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Energy Efficient Intelligent Street Lightning using systems ZigBee and sensors

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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 a new method is suggested so as to maximize the efficiency of the street lighting system and to conserve the energy usage by the system with the help of ZIGBEE and sensors. It uses a sensor combination to control and guarantee the desired system parameters. The information is transferred point by point using ZIGBEE transmitters and receivers and dissent to the control terminal used to check the state of the street lamps and hence we can take immediate actions if required.

Keywords*— ZigBee, Sensors, Solar Panel, 12v Battery, Microcontroller

I. INTRODUCTION

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 50-60years 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 issued 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 the reis 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 microcontroller used here is ATMEGA. This controller is used because of the simplicity in programming.

II. DEVICESANDMETHODS

The block diagram of the proposed system is depicted in figure1. Here we employ a microcontroller ATMEGA16 so a stopper forms the controlling actions. We do employ certain sensors namely, PIR sensor, Hall Effect sensor and LDR sensor. These sensors are connected to the ports of the microcontroller through an interfacing circuit and an amplifier. An emergency micro switch is also employed. The output from the microcontroller could be viewed through an LCD display. The microcontroller generates a PWM which is fed to the LED driver circuit which changes the operating cycles of each LED in the LED Array.

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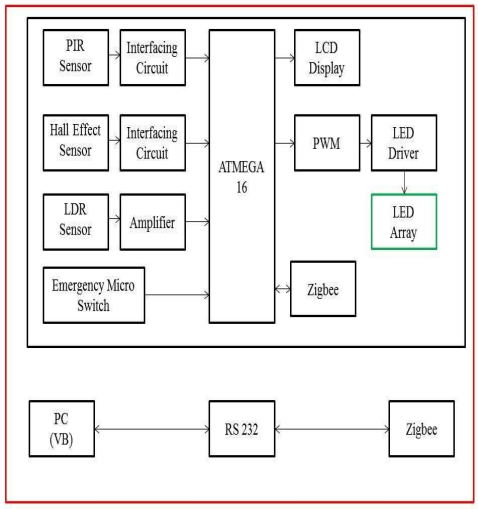

Figure1.Block diagram of PV Street lighting system

The flowchart of the system is given in figure2. The working of the entire system is mainly with the sensors present. The main idea behind the system is that the LED array will be in off position at day time. Even at day time if the intensity of light is lower due to weather conditions like fog, thunder storm etc. then the array will get turned on. Presence sensor will detect the presence of any humans or cars. At night the array will remain in half on condition. That is if 16 LEDS are there in an array only 8 will be in on state and the other 8 will be in off state. The reset 8 LEDS will get turned on only if the presence sensor generates an output. This is done so as to minimize the power consumption of the array. Here we need light only when it is needed. At night sometimes roads will be empty and hence there is no use of illuminating all the lamps. So we can turn on half set of LEDs and can conserve the power.

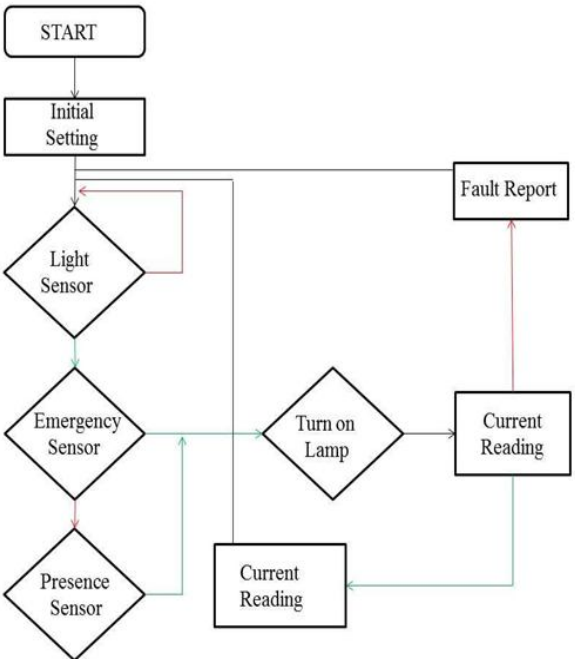

Figure2. Flowchart of the system

Yet another key aspect in this method is that as we are using ZIGBEE we will be able to communicate with the control station and the station can analyze the current state of the system and can check whether all the systems are working properly or not. And can be rectified if any problem occurs. The schematic image of on-street station is given in figure 3

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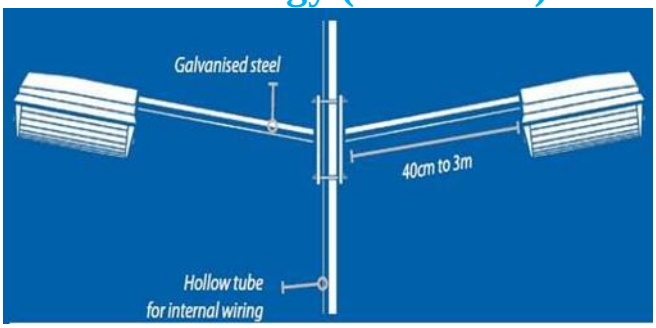

Figure3. Mechanical design of system

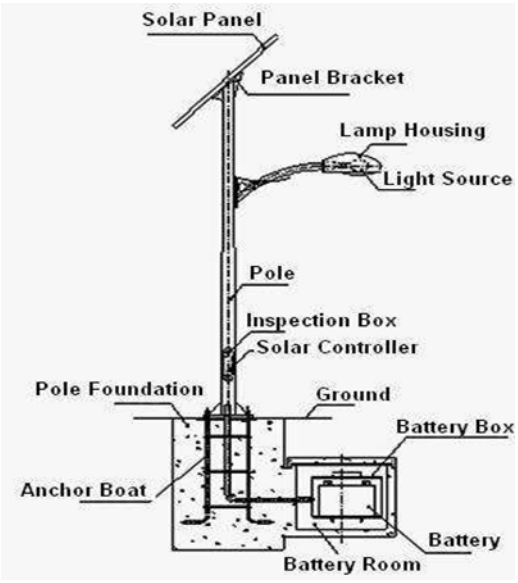

Figure4. Schematic diagram of on-street station.

The monitoring station located in each lamp post consists of several modules. The presence sensor, light sensor, failure sensor, and an emergency switch. These devices work together and transfer all the information to a microcontroller which processes the data and automatically sets the appropriate course of action. A priority in the transmission of information is assigned to each sensor. The distance from the pole centre to the LED array can be 40 cm-3m. This is shown in figure4. Module mounting can be adjusted according to the design. It could be configured between zero and 600 for optimal sun exposure. But a simple pole-top or clamped mounting configuration is easy for installation.

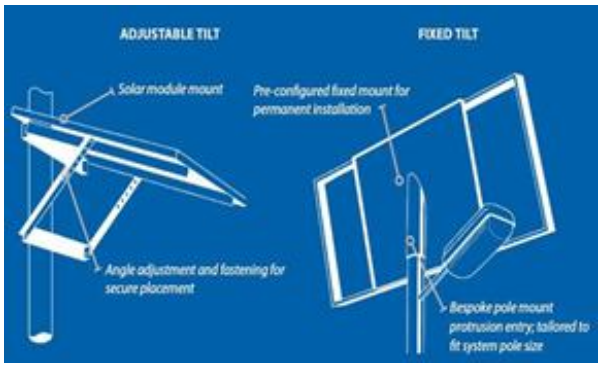

Figure5. Module mounting.

It is also very important to have a strong foundation so as to place the poles. The designing of the foundation done is given infigure6.

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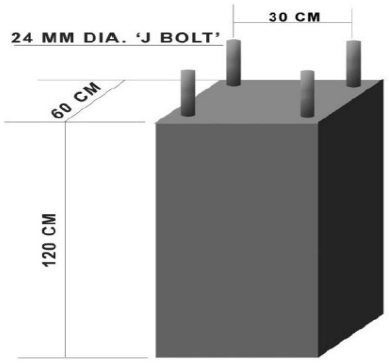

Figure6. Foundation Design.

III. TECHNICAL SPECIFICATION

The details of all the components used are given in Table I .It is very important to know the technical details so as to implement the system. All the parameters were calculated so that maximum efficiency could be yielded from the system

TABLE I. TECHNICAL DETAILS OF THE SYSTEM

Device	TECHNICAL DEAILS
SOLAR PANEL	12V, 50W
BATTERY	12V,26Ah
PIR SENSOR	5v, RANGE :3m
LIGHT SENSOR	TEPT5700, PHOTO SENSOR
ZIG-BEE	3.3V, 25M, 4GHZ,9.6Kbps

The Pin diagram of the micro controller (ATMEGA16) used is given in figure7

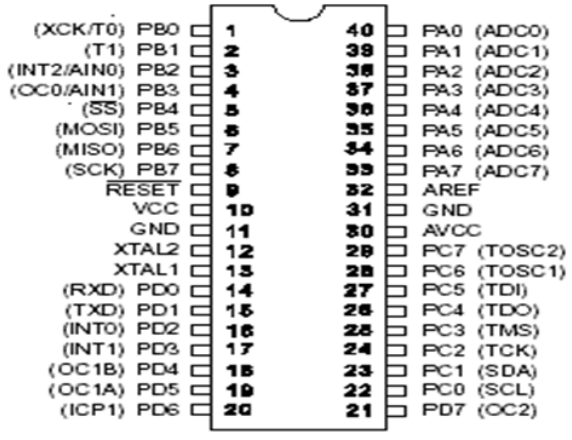

Figure 7.Pin diagram of ATMEGA 1

A. Working

Street light are powered by solar energy. Sensors senses the data, collect the information and sends to microcontroller. Microcontroller controls the signal and runs the software to analyse the system. Initially, motion sensor activates the microcontroller only when vehicle or pedestrian enters into the detection region and activates light sensor. Light sensor gets activated if light illumination is achieved less than fixed threshold to switch the lights ON, else OFF. For example in rainy or winter season

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automatically control takes action over DIMMING. (i.e., low illumination, acts as supporting feature for natural light). Now, ZigBee device (at transmission side) is ready to receive information from streetlight and communicate with ZigBee device (at receiver side), then sends to terminal via serial communication cable. ZigBee device communicates point-to-point to detect the vehicle and sunlight in the system. So that the system can receive data from android phone ,upon receiving the data the micro control unit gives appropriate signals to the driver circuits of the appliances so that the appliances can be switched on and off.

B. Advantages

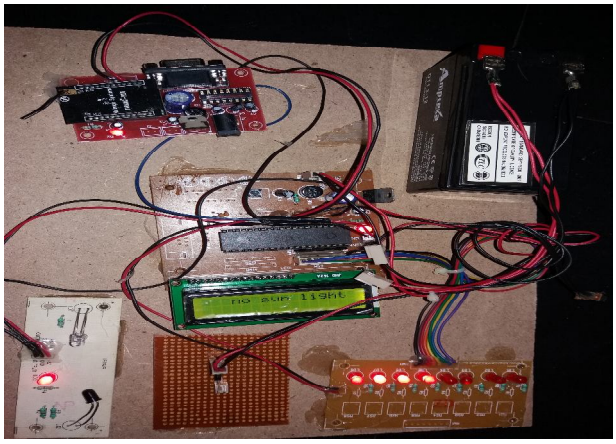
Low power conservation.
Safety Guidance development

C. Applications

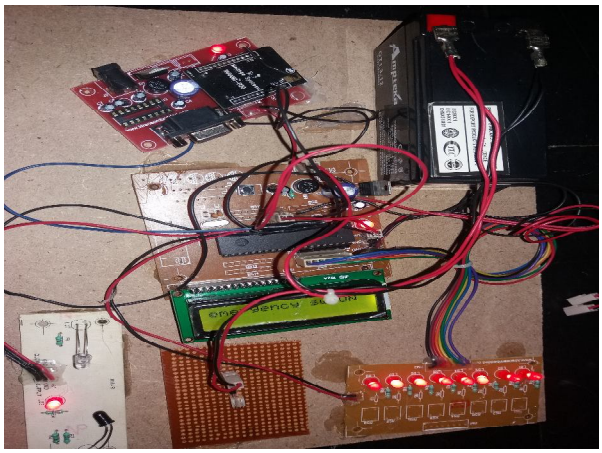
Electricity applications
Industries power control system

IV. TESTS AND RESULTS

The prototype has been tested in variable real life conditions to verify the overall functionality and seek better performance. The measurements collected during the test phase allow calculating energy savings so that it is possible to estimate cost savings also for larger systems using approximations. On day time the LED array will be in off state. During night if presence sensor is not producing any output only 4 LEDs will turn on and the rest will be in off state. When the PIR sensor produces output then entire array turns on. We can see the result of the proto type in 8.



Without sunlight



When Emergency switch is switched on

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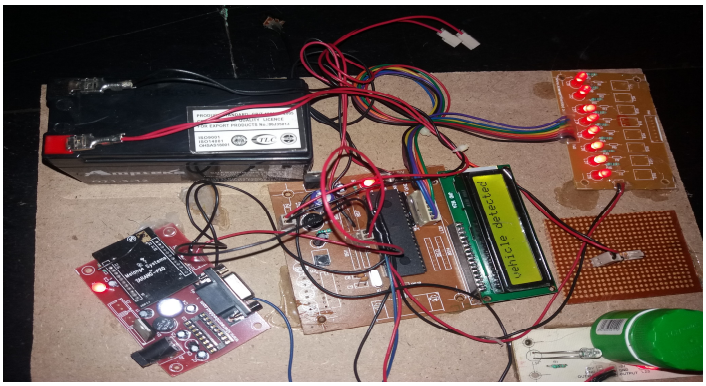

When Vehicle is detected

V. CONCLUSION

A new model is presented in this paper which will reduce the power consumption of the street lighting system about 20-35% compared to conventional design. This system is fully automated and is using ZIGBEE so that the control station can analyse all the performance of the system

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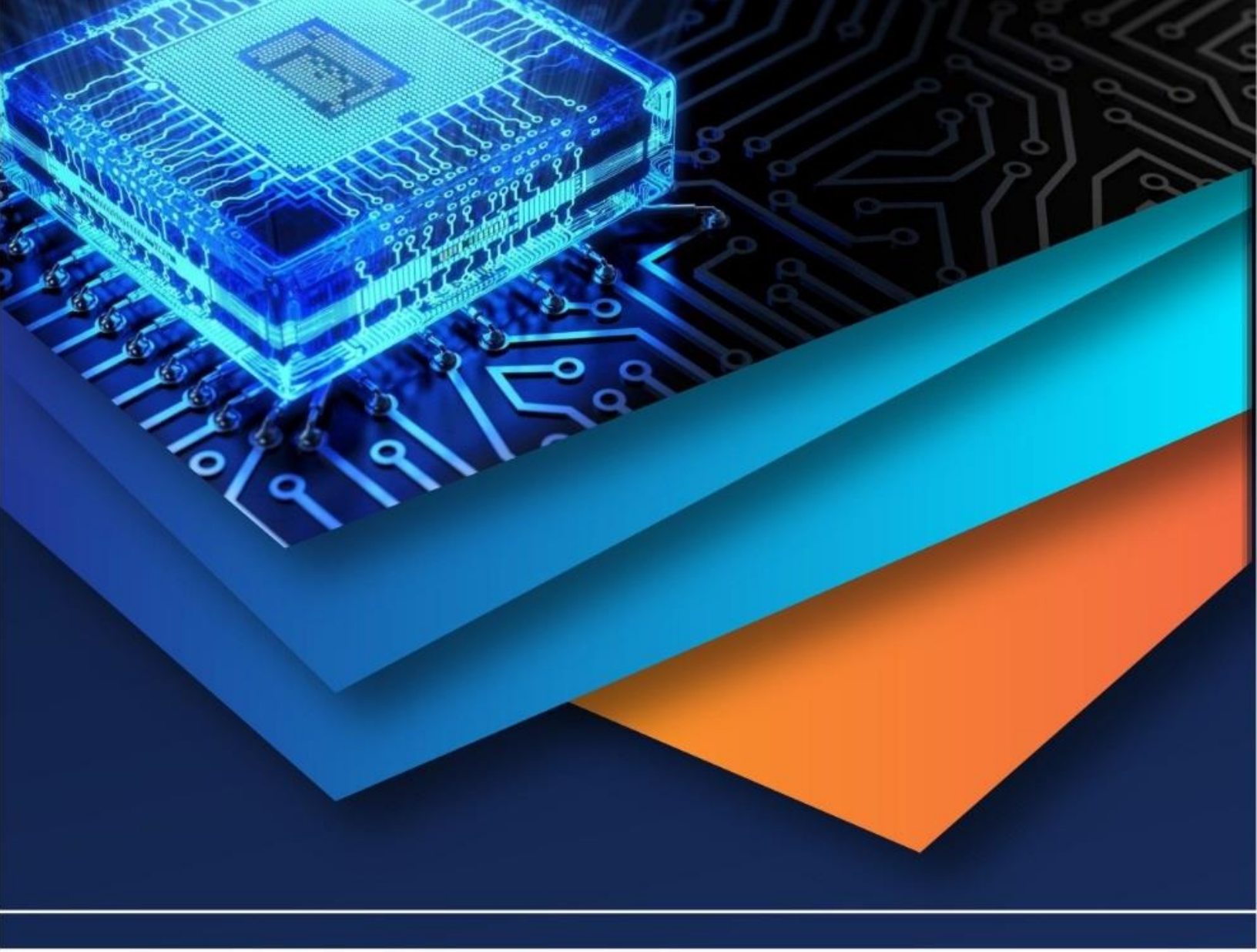

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