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Designing An Intelligent Solar Street Lighting System using Zigbee Network

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Abstract: Solar Photovoltaic panel based street lighting systems are becoming more common these days. But the limitation with these ordinary street light systems is that it lacks intelligent performance. It is very essential to automate the system so that we can conserve energy as well as to maximize the efficiency of the system. In this paper, we designed an efficient automated street light system using microcontroller LPC2148 and Zigbee wireless technology. This Novel system completely depends on the LDR, IR and Arm7 controller. By using Infrared sensor we detect the presence of vehical or pedistrian and automatically switch on the street lights. By using LDR sensor it detect the failure of any light and also day/night indication. Microcontroller collectes status of all the street lights and send it to the graphical user interface specially designed for this system through Zigbee wireless communication. In graphical user interface it's possible for us to monitor the status of street lights, fault identification and also control the street lights. In GUI we have two modes Auto/Manual. In Manual mode we also control the street lights from GUI. This novel Solar based automated street light system was found to be cheaper, effective, and feasible by the limited usage of power.

Keywords: LPC2148 Microcontroller, IR Sensor; LDR, Zigbee, LED Indicator, Solar Energy, .Net GUI.

I. INTRODUCTION

The street lighting system is an essential factor in public sectors. So we need to design and implement solar based street lighting system with the help of Zigbee network of devices and the newly proposed street lighting system offer higher efficiency and considerable savings that can be achieved by using high efficient LED technology. Early days, the street lighting systems are controlled manually. So there was much more power consumption if we forgot to switch off the light means that will be glowing all the day. It is very common these days to see solar PV based street lights. People became aware about the importance of moving from conventional resources based energy production to renewable energy based power production. We all know that fossil fuel resources are going to fed us for only 50-60 years from now. So it is high time for us to shift to renewable energy based power production and usage as it is the only alternative available. It is sure that we can't leave in a society without power. So we need to maximize the usage of renewable energy so that we can preserve conventional resources.

Normal solar PV based street lighting system lacks automation. The problem is that it will be in on state even though there is no need of light and hence it causes loss of power. Yet another problem is that in these systems which is not automated, when any fault occurs we may not be able to know about the problem and hence the problem remains won't be rectified. In this paper a new technique is suggested to automate the entire system. Here when there is no necessity of light the system will go into a power down mode and the lamps won't glow. Sensors sense the intensity of light and presence sensor is used to detect the presence of humans or cars and then it gets turned on automatically. Yet another advantage with this system is that it allows the control terminal to identify the current status of each lamp, whether they are working properly or not and can even analyze the power consumed by each lamp. Because of this we will be able to identify which lamp is working and which are not. So because of this advantage we will be able to rectify the problem. The newly proposed system combined three technologies such as LED technology, Remote control technology and solar technology and forming a good power save system.

II. LITERATURE SURVEY

It's possible to capture gestures from any body movement or state but common way is to capture from face or hand. In the proposed system we mainly concentrate on Hand gesture recognition. There are many ways to capture the gesture. As per author Fabio Leccese, "Remote-Control System of High Efficiency and Intelligent Street Lighting Using a ZigBee Network of Devices and Sensors", By using IR sensor they collected information and send it to the remote unit.[1] As per the author M. A. D. Costa, G. H. Costa, A. S. dos Santos, L. Schuch, and J.R. Pinheiro, "A high efficiency autonomous street lighting system based on solar energy and LEDs," Here The author utilized solar energy and 802.11 wireless module [2]. Dipak A. Mhaske, "Smart Street Lighting Using a Zigbee & GSM Network for High Efficiency and Reliability" paper they developed that whenever the

threshold values exceeds some values it sends message through GSM,[3]. According G.Madhusudhana Rao, "Energy Efficient Lighting System Using LABVIEW", developed a GUI in LABVIEW and analyse the values and also control the entire system[4]. The main issues associated to the existing systems are increased raw material cost and social sensitivity to the environmental issues. So the manufactures develop three solutions to solve this problem. They [5]-[9] are LED technology, remote control technology and solar technology. The newly proposed system combined three technologies such as LED technology, Remote control technology and solar technology and forming a good power save system.

A. Need

Usually street lights are switched ON at evening once some light detection device provides a signal and turn out once device give signal at the morning. Intensity of light vary is mounted within the device on top of and below of that value causes the light to ON or OFF. Additionally streets lights are remained ON for whole night after they are not any traffic on the road. This can be not economical to ON streets light for whole night. Traffic on the roads remains high before mid night thus lights are kept ON for middle night and once middle night traffic on the road decreases thus lights are switched off, currently device starts its work and switches the light on the base of car or human movement.

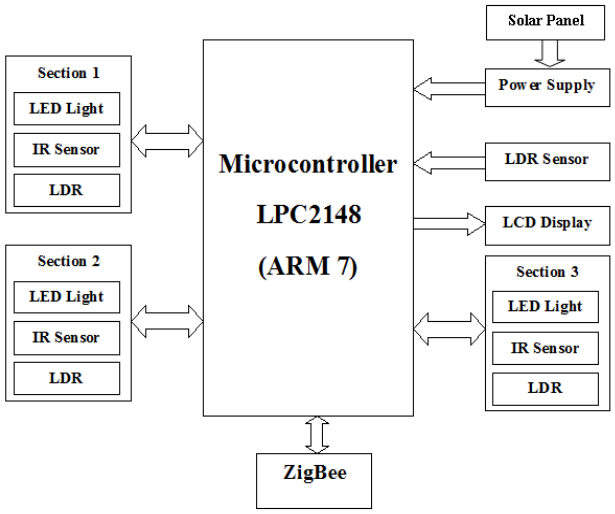

Fig1. Block diagram of street light section

B. Block Diagram and Description

After we go through the literature survey we understand that there were so many ways to automate the street light system but the proposed system is economic and effective technique to automate street lights because of auto/manual mode and fault detection. The block representation of the proposed system contains two sections street light section and remote monitoring and controlling section. In the proposed system Street light section contains different sensors to collect the vehicle presence information and status of LED's from the different units and sends that to the remote section through wireless technology. Here the Street light section consists of sensors likes IR sensor and LDR sensor that will convert the corresponding physical parameters into the electrical component (voltage) and fed it to the analog to digital converter (ADC). The ADC then convert the sensor signals into the digital form and send it to the ARM 7 processor, which will process the sensor information according to the pre installed software and fed to the zigbee wireless module. Here the controlling and monitoring section consists of zigbee transceiver which will collect the sensor information from the sensor nodes and fed to the GUI installed in Personal Computer. The GUI on the remote section is used to monitor the status of light, light condition, day/night and mode. It also sends the commands to control the street light manually as per preinstalled software (i.e. send the mode selection and pump ON/OFF commands to the sensor nodes through zigbee network).

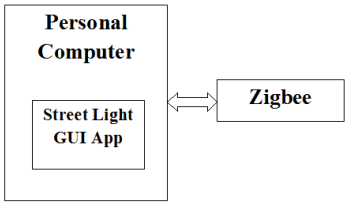

Fig2. Block diagram of Remote Controlling and Monitoring Section

III. SYSTEM DESCRIPTION

A. Hardware Components

1. ARM7 LPC2148 Microcontroller

ARM7 LPC21487 is a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and one of the most widely used micro-controller. LPC2148 is based on RISC processor that uses very few transistors than other complex processors. Because of few transistors it consumes low power and low cost. LPC2148 has 10-bit inbuilt A/D converter present because of this it's easy to interface analogue sensors without the need of external A/D conversion hardware. It has Real Time Clock circuit with 32.768 KHz XTAL and Battery Backup. Support In- System Programming (ISP) and In-Application Programming (IAP) through On-Chip Boot-Loader Software via Port UART-0 (RS232), circuit to connect with standard 20 Pin JTAG ARM for Real Time Debugging. Has standard 2.0 USB as Full Speed inside, has Circuit to connect with Dot-Matrix LCD with circuit to adjust its contrast by using 16 PIN Connector. RS232 Communication Circuit by using 2 Channel. SD/MMC card connector circuit by using SSP. EEPROM interface using I2C. It has PS2 keyboard interface and general purpose I/O pins.

2. LDR

A photo resistor or Light Dependent Resistor or CdS (Cadmium Sulphide) Cell is a resistor whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor. A photo resistor is made of a high resistance semiconductor. 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 whole partner) conducts electricity, thereby lowering resistance.

3. Solar panel and Battery

The solar panels will feed the system with solar power, which will be charging the battery during the day. At night the battery will be discharge through the project processes.

4. IR Sensor

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. In our project IR sensor is used to detect the presence of vehicles or pedestrians. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.

5. Zigbee Transceiver

ZigBee transceiver is used for sends or receives data from one place to another wirelessly. In this project two ZigBee transceiver modules are used. ZigBee sends data or receive with secure in the form of packets. It sends data based on IEEE 802.15.4 PHY and MAC layers. It trans-mits data with different speeds like 250 kbps (@ 2.4 GHz), 40 kbps (@ 915 MHz) and 20 kbps (@ 868 MHz).

B. .NET GUI App Development

The .NET Framework introduces a totally new model for the programming and readying of applications. .NET is Microsoft's vision of "software as a service", a development surroundings within which we well be able to build, create, and deploy your applications and therefore the next generation of elements, the power to use the online instead of our own laptop for varied services.

IV. RESULTS AND DISCUSSIONS

In this work, the sensors are successfully placed and interfaced with the ARM7LPC2148. The data or values received from the sensors were displayed on the 16X2 LCD display and also IR sensor placed such a way to detect the vehicles and pedestrians effectively. The snapshots and figures show the optimized results.

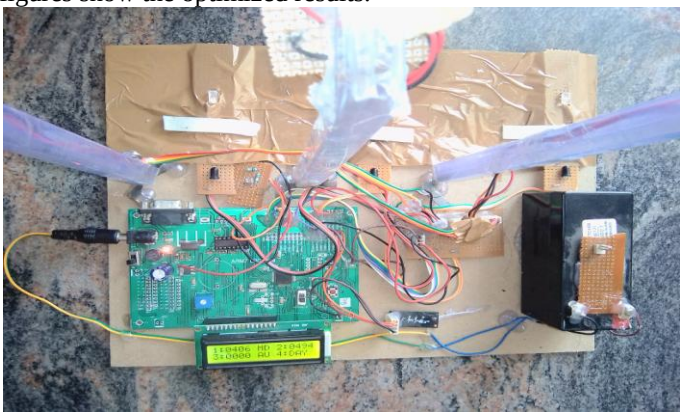

Fig 3. Complete Hardware setup.

Street light section compressed of a microcontroller LPC2148, Power supply unit, LCD, Zigbee, LDR sensor, IR sensor, Battery, Solar Panel and some street Lights. ARM 7 microcontroller interfaced with IR sensor and LDR sensor as input units and relay driver circuit as output unit. LDR senses the parameters values and fed to the ADC unit to convert it to digital form and then we send this values to microcontroller. We monitor this value by using LCD interfaced with microcontroller. If the communication between IR transmitter and Receiver disturbs then it automatically turns on the Street ight. After this we send this values wirelessly to coordinator unit through Zigbee. Microcontroller checks the mode and operates according to that. If the mode is "AUTO" it automatically switch ON/OFF the street lights based on LDR values and IR sensor communication. If the mode is manual based on received commands it turns on and off the street lights. Figure 3 shows the status of LED's, light intensity and human presence on liquid crystal display(LCD).

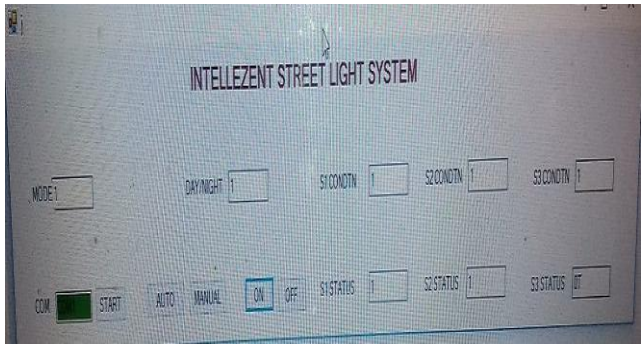

Fig4. Street Light GUI App when All lights are in manual mode and ON condition.

Figure 4 show the snapshot of the street light Remote GUI App showing status of street lights when the mode is in MANUAL and lights are in on condition. Condition shows that the light is in good condition or in fault condition. By using this app we send commands also to control the street lights manually. When we press the manual button in app then the mode is converted in to manual mode and we press ON/OFF button then lights on off in the streets.

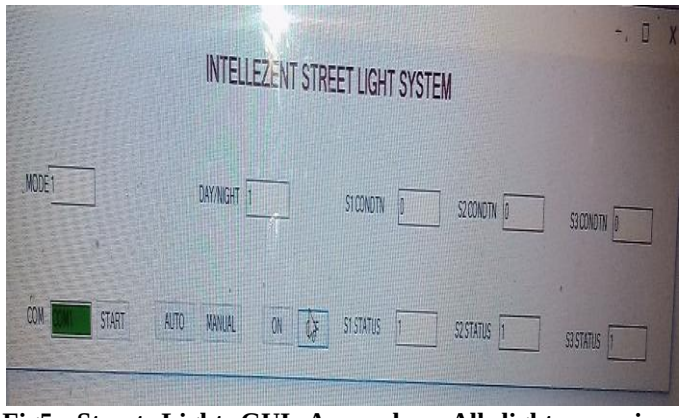

Fig5. Street Light GUI App when All lights are in manual mode and OFF condition.

V. CONCLUSION

A novel idea for implementing solar based street lighting system has been proposed. The proposed system is all about saving energy by using some smart things with present street light systems. This system uses highly economical LED lighting technology thus it offers energy saving and easy maintenance. The proposed framework is especially useful for the streets in Remote urban and rustic zones where traffic is low at all times and there is less need of street lights. Because of the low cost and high life spam of LED lights this system is quite economical and saves money, power and time. With its special features such as automatic on off control, dimming control and manual on off control it solves the inconveniences in the existing street lighting system.

VI. FUTURE ENHANCEMENT

In future we enhance this project by using timer based products and PIR sensors. In order to get maximum charge from sun we use solar tracking system. By using web based interface we control the street light system from anywhere in the globe. By using more batteries we save more energy to utilize in monsoon season. To improve lighting we use more LED lights connected in parallel.

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