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A Study on Smart Street Light using IOT

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ABSTRACT

The Internet of Things (IOT) is taking the market to a new level and bringing with it new invention opportunities with each improvement in Internet speed and bandwidth. Lighting appliances use a lot of energy, so increasing efficiency and detecting problems quickly are difficult tasks. The IOT-based surveillance and control system for energy-saving electrical devices is the main focus of this paper. This approach helps in street light automation system.

Keywords

Internet of things (IOT), Smart Street light and Wi-Fi network.

1. INTRODUCTION

IOT is a network of connected sensors, computers, and digital devices that are dispersed throughout the world via the internet. The need to automate these establishments has grown significantly as a result of the expansion of various commercial spaces and societies. Additionally, everyone is moving toward a better and more dependable electrical control system as a result of the increasing traffic chaos in cities. Here, more energy conservation and early fault detection resolution are achieved through the use of an intuitive web application and a mobile-based surveillance and control system linked to an IOT cloud server. The Automatic Street Light Control System is a straightforward yet effective idea that automatically turns street lights on and off by using a transistor as a switch.

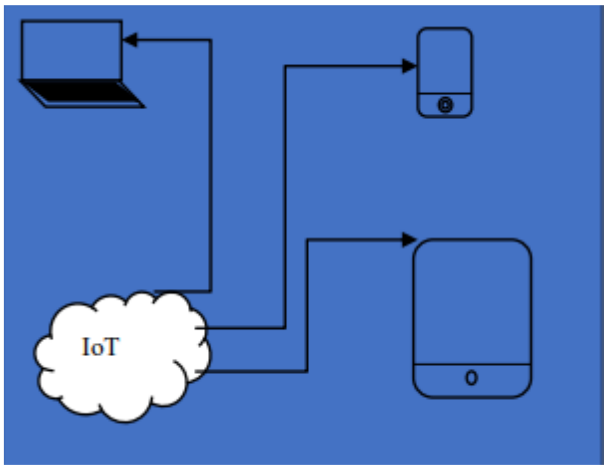

Figure 1 Internet of things

The Internet of Things opened up new ways to interact with electronic devices by digitally interacting with them and potentially giving a smart device connected to the same network as the rest of the system access to information in an easy-to-use format. Every device in this system that needs to function on the IOT is linked to every other device on the same network.
Traditional street lighting systems consume a lot of energy. The current street lighting policy results in significant light pollution, lower lamp life, and needless energy use. The intensity level of lights will be dependent on the level of use of the streets: the lights on a main road and remote area will have different brightness and cannot deal with unpredictable changes in traffic statistics.

2. LITERATURE SURVEY

An intelligent street light control system that incorporates new technologies and offers energy was developed in [1]. Using a solar panel at the lamp post with an LDR can result in greater power and energy savings. In [2], an intelligent way to manage lamp posts by using ZigBee technology has been done. In [3], detection of faulty lights has been carried out. In [4], they used high-efficiency LED lamps, which are powered by solar panels. In [5], the systems have the ability to automatically turn lights on or off and regulate switches based on traffic patterns. In [6], the system can be configured to operate automatically, controlling streetlights based on light intensity. In [7], an LED street lighting system's control network has been focused. In [8], the systems have been installed in various locations using identical module types and wattages.
According to [9], the solar-powered street lights with auto-tracking systems will maximize solar power output and boost efficiency.
In [10], a method for lowering street light power consumption by avoiding inefficient lighting has been described.
In [11], system's control command turns lights on and off.
In [12], with renewable energy-based systems like solar cells, intelligent street light control provides lower energy consumption. In [13], analysis has done on the system performance, including the transmission time and throughput. In [14], automated surveillance system offers a secure method of controlling and keeping an eye on electrical devices. In [15], a system that uses the technology for light sources like LED lamps to detect vehicle movement. In [16], Street Lighting System Based on vehicle Movements has been studied. In [17], an intelligent technology that takes automatic decisions has been focused.
In [18], the renewable source of energy has been used.
In [19] describes a task to determine the appropriate system for rural development.
In [20] explains a system which avoids inefficient lighting. These literature have provided suggestions for advancing the implementation of an effective technology.

3. HARDWARE

3.1 NodeMCU

In order to perform a complex task, an advanced microcontroller is used. A microcontroller is a device that transmits digital or analog signals to electronic devices in accordance with specifications, enabling these devices for specific operationsbased on needs. Here, electronic circuit's core is a microcontroller, which is used to manage projects that need less power, is essentially a smaller version of a standard-sized CPU found in standalone personal computers.

Figure 2. NodeMCU

3.1.1 Features

• Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
• Operating Voltage: 3.3V
• Input Voltage: 7-12V
• Digital I/O Pins (DIO): 16
• Analog Input Pins (ADC): 1
• UARTs: 1
• SPIs: 1
• I2Cs: 1
• Flash Memory: 4 MB
• SRAM: 64 KB
• Clock Speed: 80 MHz
• USB-TTL based on CP2102 is included onboard, Enabling Plug n Play

3.1.2 Different Wireless Architecture

Table 1 different wireless architecture

Criteria	Different Wireless				
	NodeMCU	*ZigBee*	*802.11 (Wi-Fi)*	*Bluetooth*	*IR Wireless*
Data Rate	Max. 300 kbps	Max. 250 kbps	Max. 54 mbps	Max. 25 mbps	Max. 4 mbps
Range	225 meters	10-100 meters	32 meters indoor and 95 meters outdoor	5-30 meters	10 meters
Networking Topology	Ad-hoc	Ad-hoc	Point to hub	Ad-hoc, very small network	Point to Point
Frequency of operation (Ghz)	2.4	2.4	2.4 5	2.4	800-900nm
Complexity	Low	Low	High	High	Low
Power Consumption	Very low	Very low	High	Low	Low
Security	WPA/WPA2	128 AES		64 and 128 bit encryption	

4 SOFTWARE

4.1 Adafruit IO

The Adafruit IO's MQ Telemetry Transport is a light weightmessage queuing and the transport protocol. MQTT can runon any kind of network, whether it will be TCP/IP or meshnetwork or Bluetooth. Adafruit.io is open source MQTTserver which is working on cellular and WiFi/ Ethernetconnections, and TCP/IP connections. Firstly, the user hasto sign in the ioadafruit.com for accessing the proposedsystem's web page and get the key code. The MQTTlibrary and program for the Arduino is downloaded forinterfacing WiFi which is connected to the serverand set a dashboard.

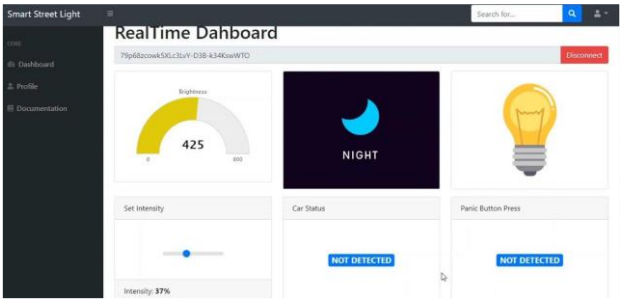

Figure 3 Adafruit io Dashboard

4.2 Blynk

A server that grants us network access so that we can connect with the devices over any distance wirelessly. In order to have a dependable connection between the two ends of the network and to accomplish the aim of making it easy to operate electronic devices wirelessly, Blynk services are used to provide project with a server . This service is further improved by Blynk's Android or iOS application, which interfaces with the electronic device that needs to be controlled by a microcontroller. This makes wirelessly controlling electronic devices even easier.

5.METHODOLOGY

The goal of this work is to install an automated street lighting system based on IOT. The street lights turn on at dusk and turn off automatically at dawn, reducing intensity gradually until morning to conserve energy. LED replaces conventional lamps in street lighting system to include dimming feature. LED lights are fast replacing conventional lights because intensity control is possible by the pulse width modulation. Strings of LED are interfaced to the Arduino board. A programmed Arduino board is engaged to provide different intensities at different times of the night. This project is enhanced by integrating the LDR to follow the switching operation precisely and IoT to display the status of street and help in controlling it.

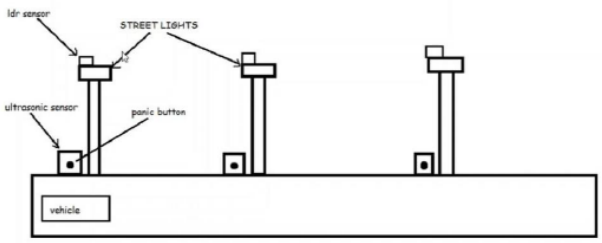

Figure 4. Proposed System

5.1 Existing System

The street lighting system industry is expanding quickly and becoming more complex as cities and industry grow at a faster rate. In the current field of electronics and electrically related technologies, automation, power consumption, and cost effectiveness are crucial factors. Various street light control systems are developed to more economically control and maintain complex street lighting systems. Using various technologies, these systems are designed to regulate and lower the energy usage of a town's public lighting system. HID lamps are used in the current work. Since the HID is currently used for gas discharge-based urban street lighting, no voltage reduction technique can regulate the intensity because the discharge path is broken. One kind of electrical gas discharge lamp is the HID lamp [10]. Limitations of Existing System include more power, less life and only indoor applications.

5.2 Proposed System

Our proposed design aims to reduce the carbon footprint and the overall costs of street lighting by integrating dimmable light-emitting diodes (LEDs) and wireless technology. The principle of operation is to efficiently control the intensity of the streetlights to respond to the needs of road users. The following is a list of requirements our system aims to fulfill such to solve the problems that the current lighting system presents:

1. Motion Detection: A motion detection sensor will ensure that the lights only brighten when motion is detected.

2. Wireless Communication: The network will enable the lights to transmit and receive data between each other. This ensures that when motion is detected near one light, the adjacent lights will turn on, therefore providing enough light for pedestrians or cars.

3. Microcontroller: The microcontroller will act as the processing unit. It will have the following functions: a. Process Data: It must process the data received from the sensor. b. Control Output: This output controls the intensity of the light according to the results of data processing. c. Communication with wireless interface: It must be able to receive and send control signals through the network.

4. Dimming: This involves adjusting the lighting levels of LEDs such that lower lighting levels are used when there are no pedestrian or cars on the streets.

5. Control: Intelligent algorithms will be used to smartly control the lights to quickly respond to the needs of road users.

6. Even Power Consumption: Adjusting the brightness level of lights introduces a problem of uneven power consumption which adversely affects power companies' carefully forecasted usage. This is required in order to produce the right amount of power such to avoid overproduction or shortages. Our solution aims to account for this by implementing an algorithm which dynamically controls the network such that an even power usage is maintained.

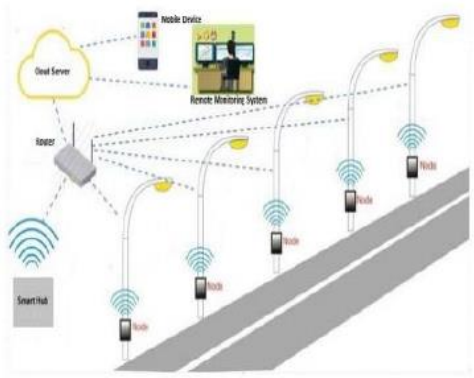

Figure 5. Smart Street Light

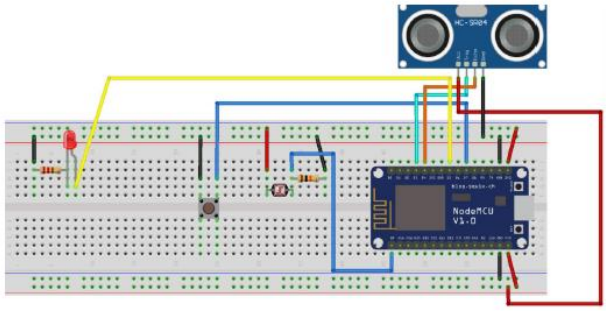

Figure 6. Circuit Diagram

5.3 Algorithm

We have decided the intensity levels of street lights on the basis of natural light at that time and the amount of traffic.
For example: When the Sun is about to set there is some amount of light present, so we have decided to keep intensity of street light to 50% at the time just before sunrise and at the time just before sunset. We are using LED's instead of Sodium Lamps which causes environmental pollution and their lifetime is also low when compared to LED's. We have decided four intensity levels as:
50% intensity: 50% intensity will be there at time of sunrise and sunset when there is some amount of natural light in the atmosphere.
100% intensity: 100% intensity will be there after sunset and before sunrise. Because after sunset, there is no natural light present in atmosphere and the traffic amount is high
due to rush hours.
65% intensity: 65% intensity will be there after the peak time in night had over. At that time, we don't need 100% intensity because the amount of crowd near the midnight is very few.
10% intensity: Our proposed model glow light to a brighter intensity only when a vehicle is there, otherwise the default intensity of street light when there is no motion near the street lights is set to 10%, so that there is little consumption of electrical energy.
We will use LED's, so that their intensities can be controlled. Our algorithm will start working according to clock in the real world.

6. RESULTS

In the beginning, the LDR sensor will sense the light intensity in the atmosphere at that time and consequently sends the data to Arduino. After receiving the data, Arduino will convert it into different discrete values from 0 to 1023 (In which 0 represents maximum darkness and 1023 represents maximum brightness) and then it will adjust the output voltage accordingly from 0 to 2.5v/5v (Dim/High) depending upon the received value (0-2023) by comparing with threshold value. So, the output will be 2.5v in the complete darkness (night time) if the received value is less than the threshold value. As a result, Dim LEDs will glow that is the half of maximum brightness, and when there is completely shine (daytime), the received value will be higher than the threshold value, and the output voltage would be 0v resulting the LEDs to be entirely switched OFF.

Initially, the IR obstacle detection sensor will be HIGH. So, when there is no vehicle/obstacle in-front of the sensor, IR Transmitter does continuously transmit the IR light. Whenever, a car or any other object blocks any of the IR sensors, then the emitted rays will reflect the IR receiver after hitting the object, then microcontroller will sense it as a motion. In simple words, when any object passed in front of the first IR sensor, the corresponding LEDs will be turned from DIM to HIGH (5v) by the microcontroller. As the object moves forward and blocks the next IR sensor, the next three LEDs will be turned to HIGH from DIM, and the LEDs from the previous set is switched to DIM from HIGH. The process continues this way for the entire IR obstacle detector sensors and LEDs. These kinds of application can be implemented in the headlights of vehicles, street lights, parking lights of hotels, malls and homes, and it can be very beneficial.

Table 2.Output

Device Name	Input Data	Verified Results	Remarks
Arduino Board testing	Digital Signal	Switching of LEDs at different intervals	Hardware is accurate
Light Dependent Resistor testing	Outside light intensity values	Dim/High LEDs glows according to light intensity and noted on the Serial monitor	Hardware is accurate
IR Obstacle Senor testing	Sense Motion	High LEDs glows whenever it detects motion	Hardware is accurate

7. CONCLUSION AND FUTURE SCOPE

The proposed street light automation system is a cost effective and the safest way to reduce power consumption. It helps us to get rid of today's world problems of manual switching and most importantly, primary cost and maintenance can be decreased easily.The LED consumes less energy with cool-white light emission and has a better life than high energy consuming lamps. Moving to the new & renewable energy sources, this system can be upgraded by replacing conventional LED modules with the solar-based LED modules. With these efficient reasons, this presented work has more advantages which can overcome the present limitations. Keep in mind that these long-term benefits; the starting cost would never be a problem because the return time of investment is very less. This system can be easily implemented in street lights, smart cities, home automation, agriculture field monitoring, timely automated lights, parking lights of hospitals, malls, airport, universities and industries etc.

In future,Integration of Wireless Power Transmission techniques mayhelp in reducing the maintenance costs and power thefts of the system.

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