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IoT Enabled Smart Lighting System for Rural Areas

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ABSTRACT

The main consideration in the present field technologies are Automation, Power consumption and cost effectiveness. Automation is intended to reduce man power with the help of intelligent systems. Power saving is the main consideration forever as the source of the power (Thermal, Hydro etc.) are getting diminished due to various reasons. As we all know that energy consumption has increased a lot and sources of energy are limited so in order to meet the increasing demand of energy use of renewable sources of energy is a must.

The project aims to describe a method for modifying street light illumination by using sensors at minimum electrical energy consumption. When presence is detected, all surrounding street lights glow at their brightest mode, else they stay in the dim mode. LED bulbs shall be implemented as they are better than conventional incandescent bulbs in every way. This shall reduce heat emissions, power consumption, maintenance and replacement costs and carbon dioxide emissions. Coupled with SSSLS (Solar Smart Street Light System), massive energy-savings are envisioned. Also, a demonstration with a real-time proto type model involving costs and implementation procedure has been developed using internet of things (IoT) to visualize the real time updates of street processing and notifying the changes occur.

Keywords : LED, Thermal, Hydro, Solar Smart Street Light System

I. INTRODUCTION

Nowadays, human has become too busy, and is unable to find time to switch the lights wherever not necessary. The present system is like the 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 outside. But the actual timing for these lights to be switched on are when there is absolute darkness. With this, the power will be wasted up to some extent. This paper gives the best solution for electrical power wastage. Also, the manual operation of the lighting system is completely eliminated. The energy consumption in entire world is increasing at the fastest rates due to population growth and economic development and the availability of energy sources remains woefully constrained. Resource augmentation and growth in energy supply has not kept pace with increasing demand and, therefore, continues to face serious energy shortages.

Streetlights are an integral part of any developing locality. They are present on all major roadways and in the suburbs too. Every day, streetlights are powered from sunset to sunrise at full strength, even when there is no one around. On a global scale, millions of dollars are spent each day on these street lights to provide the required electrical energy. The maintenance and replacement costs of conventional

incandescent bulbs are immense. They consume a lot of electric power to function and their heat emissions are also quite high.

All of this contributes to greater demand of electricity production and consequently, more carbon dioxide emissions from powerhouses. So, along with unnecessary light pollution, this practice causes damage to our planet too. The project aims at harvesting the energy from renewable energy sources like sun and to effectively use the harvested energy for the benefit of mainly the remote villages (villagers) facing the serious power problems. The main aim of the project is to provide a "IoT based Automatic Street Lightning System" powered with solar energy during night time. We use the word "smart" because the system not only provide power to the street lights but also helps in detecting the direction of movement of the pedestrian and helps him by means of illuminating the path of movement till the near next street light.

By integrating the entire street lights with Smart street light system it is possible to systematically help the pedestrian to reach the destination in the remote rural areas which are facing serious electric power supply problem. A simple and effective solution to this would be dimming the lights during off peak hours. Whenever presence is detected, the lights around it will glow at the normal (bright) mode. This would save a lot of energy and also reduce cost of operation of the streetlights.

We can check the status of street light on internet using IOT (Internet of things) from anywhere in real time and solve the issues if happen during the processing. Additionally, a table top prototype has been constructed to display the concept's functioning. The components used for the real-life implementation are substituted appropriately to recreate the ambience.

II. LITERATURE SURVEY

R. Mullner and A. Riener proposed that Conventional street lighting systems in areas with a low frequency of passers-by are online most of the night without purpose. The consequence is that a large amount of power is wasted meaninglessly. With the broad availability of flexible-lighting technology like light-emitting diode lamps and everywhere available wireless internet connection, fast reacting, reliably operating, and power-conserving street lighting systems become reality. The purpose of this work is to describe the Smart Street Lighting (SSL) system, a first approach to accomplish the demand for flexible public lighting systems [1].

A. PANDHARIPANDE AND D. CAICEDO This article considers
smart lighting control systems with luminaire-based sensing for office lighting applications. Each luminaire has a collocated occupancy sensor and light sensor and the sensing information is used to adapt artificial lighting to occupancy and daylight changes. The design goal of the lighting control system is to achieve required illumination conditions with low energy consumption. We consider two primary architectures – centralized and distributed, for lighting control [2]. We then review state-of-art control methods and make a comparative study of a few methods. Finally, we outline various technical challenges in the future design of such smart lighting systems.

K. Rajput, G. Khatav, M. Pujari 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 [3]. this paper gives the best solution for electrical power wastage.

III. PROBLEM IDENTIFICATION

The key indicators of India's energy problems include; Over 40 per cent of the households (particularly rural areas) in India still do not have electricity, about a third of our total primary energy supply to rural areas still comes from non-commercial sources (biomass, dung) and currently India faces an enormous demand supply gap of about 15-25% energy shortage. Due to shortage of the energy supply till today several villages have not facilitated with electricity and even if provided, the supply of the electricity is limited to few hours in a day and are facing serious problems due to unlimited power cuts.

During the day time we get enormous amount of light energy from sun and the problem for pedestals are common during the night time. Though most of the streets are equipped with street lights in each and every village areas but due to the uncontrolled power failures/power cut it is becoming a serious problem for villagers to commute for irrigational field work during the night time due to unlimited power cuts which indirectly affect the crop yield of the farmer. Such trends often discourage the villagers taking up agriculture which is the backbone of our economy. It also poses a serious threat to the villagers from physical hazards such as thieves, snakebites, etc. Installation of street lights may seem a pleasant option. Hence the best option is to install solar powered street lights and moving a step ahead, we designed this 'Solar Powered Smart Street Lighting System with IOT'.

IV. OBJECTIVES OF THE PROJECT

The main objective of this project is to implement an IoT based Automatic Street Lightning System. As the traffic decreases slowly during late-night hours, the intensity gets reduced progressively till morning to save energy and thus, the street lights switch on at the dusk and then switch off at the dawn, automatically. The process repeats every day. White Light Emitting Diodes (LED) replaces conventional HID lamps in street lighting system to include dimming feature.

The intensity is not possible to be controlled by the high intensity discharge (HID) lamp which is generally used in urban street lights. LED lights are the future of lighting because of their low energy consumption and long life. LED lights are fast replacing conventional lights because intensity control is possible by the pulse width modulation. This project is enhanced by integrating the LDR to follow the switching operation precisely and IOT to display the status of street on web browser and help in controlling it.

- To avoid unnecessary waste of light.
- Provide efficient, automatic and smart lighting system.
- Longer life expectancy.
- Energy saving.

V. METHODOLOGY

1. BLOCK DIAGRAM

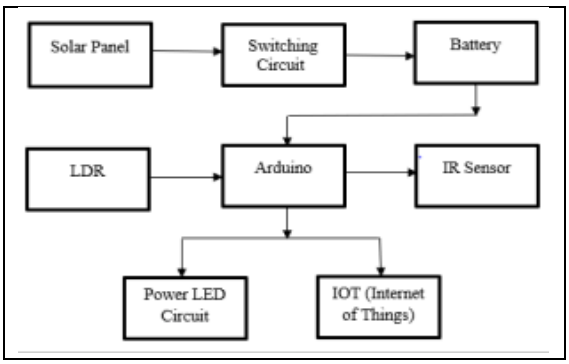

Figure 1: Block Diagram

This block diagram describes the working of project 'Solar smart Street light System with IoT'.

- Solar panel of 10Watt is used here with will converts the incoming sunlight into electrical energy and used to charge the battery using

switching circuit which converts the varying voltage into stable voltage.

- Now this charged battery is used as a supply source to rest of the system.
- Through battery we will provide supply to Arduino which is controlling the functioning of LDR and IR sensor as per the presence of vehicle.
- Then according to the changed occur in IR sensor and LDR the Arduino controls the power LED circuit.
- The serial monitor data of Arduino is now displayed on web browser using IoT.

2. FLOW CHART

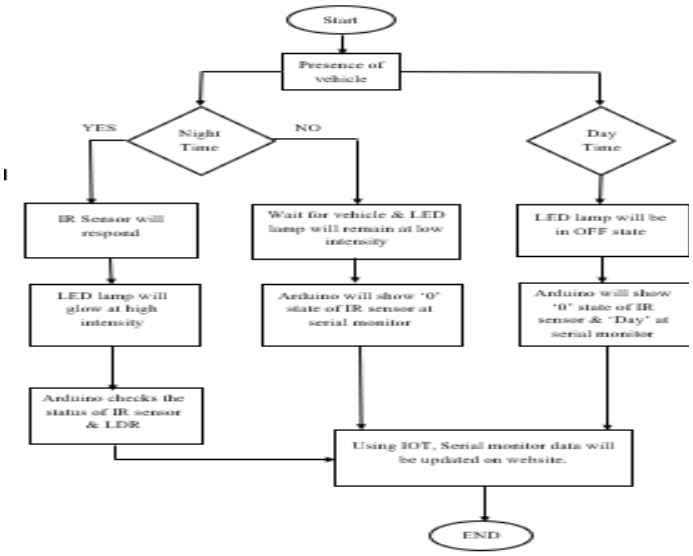

Figure 2: Flow Chart

VI. HARDWARE COMPONENTS

1. ARDUINO UNO

Arduino is a single-board microcontroller, The hardware consists of an open- source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. Current models feature a USB interface, 6 analog input pins, as well as 14 digital I/O pins which allows the user to attach various extension boards.

2. IR Sensor (Infrared Sensor)

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. It is also capable of measuring heat of an object and detecting motion. Infrared waves are not visible to the human eye.

3. LDR (Light Dependent Resistor)

A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity (hence resistivity) reduces when light is absorbed by the material. LDR's are light dependent devices whose resistance decreases when light falls on them and increases in the dark.

4. LED (light emitting diode)

LEDs are available in a variety of sizes and shapes, including the 5mm LED. We carry a wide assortment of the most common models of 3mm, 5mm, 8mm, and 10mm models. The size refers to the outside diameter of the LED, with the 5mm LED is the industry standard as the most common LED model. 3mm LEDs are the smallest and used in tight-fitting applications, while 8mm and 10mm models are used where you want to get out as much light as possible.

5. NodeMCU (ESP8266)

NodeMCU is a low-cost open source IoT platform. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit). The device features 4MB of flash memory, 80MHz of system clock, around 50k of usable RAM and an on-chip Wi-Fi Transceiver.

6. Solar Panel

Solar panels are active solar devices that convert sunlight into electricity. They come in a variety of rectangular shapes and are usually installed in

combination to produce electricity [7]. A solar panel or module is a series of interconnected silicon cells joined together to form a circuit. In greater numbers the amount of power produced by these interconnected cells can be increased and used as an electricity production system.

VII. HARDWARE DESIGN

1. Solar Battery Charging Circuit

Solar concept is not new for us. We all know the importance of solar energy. Solar gadgets are increasing day by day. As non-renewable energy sources are decreasing, usage of solar energy is increased. This solar energy is not only used on the Earth but also used in space stations where no electrical power is available.

Here is the simple circuit to charge rechargeable Lead-acid battery from the solar panel [8]. This solar charger has current and voltage regulation and also has over voltage cut-off facilities. This circuit may also be used to charge any battery at constant voltage because output voltage is adjustable.

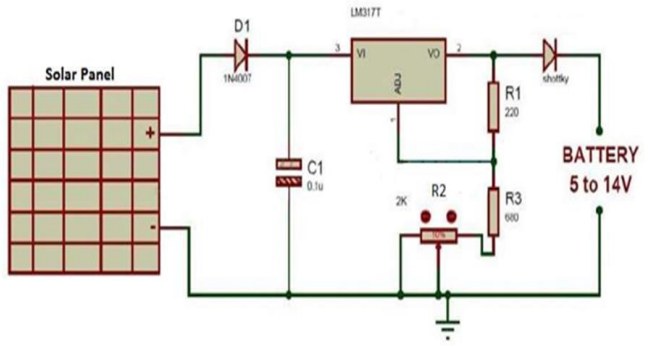

Figure 3: Solar Battery Charging Circuit

2.Smart Street Light Circuit Diagram and Working

This circuit mainly consists ESP8266, LDR sensor, IR sensors and LEDs. Here the LDR sensor is used to detect whether it is daytime or night time. Since LDR sensor generates variable resistance based on the amount of light falling on it, it has to be connected like a potentiometer. One end of the LDR sensor is connected to 5V and other end is connected to fixed resistance which is further connected to ground.

NodeMCU has one ADC pin (A0) which is connected to point between fixed resistance and one end of the LDR sensor as shown in the circuit diagram. Since the LDR sensor gives variable resistance therefore variable voltage will be generated at A0 according to the amount of light falling on LDR.

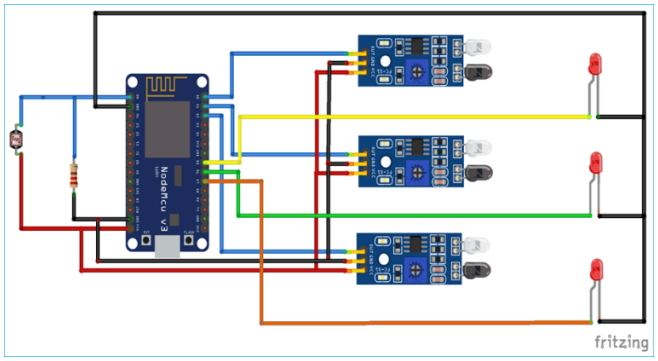

Figure 4: Circuit diagram

IR sensors are used to detect if someone is crossing the street or not. It detects the obstacle or motion in the surrounding. The transmitter will transmit IR rays which will be reflected back if it falls on some object like person, animal, vehicles, etc. The reflected ray will be received by receiver diode and hence will confirm the presence of object and the corresponding LED will be glowed.

This method will save significant amount of electricity as the street light will only turns on if there is someone present in the Street. IR sensor has 3 pins, two of which are VCC and ground and one is output pin. The output of IR sensor gets high if detects presence of some object. This pin is connected to GPIO pin of NodeMCU so whenever the IR sensor detects someone passing through the street it triggers the Street light. In our case one LED will be turned on.

3. Internet of Things (IoT)

The Internet of Things is an emerging topic of technical, social, and economic significance.

Consumer products, durable goods, cars and trucks, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play[6]. Projections for the impact of IoT on the Internet and economy are impressive, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025.

Figure 5: Internet of Things

5.6.2 ThingSpeak Key Features

ThingSpeak allows you to aggregate, visualize and analyse live data streams in the cloud [9]. Some of the key capabilities of ThingSpeak include the ability to:

- Easily configure devices to send data to ThingSpeak using popular IoT protocols.
- Visualize your sensor data in real-time.
- Aggregate data on-demand from third-party sources.
- Use the power of MATLAB to make sense of your IoT data.
- Run your IoT analytics automatically based on schedules or events.
- Prototype and build IoT systems without setting up servers or developing web software.

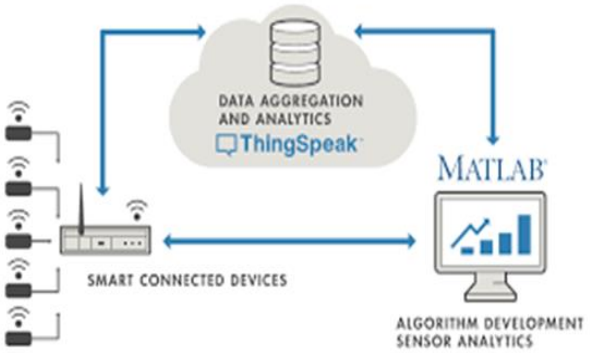

Figure 6: Thingspeak Working

VIII. APPLICATIONS

1. Area of applications

- We can used it outside of house, corridors or industry area, which helps to save power.
- It can be used as a street light.
- In sea off-shore side we can use it as a dangerous sign.
- Street lights use photo resistors to detect whether it is day or night and turn the light on or off accordingly.
- Photo resistors are also used in digital cameras to detect how much light camera sees and adjust the picture quality accordingly.
- Automatic lighting control.
- Camera (electronic shutter).

2. Advantages

- Solar street light is independent of grid as a result of this operating cost is much low.
- Maintenance cost is much low compared to conventional street light.
- Intensity of LED can be controlled effectively without changes in its light colour.
- Longer life compared to conventional street lights.
- Power consumption is much lower.
- LDRs are sensitive, inexpensive and readily available devices.

3. Disadvantages

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

IX. RESULTS AND CONCLUSION

The project aims were to reduce the losses of the current 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. The project shown in the figure has been implemented and works as expected and will prove to be very useful.

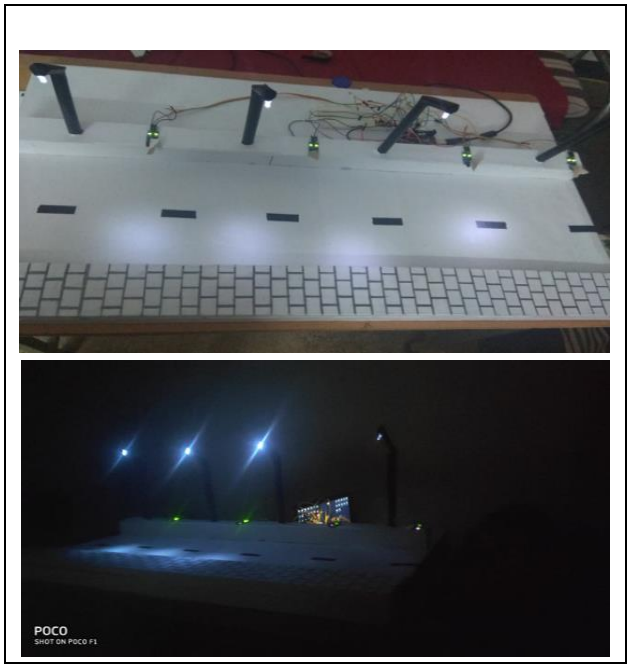

Figure 7: Working model of Project

Solar Smart Street Light System with IoT is an excellent and effective solution. It combines safe lighting protocols with consumption of minimal amount of power. The energy savings, as discussed before are phenomenal. The future scope of this project expands into speed detection and customizable area of illumination.

An additional component which would lead to better functioning of the concept would be the use of LED bulbs. Despite their high initial costs, they are a viable option as they drastically reduce the power consumption. They will aid in further saving of energy and reduction in operational costs.

Figure 8: Thingspeak Data Aggregation and Analysis

X. FUTURE SCOPE

The above project i.e. Solar Smart Street Light System with IoT can be powered from a battery, which can be charged during day time by harvesting the solar energy through a solar cell. The solar energy harvested from sunlight can be stored, inverted from DC voltages to AC voltage using converter.

Using this smart project, we can also estimate the speed of the vehicle, recognizing the number plate, recognizing the accidents took place on roads etc.

This Smart Street light project not only helps in rural areas but also beneficial in urban areas too. As we are moving towards more advancement, we require more power so use of renewable resources is useful and advantageous. With this project, we can even add smart parking of vehicle and it is even useful for driverless cars.

This project has a bright future not only to save power but also reduced the calamities and even reduced the crime rate.

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