows the current to flow this block diagram of circuitry goes into working condition. IR sensors start emitting IR rays via IR transmitters. As soon as any vehicle crosses or obstructs the path of IR rays and prohibits it to reach at IR receivers the microcontroller starts getting the blockage signals. The programming installed in microcontroller starts running which basically presented here allow three street lights to glow that are- the light in front of vehicle, behind the vehicle and parallel to vehicle making backward and Forward Street visible. Transformer converts the high 230V AC to 12V AC, Rectifier converts it into DC. For voltage regulation we are using LM 7805 and 7812 to produce ripple free 5 and 12 volts DC constant supply. Emitting Diode (LED) replaces HID lamps by engaging a programmable microcontroller that controls the street light on/off conditions.

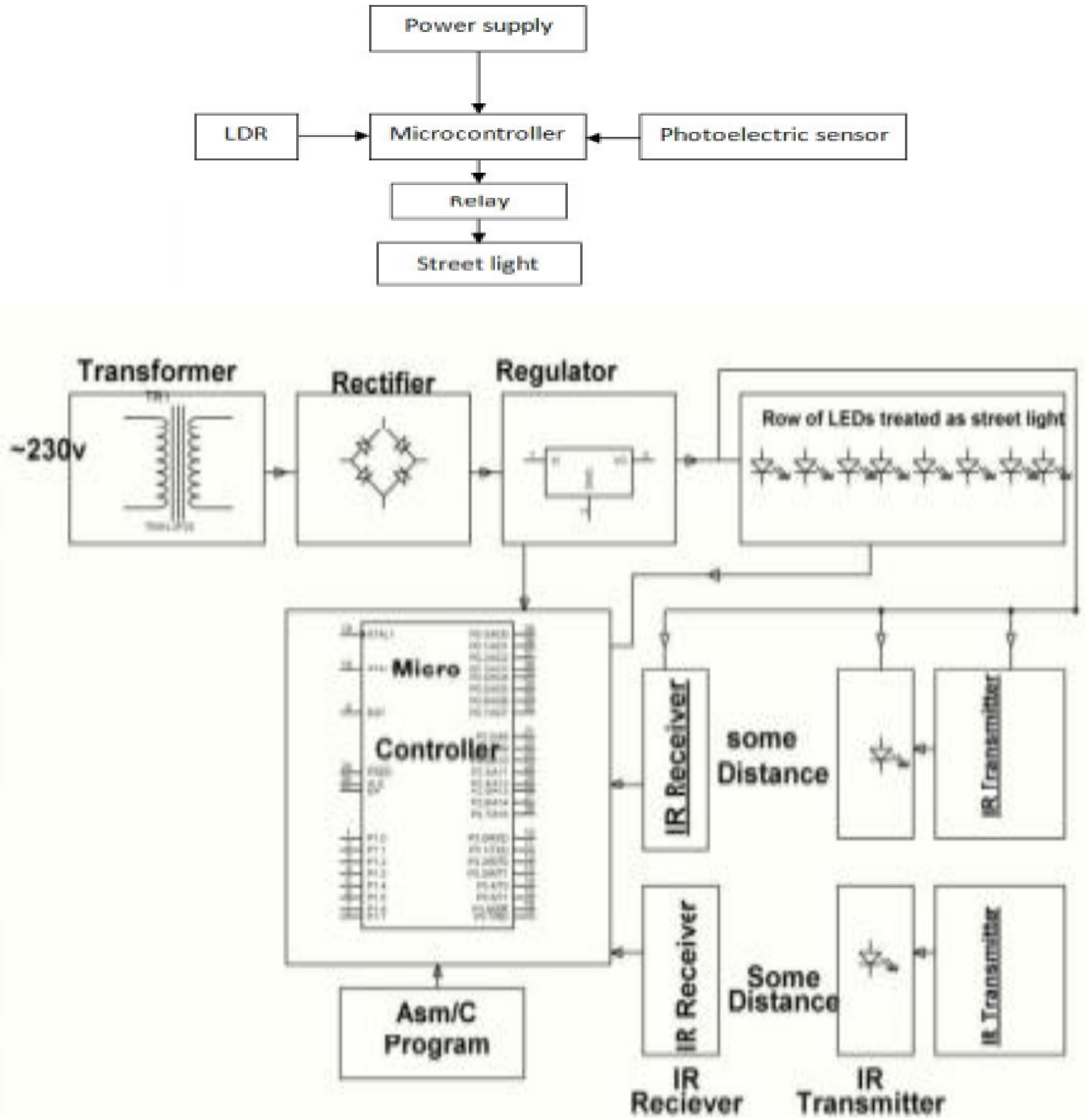

Figure 1: Block Diagram.

2. MATERIAL AND METHODS

2.1 LDR

An LDR (Light dependent resistor), as its name suggests, offers resistance in response to the ambient light. The resistance decreases as the intensity of incident light increases, and vice versa. In the absence of light, LDR exhibits a resistance of the order of mega-ohms which decreases to few hundred ohms in the presence of light. It can act as a sensor, since a varying voltage drop can be obtained in accordance with the varying light. It is made up of cadmium sulphide (CdS). The theoretical concept of the light sensor lies behind, which is used in this circuit as a darkness detector. The LDR is a resistor as shown in Fig. 2, and its resistance varies according to the amount of light falling on its surface. When the LDR detect light its resistance will get decreased, thus if it detects darkness its resistance will increase.

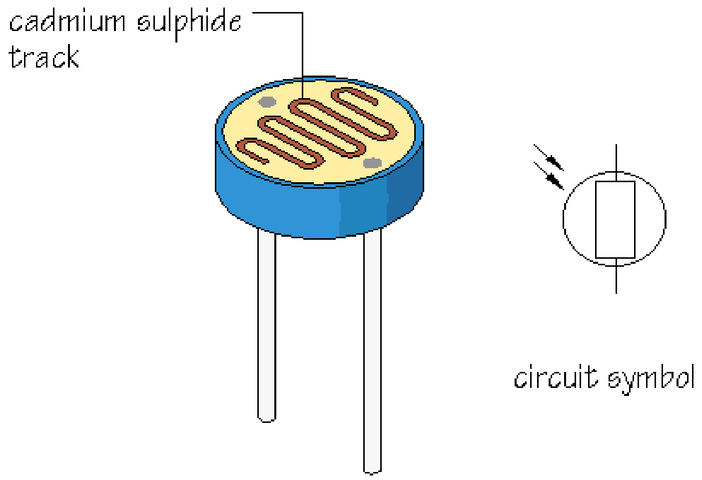

Fig. 2(1): LDR

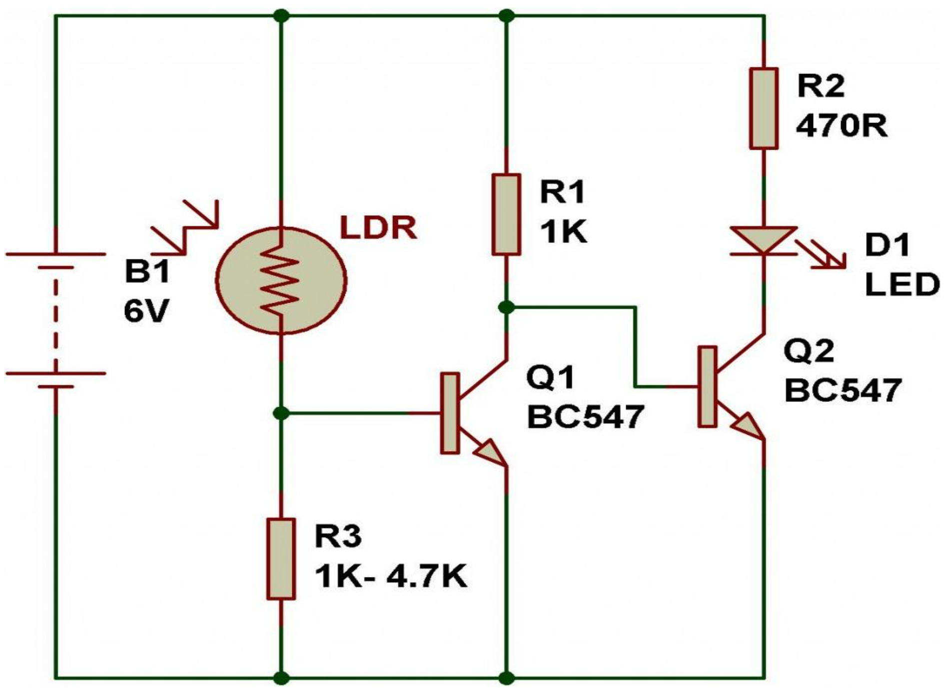

Fig. 2(2): LDR Circuit Daigram

2.2 Photoelectric Sensor

Photoelectric sensors use a beam of light to detect the presence or absence of an object. This technology is used to identify size and contrast of an object. 4 kinds of general purpose photoelectric sensor product lines are designed to ensure advanced technology performance combined with optic & electric technology and are widely applied in various fields of industry for its optimized functions, quality, application flexibility and reliability while remaining strongly competitive with its price among the whole industry. Application areas of photoelectric sensors include industrial automation lines, elevators, parking facilities, logistics services, semiconductor devices, packaging machines and construction areas. The photoelectric sensor specifications are illustrated in Table 1.

Fig. 3 Photoelectric sensor

Table 1: Photoelectric sensor specifications

Photoelectric Sensors (MC005)	
Sensing range	3-80 cm
Sensing object	Translucency, opaque
Supply voltage, current	DC 5V, 100mA
Output operation	Normally open
Output	DC three-wire system (NPN)
Diameter, Length	18mm, 45mm
Ambient temperature	-25_70

2.3 Regulated Power Supply

Usually, we start with an unregulated power supply ranging from 9volt to 12volt DC. To make a 5volt power supply, KA7805 voltage regulator IC as shown in Fig. 4 has been used.

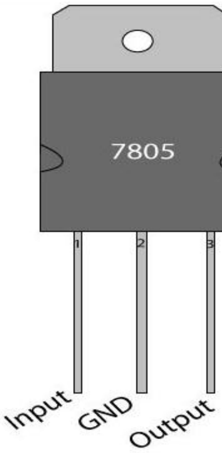

Fig. 4: Power supply regulator (IC 7805)

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels. The KA7805 is simple to use. Simply connect the positive lead form unregulated DC power supply (anything from 9VDC to 24VDC) to the input pin, connect the negative lead to the common pin and then turn on the power, a 5 volt supply from the output pin will be gotten.

Pin Description of IC 7805

Pin No	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 5V (4.8V-5.2V)	Output

2.4 Relays

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contractor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Relays are remote control electrical switches that are controlled by another switch, such as a horn switch or a computer as in a power train control module. Relays allow a small current flow circuit to control a higher current circuit. Several designs of relays are in use today, 3-pin, 4-pin, 5-pin, and 6-pin, single switch or dual switches. Relays which come in various sizes, ratings, and applications, are used as remote control switches. Fig. 5 shows different types of relays. In this paper, the 4-pin relay will be used.

Fig. 5: Different types of relays

PIC16F887 Microcontroller

The PIC16F887 is one of the latest products from *Microchip*. It features all the components which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc. Some of its main features are listed below.

- **RISC architecture**
  - Only 35 instructions to learn
  - All single-cycle instructions except branches
- **Operating frequency 0-20 MHz**
- **Precision internal oscillator**

- Factory calibrated
- Software selectable frequency range of 8MHz to 31KHz
- **Power supply voltage 2.0-5.5V**
- Consumption: 220uA (2.0V, 4MHz), 11uA (2.0 V, 32 KHz) 50nA (stand-by mode)
- **Power-Saving Sleep Mode**
- **Brown-out Reset (BOR) with software control option**
- **35 input/output pins**
- High current source/sink for direct LED drive
- software and individually programmable *pull-up* resistor
- Interrupt-on-Change pin
- **8K ROM memory in FLASH technology**
- Chip can be reprogrammed up to 100.000 times
- ***In-Circuit Serial Programming* Option**
- Chip can be programmed even embedded in the target device
- **256 bytes EEPROM memory**
- Data can be written more than 1.000.000 times
- **368 bytes RAM memory**
- **A/D converter:**
- 14-channels
- 10-bit resolution
- **3 independent timers/counters**
- **Watch-dog timer**
- **Analogue comparator module with**
- Two analogue comparators
- Fixed voltage reference (0.6V)
- Programmable on-chip voltage reference
- **PWM output steering control**
- **Enhanced USART module**
- Supports RS-485, RS-232 and LIN2.0
- Auto-Baud Detect
- **Master Synchronous Serial Port (MSSP)**
- supports SPI and I2C mode

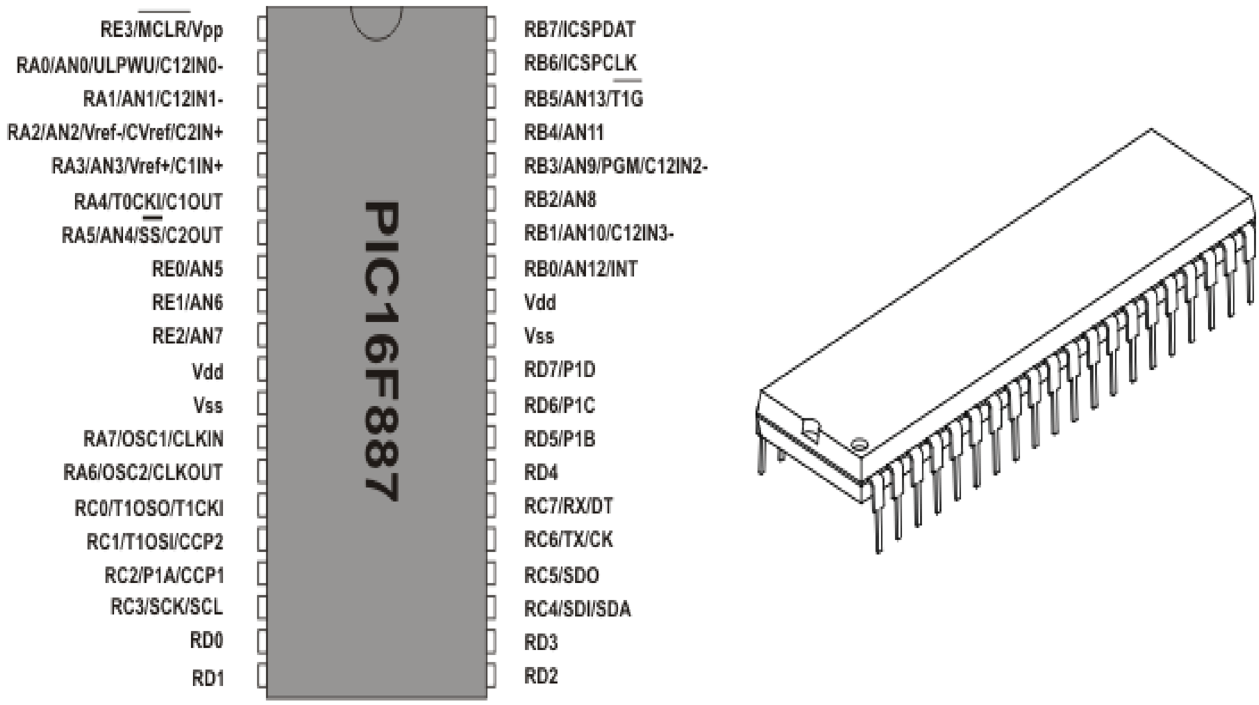

Fig. 6(1): PIC16F887 PDIP 40 Microcontroller

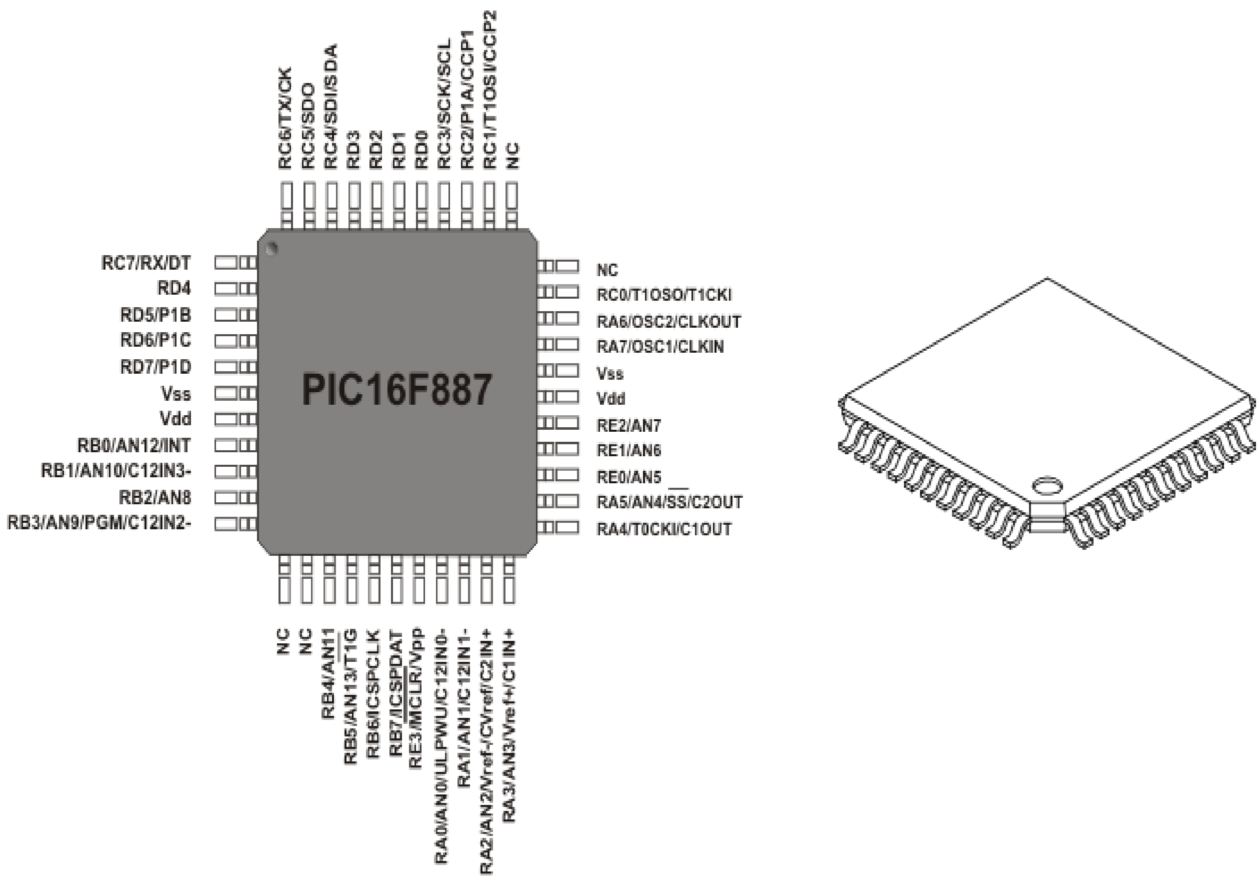

Fig. 6(2): PIC16F887 QFN 44 Microcontroller

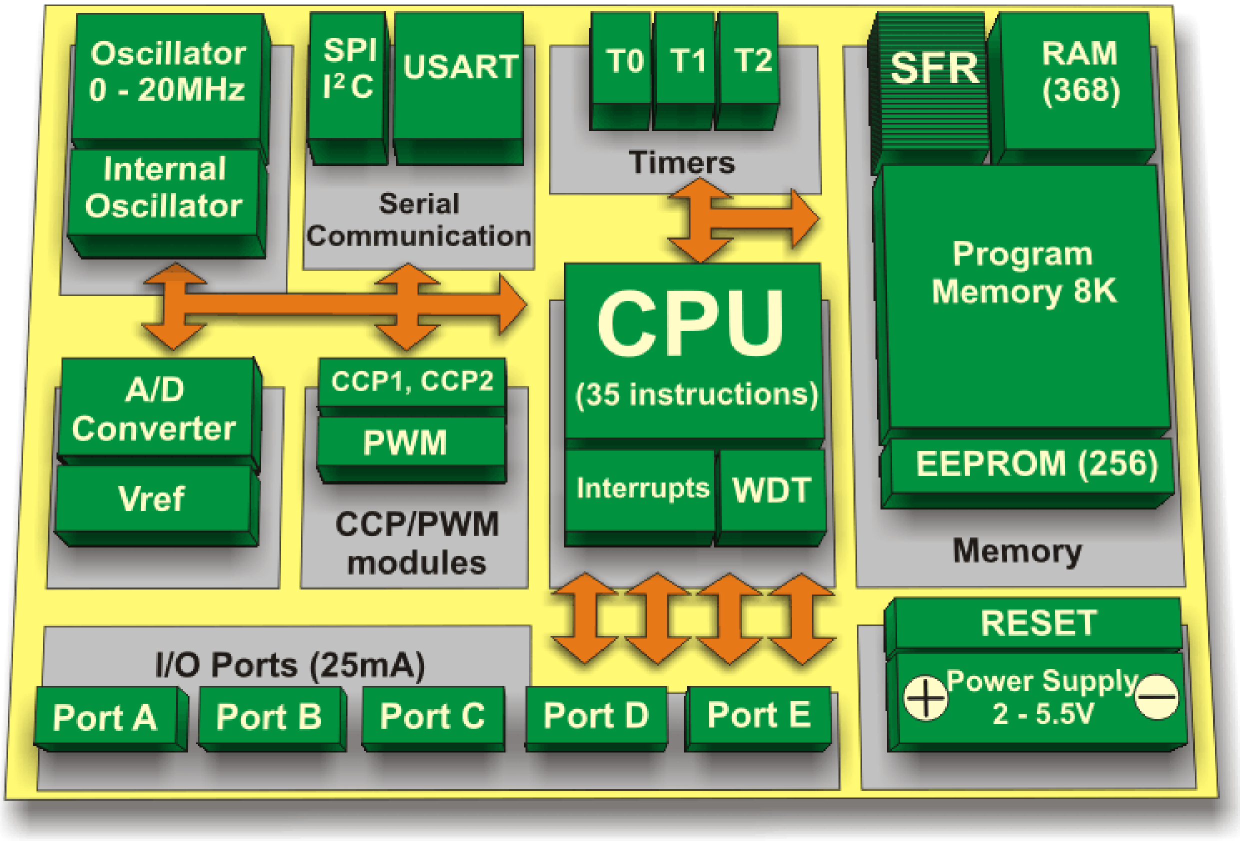

Fig. 6(3): PIC16F887 Block Diagram

3. RESULTS AND DISCUSSIONS

The project aims were to reduce the side effects of the current street lighting system, and find a solution to save power. In this project the first thing to do, is to prepare the inputs and outputs of the system to control the lights of the street. The prototype as shown in Fig. 8 has been implemented and works as expected and will prove to be very useful and will fulfill all the present constraints if implemented on a large scale. Figure 7 shows the street light system, from the figure it can be seen that, all lighting column are OFF, because there is no any object passes through the street, even though the weather is night. This is the idea of using the microcontroller to control each lighting column alone. When any object passes in front specific photoelectric sensor the lighting column which connected to it will be turn ON automatically.

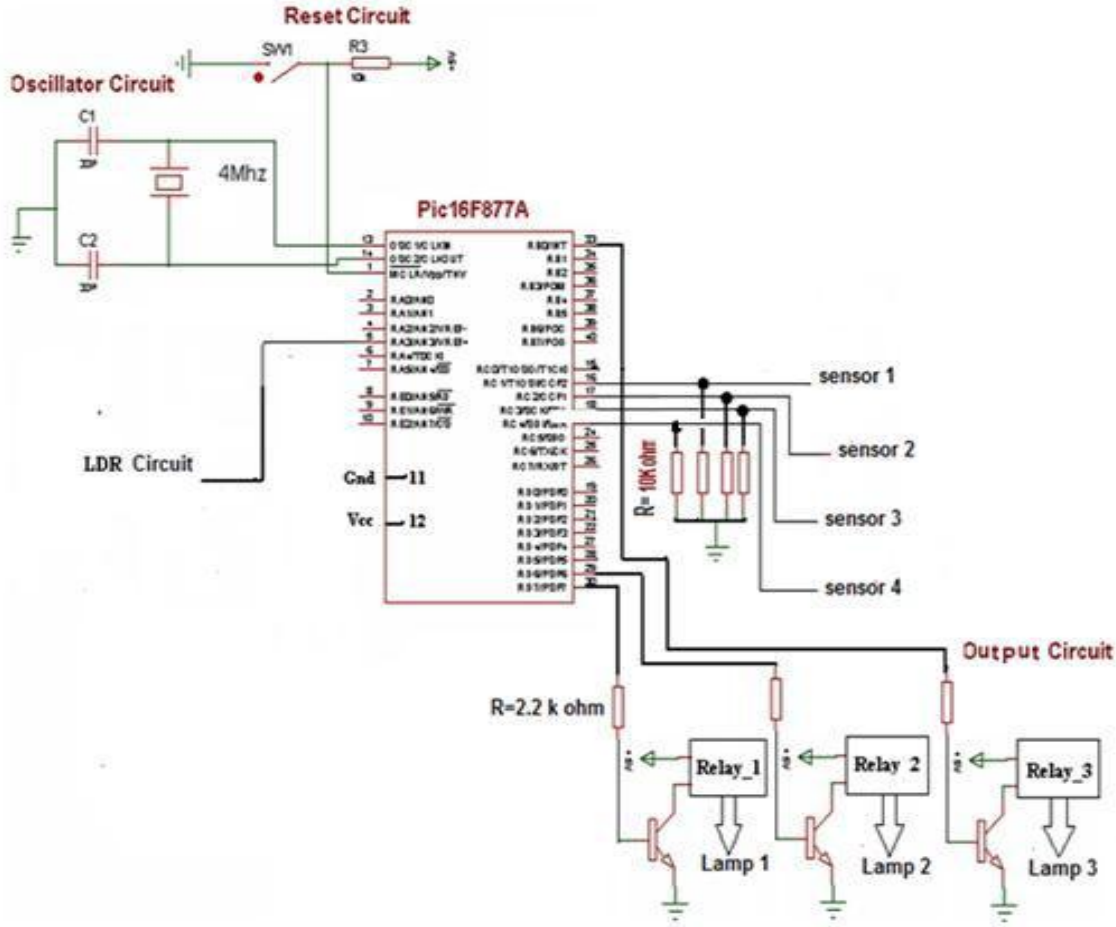

Fig. 7: Circuit Diagram

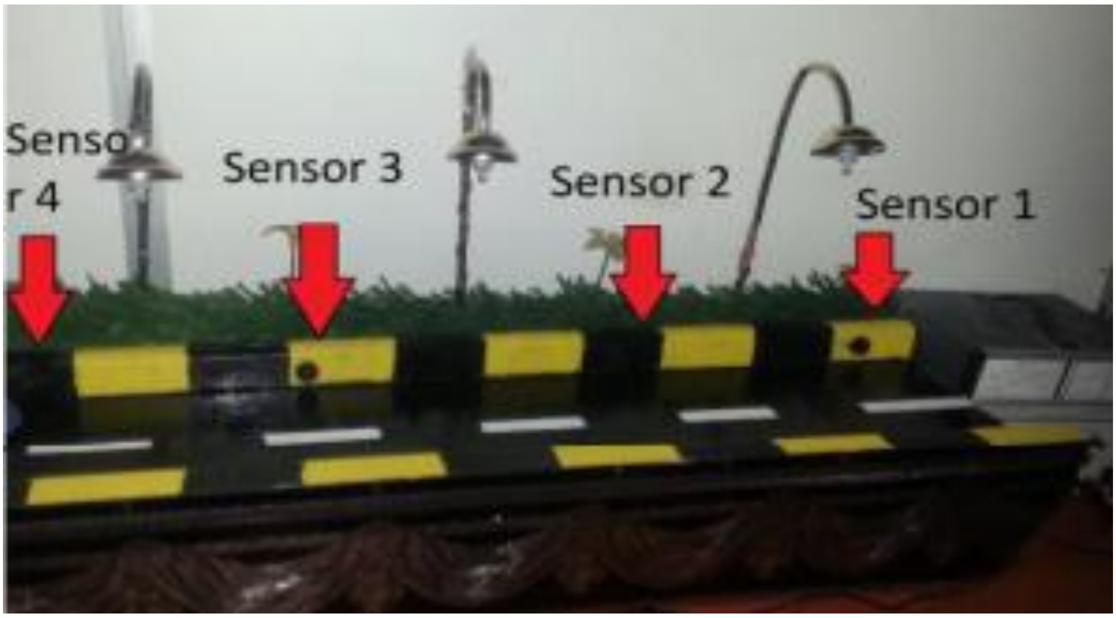

Fig. 8: Proposed Model of Automatic Street Lights

PROGRAM

```
int light;
void read_ldr()
{
unsigned int adc_value=0;
adc_value=ADC_Read(0);
light = 100 – adc_value/10.24;
if(light>=80) // SWITCH of the light when light is 80 percent
{
PORTB.F1=0;
}
else
{
PORTB.F1=1;
}
}
void main()
{
TRISB=0X00;
PORTB=0X00;
Adc_Init();
while (1)
{
read_ldr();
}
}
```

ADVANTAGES

1. Complete elimination of manpower
2. Reduced energy costs.
3. Reduced green house gas emissions.
4. Reduced maintenance costs.
5. Higher community satisfaction.
6. Fast payback.

Applications

1. Balcony, stair case, parking Lightings.
2. Street lights.
3. Garden Lights.

Future Aspects

1. Pole damage detection with the addition of a suitable sensor.
2. Taxi call buttons on lamp posts to signal to the network management centre to generate a Taxi call to the appropriate location.
3. If the system has traffic speed sensors then this information could be used to manage traffic speed via the dimming of the streetlights. If the average traffic speed is too fast during evening and night hours, this could be used to trigger a slight dimming of the streetlights. The level of dimming would be imperceptible to motorists but they would slow down, regardless, in response to the slightly diminished lighting. A five percent light reduction slows traffic but is not noticeable to motorists.
4. With the added intelligence in the lamp, you can add further features to increase HID lamp life, such as softer start-up and protection against re-igniting an already hot HID lamp, since this shortens the lamp life.
5. Information management.

CONCLUSIONS

This project of " AUTOMATIC STREET LIGHTS" is a cost effective, practical, ecofriendly and the safest way to save energy. It clearly tackles the two problems that world is facing today, saving of energy and also disposal of incandescent lamps, very efficiently. According to statistical data we can save more that 40 % of electrical energy that is now consumed by the highways. Initial cost and maintenance can be the draw backs of this project. With the advances in technology and good resource planning the cost of the project can be cut down and also with the use of good equipment the maintenance can also be reduced in terms of periodic checks. The LEDs have long life, emit cool light, donor have any toxic material and can be used for fast switching. For these reasons our project presents far more advantages which can over shadow the present limitations. Keeping in view the long term benefits and the initial cost would never be a problem as the investment return time is very less.

The project has scope in various other applications like for providing lighting in industries, campuses and parking lots of huge shopping malls. This can also be used for surveillance in corporate campuses and industries.

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