Arm Based Street Lighting System with Fault Detection

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***Abstract*— In this paper a new innovative street light system with optimized street light management and efficiency is presented. It uses many sensors to control and guarantee a better efficient system. Presence of a person or an obstacle is detected by using the presence detector sensors. Street lights will be switched ON only when a person or an obstacle comes in the detection range else it will be switched OFF. Wireless communication uses GSM devices which allow more efficient street lamp management system and control. Arm processor will check the state of street lamp and informs through GSM module to the control by sending a message to the prescribed number. The system allows substantial energy savings with increased performance and maintainability. By using this system the manual works will be reduced to a great extent**.

I. INTRODUCTION

In lighting system, particularly within the public sector are not designed as per the standards of the reliability and low power consumption and they wont use latest technological developments. Recently however with the increasing importance for saving power and proper maintenance are leading to develop new techniques and technologies which permit significant power savings and larger respect for the environment and more effective management. In this model we proposed three solutions to those issues.

The main lamp types used in street lighting are the high pressure discharge lamps, e.g.: mercury vapor lamps, HPS lamps, and metal halide lamps. The discharge lamps demand a ballast that provides their starting and steady state behavior, which is commonly electromagnetic. The power consumption is achieved using High power LEDs for the source of light, which uses less power and gives more illumination.

The second one and perhaps the most revolutionary is the use of remote management system. This system uses light dependent resistors for finding the faulty condition of any bulbs and then giving the information to the processor, which will then send a message to the control room, by using GSM modem.

Finally, the third solution is to use of renewable energy as power source instead of typical power sources, therefore taking care of the environment. In this field solar energy is the most often used resource.

Our work aims at unification of the three prospects, making an intelligent street lighting system, which uses high power leds, and using solar energy as the alternative energy. The management system is implemented by using fault detector circuit to gather the faulty state of the lamp and then transferring the data to the arm processor. Arm processor takes the relevant action whether to notify to the control room or not based on the state of the street lamp.

II. GENERAL CONCEPT OF THE SYSTEM

Automatic Street Light Control System is a simple yet powerful concept. Street lamps runs using solar panels which are non polluting source of electricity and requires much less maintenance compared to conventional street lighting system. By using solar panel we can eliminate external wiring and risk of accidents can be minimized.

The entire system will run only when sunlight goes below the visible region of our eyes and the system will be off when the sunlight comes visible to our eyes. This is sensed by sensor called Light Dependent Resistor (LDR), which senses the light actually like our eyes. Streetlights will automatically be switched ON when it detects a person in its detection range and streetlights will automatically switched OFF whenever the person moves out of the detection range. To make the system more efficient the successive streetlight will be switched ON when the person reaches the end of the first lamppost range.

For detecting the presence of a person or vehicle in the detection range it is accomplished by using PIR sensors. They are often referred to as passive infrared or IR motion sensors. These are small inexpensive, low power, easy to use and don't wear out.

The proposed model using GSM module can manage street lamps when they are not in working condition. GSM module is used to send messages. Each street lamp will be monitored continuously using fault detecting circuit. If the circuit detects any faulty lamp it sends the information to the controller which in turn notifies to corresponding maintenance department using the GSM module.

The entire set of inputs are monitored and the corresponding outputs are enabled based on input conditions by an arm processor. Benefits of using ARM processor are lower costs, less heat and less power usage, portable.

Arm Processor

The arm processor is the key component of many embedded system like mobile phones, handheld organizers etc. It uses a 32 bit load- store architecture RISC architecture. It means the core cannot directly manipulate the memory. The data manipulations can be done by loading registers with information located in its memory, performing the data operation and then storing the value back in the memory. There are 37 total register in the arm processor and the total number is divided among the 7 different processor modes. Processor would follow a Von neuman style architecture i.e. having a single memory rather than having separate memories for instruction and data. In the register style instruction there would be one write register and two read registers.

B. Presence sensor

The presence sensor has the task of identifying the presence of a person or any obstacle in its detection range causing the switch ON and OFF of the lamps. In this model we have used pir sensors for detecting the presence of person or any obstacle. Infrared proximity works by sending a beams of invisible infrared light in a straight path. A photo detector on the proximity switch detects any reflections of this light. These reflections allow infrared proximity sensor to determine whether there is an object nearby. As proximity switches with just a light source and photodiode are susceptible to false readings due to background light, more complex switches modulate the transmitted light at a specific frequency and have receivers which only respond to that frequency. Even more complex proximity sensors are able to use the light reflected from an object to compute its distance from the sensor. These sensors will be deployed at some particular height so as to avoid unwanted detection like animals.

C. Light sensor

Light sensor will measure the external light intensity and if the external light intensity falls below a threshold level the entire system will be switched on. This is to make the street lamps to be switched ON only in the night time and to remain OFF in the day time. In this model we used an light dependent resistor which varies its resistance based on the illumination of light that falls on it. The range of the resistance is 0 to 15k ohms. These light dependent resistors (LDR) are having high reliability, less power consumption, wide ambient temperature.

D GSM module

GSM stands for global position for mobile communication. GSM is a kind of protocol that is used for mobile or radio communication. It is widely used because it provides low cost, long wireless communication channel where no need of high data rate.

E Fault detection

The faulty condition of the bulbs are detected by using light dependent resistor attached close to the street lights. The LDR offers a high value of resistance thereby making the circuit open. Arm processor will check for this condition only when the corresponding street light is switched ON. When this condition is triggered the arm processor will sends a message to the control room using the GSM modem connected to the processor and thereby making a better management system. The model of fault detection circuit is shown in fig 1.

III. SYSTEM TESTING AND DISCUSSION

The prototype has been tested to verify the general functionality and determine points for improvement and optimization. The measurements collected throughout the testing permit to calculate energy savings and economic benefits.

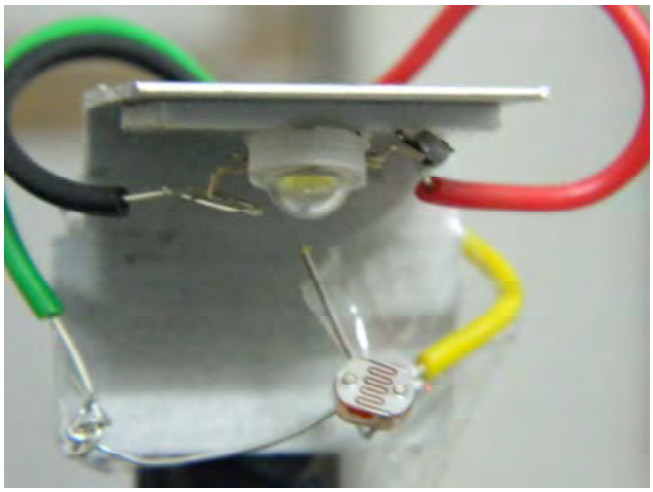

Fig 1 Fault detection

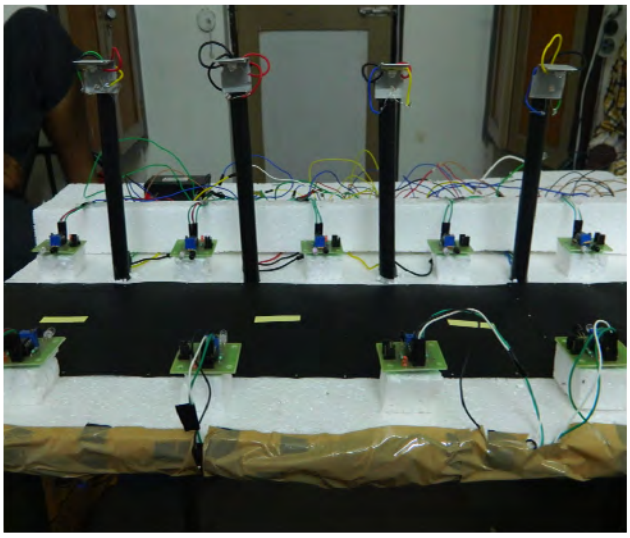

Fig 2 System in Day light

Fig 3 system in night time

A *Power management and consumption*

The system was designed to operate in stand –alone, by the energy supplied from the solar panel. The benefits from this type of power are important thus avoiding the tedious and expensive wiring and connection to external

power networks, enabling considerable savings and ease of implementation. The system is intended to be a low-power, minimizing the battery capacity and also the energy acquired from the solar panel.

The program that controls the system is designed primarily to avoid wasting energy. Firstly, as a result that the system works solely in the darkness, avoiding waste of energy throughout sunlight hours when the sole active device is the solar panel that recharges battery. Secondly, the sensors enable the system to operate solely when necessary. Thirdly, the system employs highly economical LEDs to ensure correct illumination and assure energy savings. Finally, when the system is disabled, all devices (wireless module and microcontrollers) are in the sleep mode, that permits negligible power consumption. The wake-up is triggered by the change of conditions (emergency device, presence sensor, etc.). The selection of the battery depends on the conditions where the system is installed.

B Estimation of prices and savings

This proposed system may be criticized as being expensive however we must consider its advantages: slightly higher prices of the lampposts are compensated by lack of costly external wiring and the availability of power network and considerably lower prices of maintenance (due to central management and reliability of LEDs).

Energy savings are of utmost importance today. The goal is, therefore, the reduction of operating prices of street lighting with the creation of a system characterized by straightforward installation and low power consumption, powered by a renewable supply of energy through solar panels with no harmful atmosphere emissions and minimizing light pollution.

Making a short comparison with the normal street lighting systems: Supposing that one lamp is switched on for 4,000 hours per year. One streetlight has a median consumption of 200 W and the price of energy is of Rs 16000 yearly. If suppose a 5 km long street, it is necessary to install 125 street lights (one each forty meters), with yearly energy consumption of Rs 2000 With the system presented in this paper, every lamp uses about 20-25 W (95% of energy consumed by the LEDs). With an equivalent example as before, energy cost decrease to Rs 500 (savings of 80%).

Based on the field tests another possibility of energy savings becomes evident. Classical system consumes energy independently if it is needed or not. It is active for about 10 hours daily and the total number of working hours is about 300 per month, versus 87-108 hours proposed system, savings of about 66% to 71% are expected. The savings may be improved by using more efficient LEDs, since the consumed energy almost entirely depends on LEDs consumption.

Finally, since the system is powered by solar panels (with batteries), the energy price does not depend on provider costs. Consequently, the sole price to consider is that of the installation and implementation of the system; with following savings thanks to lower maintenance and energy savings.

IV. CONCLUSIONS

In this paper a proposal of an intelligent street lighting system is described that integrates new technologies, offering ease of maintenance and energy savings. This is obtained by using the highly economical LED technology supplied by renewable energy provided by the solar panels and by using the intelligent management of the lampposts.

The proposed system is especially appropriate for street lighting in remote urban and rural areas where the traffic is low at times. Independence of the power network permits to implement it in remote areas where the classical systems are prohibitively expensive. The system is versatile, extendable and totally adjustable to user needs.

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