A Smart Street Lighting System Using Solar Energy

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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 ir sensors to detect the movement on the street. the microcontroller PIC16F72 is used as brain to control the street light system, where the programming language used for developing the software to the microcontroller. Finally, the system has been successfully designed and implemented as prototype system.

Keywords: Street light, LDR, IR Sensor, Solar Energy, Microcontroller.

1. INTRODUCTION

Automation has created a bigger hype in the electronics. The major reason for this hype is automation provides greater advantages like accuracy, energy conversation, reliability and more over the automated systems do not require any human attention. Any one of the requirements stated above demands for the design of an automated device. The energy conversation is very important in the current scenario and should be done to a maximum extent where ever it is possible. Energy can be effectively conserved if we can control the traffic lights on the highways by glowing them only when there is traffic on the road, and this is all most impossible to detect the arrival of a vehicle manually without the presence of light. So in this situation we should think about a system which is capable of sensing the arrival of vehicle and ON the lights and turn OFF as soon as the vehicle leaves the area.

Our solar panel based street light controlling system is the result of this idea. This was designed with a vehicle detecting sensor which is capable of sensing the arrival of a vehicle. It drives the same information to a micro controller. The micro controller is interfaced with the street lights and it is the responsibility of the controller to switch the status of the lights with respect to the acknowledgement received to it from the vehicle sensor. The major advantage of the device is it not only controls the status of the light but also controls the intensity of the light with respect to the intensity of the light received from the vehicle. The power supply to the street is supplied from solar panel.

The basic firmware for the microcontroller is written in Embedded C language and compiled using PIC complier. The compiler generates the Hex code for the microcontroller and the Hex code is stored /programmed in flash memory of micro controller.

2.BLOCK DIAGRAM OF AUTOMATIC STREET LIGHTING SYSTEM

The block diagram of street lighting system as shown in Fig. 1 consists of microcontroller, LDR, and IR 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 IR 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 transistor to act as an ON/OFF switch.

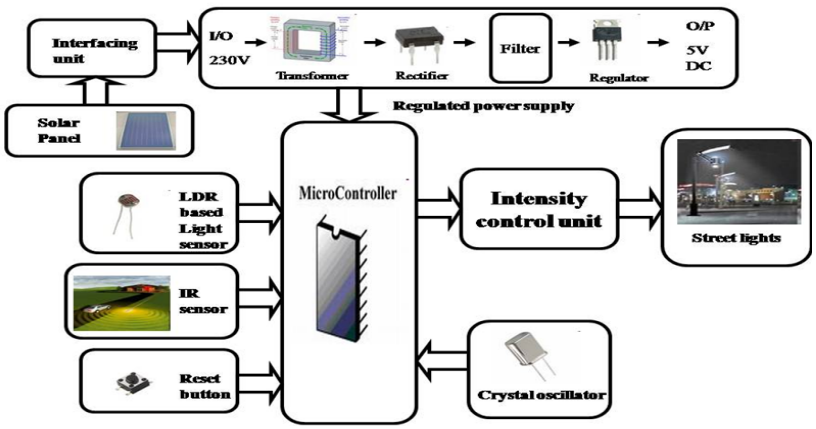

Fig: 2. Block Diagram of Automatic Street Lighting System

2.1 LDR

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.

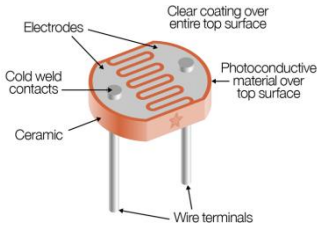

Fig: 2.1 LDR

2.2 IR SENSOR

As its name illustrates it is used for checking the presence vehicle. That is this sensor will sense vehicle presence.Whenever it will find presence of vehicle it give signal to the micro controller that is it found the presence of vehicle. Micro controller will check the presence of light using the LDR.

If LDR resistance is high then micro controller assumes that it is day time and no need to switch ON the high power LED. If resistance is too low then micro controller assumes that it is night time and it as to switch on the high power LED for few seconds.

Like this the the project first check the presence of vehicle using vehicle sensor and after that it will check the presence of light. After this depending up on the condition it will decrease or increase the intensity of high power LED.

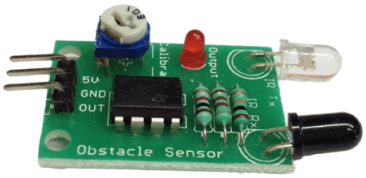

Fig:2.2 IR Sensor

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 the fig 2.3

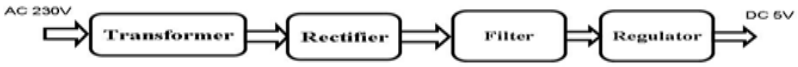

Fig:2.3 Regulated Power Supply

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 then turn on the power, a 5 volt supply from the output pin will be gotten.

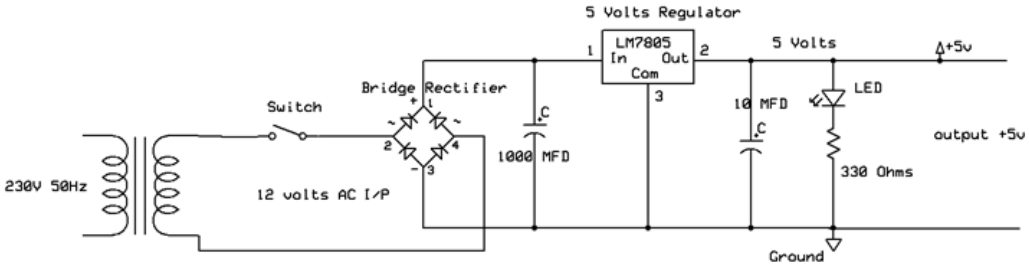

Fig:2.3.1 Circuit Diagram Of Regulated Power Supply

2.4: SOLAR PANEL

PHOTOVOLTAIC CELLS: CONVERTING PHOTONS TO ELECTRONS

The solar cells that you see on calculators and satellites are also called photovoltaic (PV) cells, which as the name implies (photo meaning "light" and voltaic meaning "electricity"), convert sunlight directly into electricity. A module is a group

of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays.

Photovoltaic cells are made of special materials called semiconductors such as silicon, which is currently used most commonly. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely.

PV cells also all have one or more electric field that acts to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off for external use, say, to power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce.

2.5: MICROCONTROLLER.

Fig:2.5 Microcontroller

The microcontroller used in this project is PIC16F72. The PIC families of microcontrollers are developed by Microchip Technology Inc. Currently they are some of the most popular microcontrollers, selling over 120 million devices each year. There are basically four families of PIC microcontrollers:

PIC12CXXX 12/14-bit program word
PIC 16C5X 12-bit program word
PIC16CXXX and PIC16FXXX 14-bit program word
PIC17CXXX and PIC18CXXX 16-bit program word

2.5.1 PIC16F72 Pin diagram:

PIC16F72 has a total of 28 pins. It is most frequently found in a DIP28 type of case but can also be found in SMD case which is smaller from a DIP. DIP is an abbreviation for Dual In Package. SMD is an abbreviation for Surface Mount Devices suggesting that holes for pins to go through when mounting aren't necessary in soldering this type of a component.

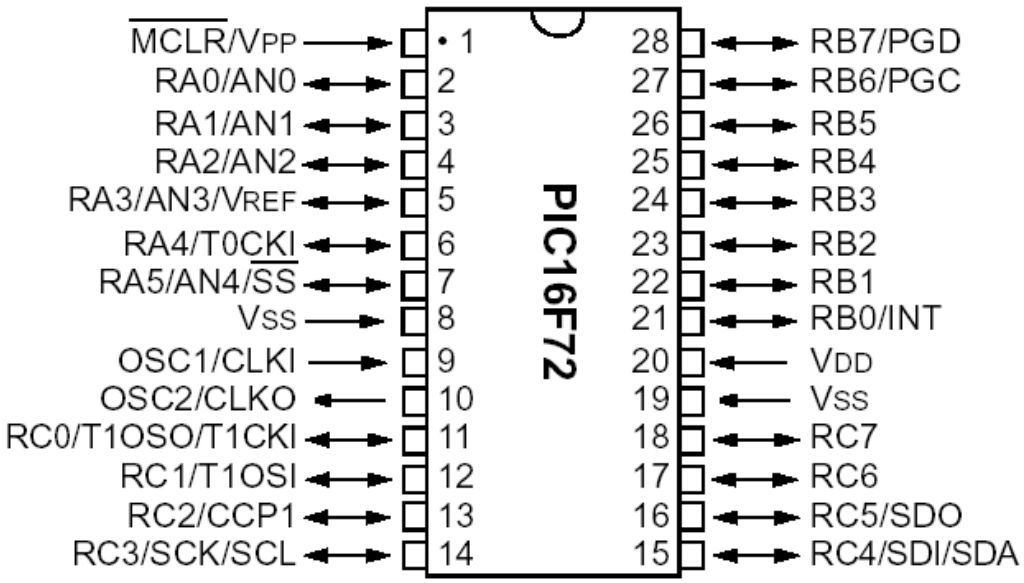

Fig. 2.2.1 Pin Description of PIC16F72

The inputs in the streets lighting system are LDR and photoelectric sensors, after dusk the light sensor will activate the system, to be ready to detect any object by photoelectric sensors, on the road to turn ON the streetlights. Lamps will be used as streetlights in this paper.

In this section each circuit, which has been designed will be discussed. Firstly the LDR circuit as shown in Fig. 7, the LDR and RV1 form one arm of the bridge, and R1-R2 form the other arm. These arms can actually be regarded as potential dividers, with the R1-R2 arm applying a fixed half-supply voltage to the non-inverting input of the op-amp, and with the LDR-RV1 divider applying a lightdependent variable voltage to the inverting terminal of the op-amp.

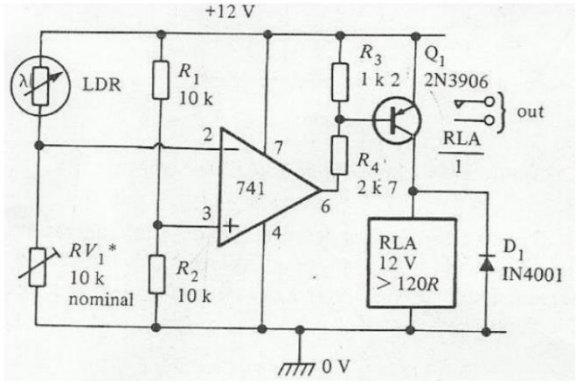

Fig: 2.2.3 LDR Circuit.

In use, RV1 is adjusted so that the LDR-RV1 voltage rises fractionally above that of R1-R2 as the light intensity rises to the desired trigger lever, and under this condition the op-amp output switches to negative saturation and thus drives the relay on via Q1 and biasing resistors R3-R4 when the light intensity falls below this level, the op-amp output switches to positive saturation. The circuit is very sensitive, being able to detect light-level changes too small to be seen by the human eye, the circuit can be modified to act as a precision dark-activated switch by either transposing the inverting and noninverting input terminals of the op-amp, or by transposing RV1 and the LDR. Further, the Reset circuit is used to put the microcontroller into known state. Normally when a PIC microcontroller is reset, execution starts from address 0 of the program memory. Also, the oscillator circuit has been used to provide a microcontroller with a clock, so that the microcontroller can execute a program. Four photoelectric sensors are used in this paper. Their function to sense the objective that will pass through the street, at the same time give a signal to the microcontroller to turn on the lamp. The idea to save the energy, where the system have been designed to light ON the lamp in the night only and only if there is any object passes through the street. Except to that the light will be OFF. First photoelectric sensor is used to turn ON the first lighting column via microcontroller automatically when any object passes in front of it. Meanwhile the second photoelectric sensor will turn ON the second lighting column and turn OFF the first one after few delay when the object passes in front of it. The third sensor will activate the third lighting column when the object passes in front of it, and will turn OFF the second lighting column after few delays.

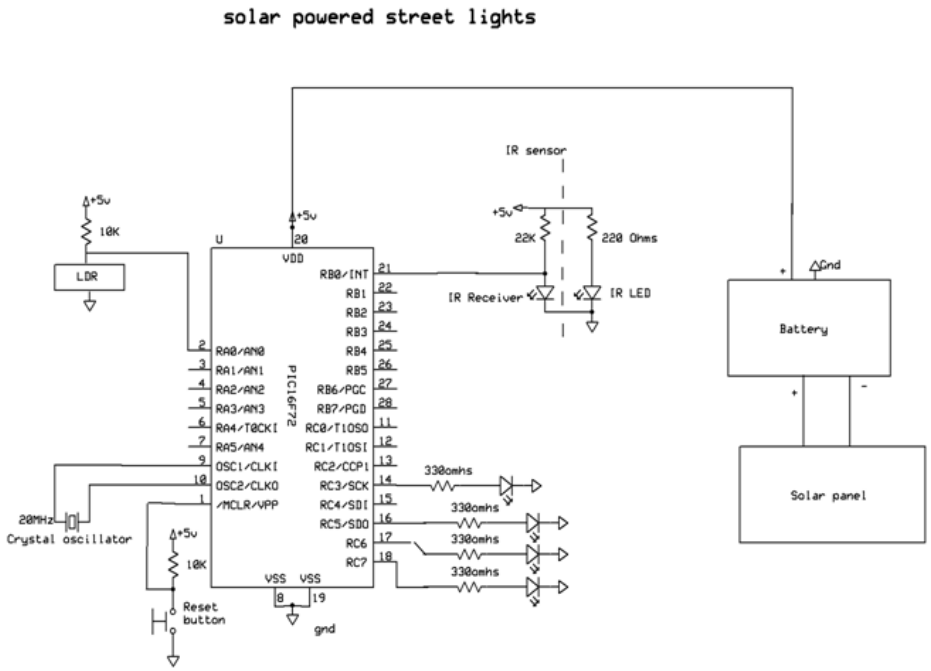

Fig: 2.2.4 Circuit Diagram of Solar Power Street Lights

The details of this circuit can be summarized as follow.

1.Pins 9 and 10 of the PIC are connected to crystal oscillator which is of 20MHZ frequence
2.Pin 1 of the PIC is connected to Reset button.
3.Pin 2 of the PIC is connected to LDR.
4.Pin 20 of the PIC is connected to Battery.
5.Pin 21 of the PIC is connected to IR Sensor.
6.Pins 14,16,17,18 of the PIC are connected to LED with 330 Ohms.
7.Pins 8and 19 of the PIC are connected to ground.

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. 9 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.

Fig.3 Prototype of 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 IR sensor the lighting column which connected to it will be turn ON automatically.

4.CONCLUSION

This paper elaborates the design and construction of automatic street control system circuit. Circuit works properly to turn street lamp ON/OFF. After designing the circuit which controls the light of the street as illustrated in the previous sections. LDR sensor and the photoelectric sensors are the two main conditions in working the circuit. If the two conditions have been satisfied the circuit will do the desired work according to specific program. Each sensor controls the turning ON or OFF the lighting column. The street lights has been successfully controlled by microcontroller. With commands from the controller the lights will be ON in the places of the movement when it's dark. furthermore the drawback of the street light system using timer controller has been overcome, where the system depends on IR sensor. Finally this control circuit can be used in a long roadways between the cities.

5.REFFRENCES

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