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International Journal of Science Engineering and Advance Technology, IJSEAT, Vol 3, Issue 9
ISSN 2321-6905
September-2015

International Journal of Science Engineering and Advance Technology

Design and implementation of Traffic Flow based Street Light Control System with effective utilization of solar energy

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ABSTRACT

Street Light Control System which operates automatically is not only easiest but also the intelligent system. This system can be set to operate in automatic mode, which regulates the streetlight according to detection of moving object. The main objective of this project is to save the power from street lighting in rural areas where there will be very less use of street lights after 11pm to morning 5am. So here, in this project we use automatic ON/OFF mechanism of street lighting by detecting the movement of object (vehicle/person).

In this project, we use renewable source of energy i.e., solar power for street lighting. Apart from this, we replace normal bulbs in street lighting with LEDs due to which the power consumption in reduced by 3 times. And also, we use IR sensors to detect the movement of object to activate the lighting a few meters before the object is about to reach the lighting area.

Here, the IR sensors are deactivated after a timing delay of 30seconds and similarly remaining sensors are activated and deactivated after 30seconds. We also place a battery backup for 2days in order to supply power continuously in the worst cases such as rainy time. We also connect this solar power region to the grid to supply excessive power to the grid to avoid saturation of battery and also vice-versa i.e., to receive power from grid in rainy seasons and winter seasons. So, this is a very effective way of saving a large amount of power.

INTRODUCTION

The project is designed to detect vehicle movement on highways/rural areas to switch ON only a block of street lights ahead of it and to switch OFF the trailing lights to save energy. During night all the lights on the highway/rural areas remain ON for the vehicles, but lots of energy is wasted when there is no vehicle movement.

This proposed system provides a solution for energy saving. This is achieved by sensing an approaching vehicle and then switches ON a block of street lights ahead of the vehicle. As the vehicle passes by, the trailing lights switch OFF automatically. Thus, we save a lot of energy. So when there are no vehicles on the highway, then all the lights remain OFF.

Sensors used on either side of the road senses vehicle movement and sends logic commands to microcontroller to switch ON/OFF the LEDs. Thus this way of dynamically ON/OFF helps in saving a lot of energy. The project uses an 8052 seriesmicrocontroller.

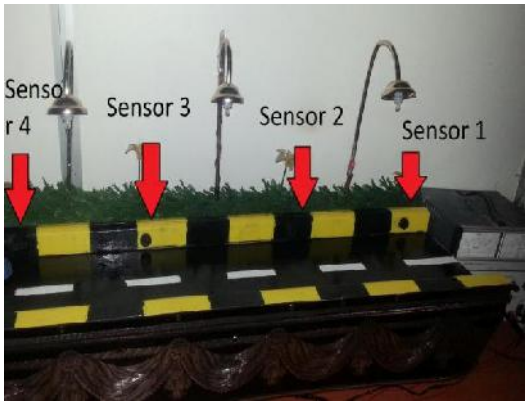


Fig: Prototype of street light system

Figure represents our proposed concept for effective utilization of electrical energy. Figure above shows the street light system, from the figure it can be seen that, all lighting column are OFF, because there is no object passing 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 of the sensor the lighting column which is connected to it will be turn ON automatically.

PROPOSED CONCEPT

INTRODUCTION

The main objective of this project is to save the power from street lighting in rural areas where there will be very less use of street lights after 11pm to

morning 5am. So here, in this project we use automatic ON/OFF mechanism of street lighting by detecting the movement of object (vehicle/person).In this project, we use renewable source of energy i.e., solar power for street lighting. Apart from this, we replace normal bulbs in street lighting with LEDs due to which the power consumption in reduced by 3 times. And also, we use IR sensors to detect the movement of object to activate the lighting a few meters before the object is about to reach the lighting area. Here, the IR sensors are deactivated after a timing delay of 30seconds and similarly remaining sensors are activated and deactivated after 30seconds. We also place a battery back-up for 2days in order to supply power continuously in the worst cases such as rainy time. We also connect this solar power region to the grid to supply excessive power to the grid to avoid saturation of battery and also vice-versa i.e., to receive power from grid in rainy seasons and winter seasons. So, this is a very effective way of saving a large amount of power. Fig. shows basic block diagram of our proposed system.

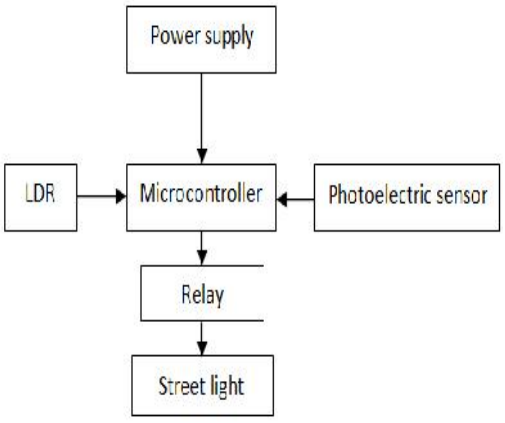


Fig: Block diagram of street light system

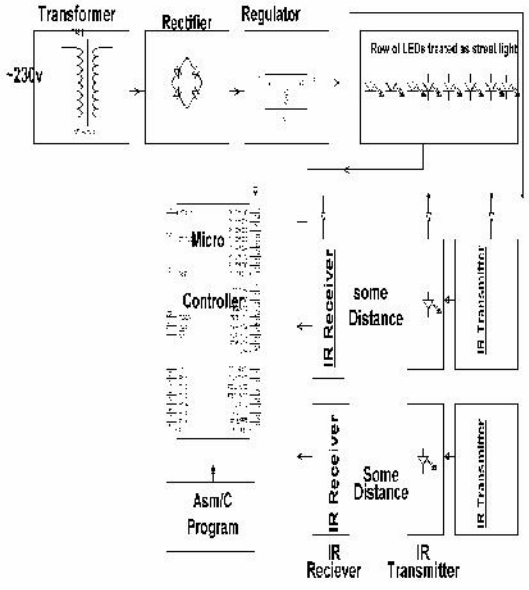
At first, the light energy from the sun is absorbed by the photovoltaic cells in the solar panels and converted into electrical energy and stored in the battery back-up available. Now, this battery back-up is used in the evening for street lighting. This street lighting system is made automatic i.e., ON/OFF with the help of IR sensors by the detection of movement of any object passing through the sensors. With the help of a microcontroller the IR sensors are designed to activate the LED based street lighting for a duration of 30 seconds and turn-off the lights after 30 seconds. And similarly, the next sensor senses the movement of vehicle/passing object and activates the lighting at the next pole and this process continuous till the last pole.

IR LED/SENSOR:

- An IR LED, also known as IR transmitter, is a special purpose LED that transmits infrared rays in the range of 760 nm wavelength.
- Such LEDs are usually made of gallium arsenide or aluminum gallium arsenide. They, along with IR receivers, are commonly used as sensors.
- The appearance is same as a common LED. Since the human eye cannot see the infrared radiations, it is not possible for a person to identify whether the IR LED is working or not, unlike a common LED.
- Overcome this problem, the camera on a cell phone can be used. The camera can show us the IR rays being emanated from the IR LED in a circuit.

To detect the movement in the street, the IR sensors have been used in this project, where emitter and receiver are in one unit. Light from the emitter strikes the target and the reflected light is diffused from the surface at all angles. If the receiver receives enough reflected light the output will switch states. When no light is reflected back to the receiver the output returns to its original state. In diffuse scanning the emitter is placed perpendicular to the target. The receiver will be at some angle in order to receive some of the scattered (diffuse) reflection.

Block diagram of proposed system:



The above block diagram is the representation of connection of power supply from grid to the street

lighting.

In this connection, the 230V ac supply is stepped down to our desired voltage level (i.e., 12V) with the help of a step down transformer. And now, this 12V ac supply is converted into 12V dc supply with the help of a modern rectifier. This 12V dc supply is passed through a modern rectifier to become pulsating dc supply. And this 12V dc supply is further allowed through capacitors/filters to become ripple free and pure dc supply. Here, the 12V dc supply is regulated to our desired level i.e., 5V dc with the help of a voltage regulator 7805.This 5V dc is supplied to the LEDs which are available for street lighting and also for the microcontroller 8051 and the IC555 timer.

OPERATION OF BLOCK DIAGRAM

When a movement of an object/vehicle is passing over the IR sensor, then the signal from transmitter is reflected and is received by the receiver. And when this happens, a signal is sent to microcontroller to activate the street lighting and then the LED light goes ON. Similarly, at the same time IC555 timer is activated and a delay of 30seconds is provided to the lights as the moving object/vehicle takes some time to reach the region of light because the IR sensor is placed few meters before the light pole as the light got to be activated before the vehicle reaches the light.

STREET LIGHT AUTOMATIC CONTROL METHODOLOGY

The street light control system adopts a dynamic control methodology. According to this, the initial state of the lights is set as off. Street light schematic is shown in Figure 4 and control flow in Figure 5. When the signal is detected at the point S, the state of lamp A switched (On to Off or Off to On), when the signal gets detected at the point B, the states of lamp A and lamp C are switched on or off simultaneously, while point D detects the signal, lamp C and lamp E are switched on or off simultaneously, while S' detects the signal, lamp E is switched on or off.

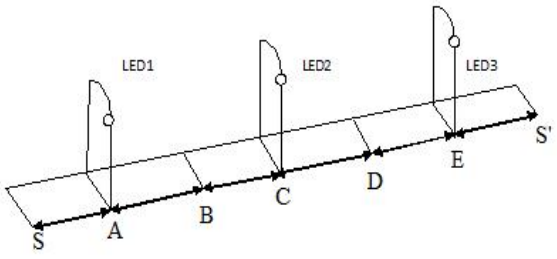


Fig: Streetlights schematic

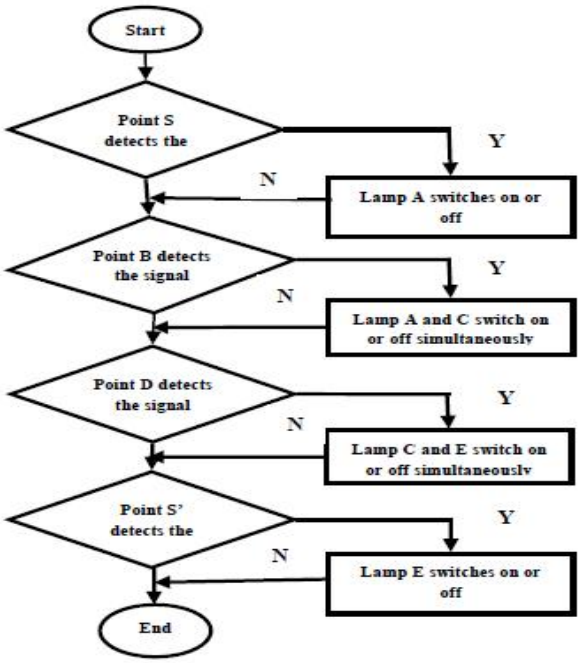


Fig: The control flow chart

MICROCONTROLLER:

Microprocessors and microcontrollers are widely used in embedded systems products. Microcontroller is a programmable device. A microcontroller has a CPU in addition to a fixed amount of RAM, ROM, I/O ports and a timer embedded all on a single chip. The fixed

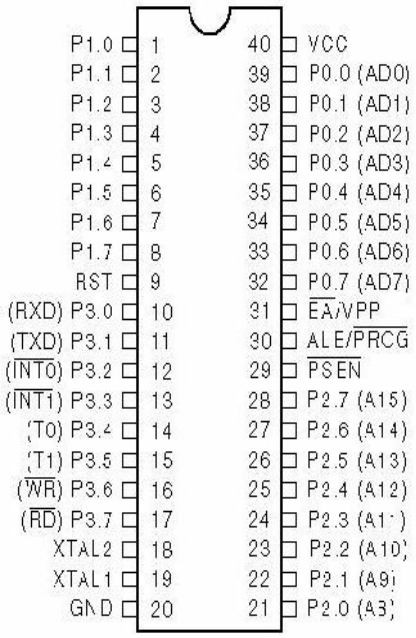


Fig: pin diagram of micro controller

amount of on-chip ROM, RAM and number of I/O

ports in microcontrollers makes them ideal for many applications in which cost and space are critical.

The Intel 8051 is Harvard architecture, single chip microcontroller (µC) which was developed by Intel in 1980 for use in embedded systems. It was popular in the 1980s and early 1990s, but today it has largely been superseded by a vast range of enhanced devices with 8052-compatible processor cores that are manufactured by more than 20 independent manufacturers including Atmel, Infineon Technologies and Maxim Integrated Products.

8051 is an 8-bit processor, meaning that the CPU can work on only 8 bits of data at a time. Data larger than 8 bits has to be broken into 8-bit pieces to be processed by the CPU.

The present project is implemented on Keil vision. In order to program the device, pro load tool has been used to burn the program onto the microcontroller.

The features, pin description of the microcontroller and the software tools used are discussed in the following sections.

FEATURES OF AT89S52:

- 4K Bytes of Re-Programmable Flash Memory.
- RAM is128 Bytes.
- 2.7 V to 6V Operating Range.
- Fully Static Operation :0Hz to 24Mhz.
- 32 Programmable I/O Lines.
- Two 16 Bit Timer/Counters.
- Six Interrupt Sources.
- Programmable Serial UART Channel.
- Two-Level Program Memory Lock.
- 128 x 8-bit Internal RAM.

Description:

The AT89S52 is a low-voltage, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable memory. The device is manufactured using Atmel's high- density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcomputer, which provides a highly flexible and cost effective solution to many embedded control applications. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions.

IMPLEMENTED HARDWARE

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. 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.

CONCLUSION

The project work "Effective utilization of solar-powered street lighting with automatic ON/OFF mechanism in rural areas" is designed & developed successfully. For the demonstration purpose, a proto type module constructed with lower ratings of devices, & results are found to be satisfactory. As it is a demo module it cannot be used for real applications, but the concept is near to the real working system, to make it more realistic, desired rating devices and components should be implemented practically.

So, finally from the results observed in the prototype we can clearly say that a large amount of power can be saved by the use of automatic ON/OFF mechanism of street lighting in addition to renewable source of energy i.e., solar energy. Highly efficient solutions like MPPT are needed to maximize the efficiency from solar panels. Expectations are increasing for solar-powered LED lighting to become the environmentally friendly outdoor solution for the 21^{st}century.

FUTURE SCOPE:

This project can be further extended to create a better performance and reliability in many ways. At first, by the use of separate microcontroller for each IR

sensor each light can be controlled individually without depending on same microcontroller. Here, as all the sensors are depending on same microcontroller the controllability and operation of street lighting is difficult, because in this case when the vehicle crosses the first sensor the first light is activated and when the vehicle again crosses the second sensor, the second light is not activated until the first light goes OFF.

Secondly, a connection to grid can be given which should be bi-directional. It means, the power can be imported and exported to grid. In this project as we use solar power stored in battery for street lighting it's an advantage for us as we are using renewable source of energy. So, when a large amount of power is extracted from sun, the battery gets completely charged and the excess power which has no place to go saturates the battery by pushing excess power to the battery. Hence, we export the excess power to the grid. And similarly in case of failure or shortage of back-up battery the required power can be imported from the grid. This is a very great advantage for effective operation of street lighting.

Thirdly, for bi-directional connection of grid and battery back-up a specially designed meter should be placed as mediator. In future, by designing a bi-directional meter the amount of power imported to and exported from the grid can be calculated and a further extension to this project can be done.

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