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SOLAR BASED STREET LIGHT CONTROL

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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.*

Key-Words: - Street light, LDR, photoelectric sensor, microcontroller, energy saving and circuit design

1.Introduction-

The idea of designing a new system for the streetlight 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 Mathematical Methods and Optimization Techniques in Engineering ISBN: 978-960-474-339-1 92then 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.

2 Automatic street light system circuit design

The system basically consists of a LDR, solar pannel, battery, Relays and Micro controller.

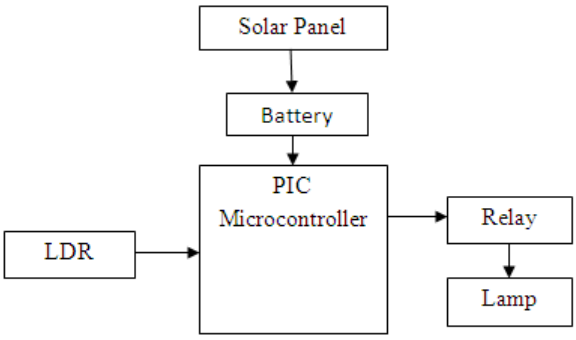

Fig. Block Diagram

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.

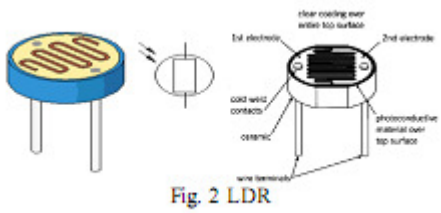

Fig. 2 LDR

2.2 Solar panel-

A Solar Panel is basically a module that converts light energy (photons) from the sun to generate electricity in direct current (DC) form. There are two types of solar panels, mainly crystalline and thin-film types.

There are two types of crystalline solar panels :

- Poly-crystalline Solar Panel
- Mono-crystalline Solar Panel
- As for Thin-film types, there are : Amorphous Silicon (a-Si)
- Cadmium Teluride (Cd-Te)
- Copper Indium Gallium Selenide (CIGS)
- Dye-Sensitized Solar Cell (DSC)

2.3 Batteries-

Batteries are the most important component in the installation of solar system. Batteries store electricity from solar panels during day time and deliver this energy to the fixture during night. The life cycle of battery is very important to the lifetime of light and capacity of battery will affect the backup days of the lights. Two types of batteries are usually used which are Gel Cell Deep Cycle battery and Lead Acid Battery and many more. During charging time, electrical energy is converted into chemical energy and stored in the form of chemical energy and during discharging time the chemical energy is converted into electrical energy. The proper selection of batteries for PV systems depends upon the best knowledge of their design features, operational requirements and performance characteristics. Batteries are manufacture by the combination of different sequential and parallel processes. Conduction of charging and discharging cycles on batteries are done necessarily before bringing them to the market for distribution to consumers. Important components of batteries are cells, active element, electrolyte, grid plate, separator, terminal posts, cell events and case.

2.4 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.

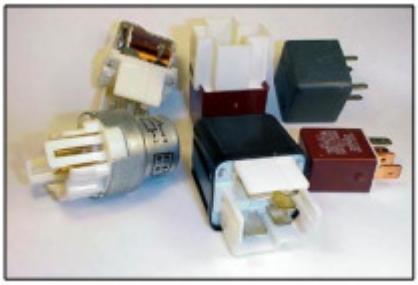

Fig. 5 Different types of relays

2.5 PIC16F877A Microcontroller-

A microcontroller is a computer control system on a single chip. It has many electronic circuits built into it, which can decode written instructions and convert them to electrical signals. The microcontroller will then step through these instructions and execute them one by one. As an example of this a microcontroller we can use it to controller the lighting of a street by using the exact procedures. Microcontrollers are now changing electronic designs. Instead of hard wiring a number of logic gates together to perform some function we now use instructions to wire the gates electronically. The list of these instructions given to the microcontroller is called a program. There are different types of microcontroller, this project focus only on the PIC16F877A Microcontroller where it's pins as shown in fig.6

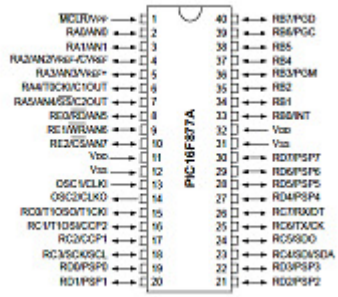

Fig. 6 Pin diagram of PIC16F877A microcontroller

3 Automatic street light control

Circuit Design

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 light-dependent variable voltage to the inverting terminal of the op-amp.

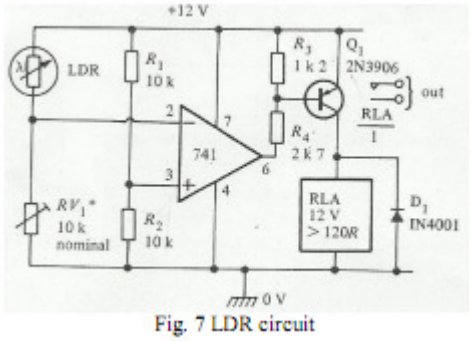

Fig. 7 LDR circuit

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 non- inverting 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. The details of this circuit can be summarized as follow-

1. Pins 13 & 14 of the PIC are connected to the Oscillator circuit and Crystal which consisting of 4 MHz crystal connected to two 33 Pf capacitors.

2. Pin 1 is connected to VCC +5V through 10KΩ resistor, connected to reset bottom for resetting the circuit.

3. Pin 5 is connected to the LDR Circuit.

4. Pins 16, 17, 18, and 19 connected to the photoelectric sensors through 10KΩ resistor.

5. Pins 29, 30 and33 connected to the lamp1, lamp2 and lamp3, through 2.2KΩ resistance and transistor and Relay.

Advantage-

1. Solar street light is independent of grid as a result of this operating cost is much low.
2. Risk of accidents is very low.
3. It is environmental friendly, no harmful emissions.
4. Longer life compared to conventional streel lights.
5. Power consumption is much lower.

Disadvantage-

1. Initial investment is very high.
2. Rechargeable batteries have to be replaced from time to time .
3. Non-availability of sunlight during rainy and winter seasons is a problem.
4. Dust accumulation on the surface of panel creates a problem.

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 photoelectric sensor. Finally this control circuit can be used in a long roadways between the cities.

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