Smart Street Light Systems

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Abstract — In this present world, most of us choose to settle for an advanced life with all facilities. To meet the above requirements, the development of science and technology is growing rapidly. To automate different areas like traffic management, health, monitoring, street lights, classrooms, agricultural irrigation, etc, the Internet of Things (IoT) plays a very important role in using advanced innovations. At present, to carry out the working of the street lights we are using the manual system which leads to a large amount of energy waste across the world and this type of method should be replaced with another alternative for effective results. Thus, to reduce the electricity during the night and to detect the object we are using Arduino microcontroller and sensors to accomplish the proposed work. We studied a lot during this survey but most importantly we learned how to develop the street lights in a smart way for our modern era using IoT. Developing the street lights and solving the energy crisis are important facts to the entire world. We described and analysed different components and sensors that are being used in the IoT environment along with the study on smart street lighting systems. In this survey, every component is frequently used and also effective to make steady or constant intelligence systems.

Keywords— Microcontroller Arduino UNO, IOT, Smart Street Light Systems, Temperature sensor, LDR, Serial Monitor.

I. INTRODUCTION

The conservation of energy resources is one of the most challenging factors the world has to look out for in the coming years ahead. There is a huge necessity for lighting in public places, mainly in streets and highways as it plays an essential role daily for the existence of the civilians [5].

Street Lights are one of the vital elements of a community that consumes a large part of the energy and is also a major energy expense for the state. The use of technological systems can reduce the cost value of street lighting by close to 50-70% and also increase the lifetime of the equipment [1].

In the existing traditional method of operating street lights, there is a need of switching ON/OFF the lights at the right time. Sometimes the street lights remain in working condition for the entire day and night resulting in wastage of power and efficient working of the equipment.

As per our observations, there is still a need for a system that can control the intensity of light based on the detection of vehicular motion. Our paper aims to resolve the street lighting systems in which the lights are turned off during the day time when there is no necessity for additional lights. And on the other hand, during the night or when it gets dark the light turns dim and on detection of motion, the intensity of light is increased. This is achieved by placing the components such as microcontroller Arduino UNO, sensors, LDR, and resistors accordingly. [2]

The concept not only reduces power consumption but also helps prevent accidents and criminal activities. All together this project is aimed at advancing energy-efficient and environmentally friendly street lighting.[1]

II. LITERATURE REVIEW

In this section, an overview of smart street lighting system using various technologies is discussed.

In [1], the project is based on the application called SUMO (Simulation of Urban Mobility) which is an open-source traffic simulation. With minimum interference of humans, the system can be completely automated. They also have used a method called Dynamic Street Lighting System (DSLS) which adapts to the motion of cyclists, pedestrians, and other vehicles. When no activity is detected in its sensing area it goes to the minimum intensity and hence it is also called Light-On-Demand or adaptive street lighting. Another application of this method is to switch on the lights based on the weather conditions, the period of the day, and the level of visibility.

This paper also introduces the concept of cellular automata. Their work also involves a simulation of a one-way road that considers the distance between the poles as 60m. IEC 61499 control for six street lights is used. It also approaches to cover bi-directional traffic and for pedestrian sidewalks. The simulation results involve energy savings as a function depending on pedestrian and vehicle capacity. This paper also talks about speed detection as one of the functions. The pedestrian and vehicle speed is obtained by the Doppler detector which controls the switching of the lamps. An algorithm- isolated nodes relief algorithm, is also used during node transfer in wireless communication. [8] Using the node metastasis mechanism of ZigBee both energy and traffic safety are under control.

Sharath Patil et al. has stated that the relay is the automatic switch that releases the manual work at most 100%. Light intensity sensors like Zigbee, PIR and LDR sensors are used to illuminate the status of human use. The nearby EB section is informed of the ON/OFF status of the street lights to prevent the wastage of energy. The whole system is operated with battery backup and artificial solar energy.[9]

Lakshmana et al. has suggested that to save electricity in the urban areas, solar energy can be used in street lights and this energy is gained by photovoltaic and is then transferred to the LEDs of the street lights. The acquired energy from the photovoltaic is then stored in a rechargeable battery, hence when there is no sunlight the LED lamps will switch on automatically.[7]

M. Kokilavani et al. have also suggested that PIR sensors and LDR sensors sense human activity and light intensity of specific areas and this data is then sent to the EB section via a wireless connection.

Prakash et al. has spoken about designing a lighting system based on IoT by a combination of IR receivers and transmitters. This combination recognizes the vehicle's motion and sends the data to the microcontroller to switch ON/OFF the light accordingly. [10]

Fathima et al. propose that to provide the required intensity of the light at the different time programmed Arduino board is used. DHT11 sensors are used to sense the scaled digital signal output of temperature and humidity. [11]

B.K Subramanyam on the other hand designed and developed a wireless street light system with Graphic User Interface (GUI). In which the street lights are governed by plotting a specific GUI in the PC. [12]

B. Abhinaya et al. proposes smart weather adaptive lighting in street light which specifies the control smart embedded system. Internet is used to switch ON/OFF the lights. A camera is used to track the actions on the road and saved in the server. There is also an addition of a panic button which raises an alarm to the nearby security station. [6]

In [3] the concept of using Light Emitting Diode (LED) lamps instead of High-Intensity Diode (HID) lamps as they are not cost-effective and reliable is introduced. It also suggests that street lights can be made energy efficient by using a Global System for Mobile (GSM) that sends the relevant information to the control station. The wireless Street Lighting System uses a combination of researches and current technologies related to this field for convenient use of electricity. This system works effectively in any weather condition by using LDR instead of solar lamps.

Srikanth et al., his work is related to an automated system with remote control using ZigBee. The system is entirely automated and the operations of turning ON/OFF the lights or turning the lights dim are preciously done on sensing the movement of the detected objects. And this motion is detected using PIR sensors. [13]

In [3], they have worked on smart street lights based on GSM. They also proposed the idea of 24-hours monitoring street lights with maintenance to check the lamps working conditions.

This paper also introduces the concept intelligent light poles with emergency lights which would warn during emergencies or dangers.

In the study of IoT- based Street light system for smart city, they used infrared sensors to detect vehicular movement to switch ON/OFF the lights. This study monitored system parameters via the internet and eliminated manual control of street lights but did not include tracking and vandalization monitoring.

Some of their work used lead-acid batteries which were charged by the solar panel. [4]

Sharmitha et al. proposed a system with combined LDR and IR sensors. Based on the condition, to switch between grid and solar power relays were used. [14]

A study by Kirunguru et al. on "Design and Implementation of a Transformer Vandalization Monitoring System" put forward a system with an installed alarm mechanism on the transformer. To detect the presence of a vandal near the transformer the system combined a PIR sensor, Arduino and GSM. When the presence is detected then an alarm is raised and a message/call is sent to the control room. [15]

Iyapo et al. proposed a system constructed with the help of an embedded microcontroller system that detects the motion of any object or person and rises an alarm. The intruder is detected by the body temperature sensed by the PIR sensor. On the other hand, the system doesn't have a monitoring system to alert securities. [16]

Aliyu et al. presented a system that used a Passive IR, vibration, and sound sensors to detect the intruder. The intruders are sensed by the above three sensors even before they come in contact with the pipelines, hence it concludes the presence of the intruders. The concerned authority receives a message containing the location of the intruders by a GSM module. [17]

III. VARIOUS COMPONENTS USED FOR STREET LIGHT SYSTEM

MICROCONTROLLER & PROCESSORS:

i) ARDUINO UNO- Arduino Uno's working is based on ATMEGA328P microchip. It has 14 digital input and output pins- 6 analog inputs, 6 PWM outputs, and a 16 MHz ceramic resonator.[2] It also has a USB connector, a power jack, an ICSP header, and a reset button. The original protocol used by the Arduino to an interface is the STK500 protocol. Using a USB cable, the Arduino board is connected to the computer, where the code is uploaded in the Arduino software (IDE) and executed. Arduino allows interface with as this is like a serial device.

ii) MICROCONTROLLER- Microcomputer like PIC(Peripheral Interface controller) is designed to check the production of any embedded system like portable radios, home appliances, motor vehicles, office machines, robots, and many other devices.

iii) RASPBERRY PI- A Raspberry Pi construction is based on a 32- bit ARM processor. It is a low-cost, credit-card-sized computer and it can be used by any age group people. This mainly helps in learning how to code in popular languages like Python and C.

2. SENSORS:

i) LDR SENSOR- The abbreviation of LDR is light dependant resistor, which is also known as Photoresistor. LDR sensor has a sensitivity surface, where the light intensity is determined. It's a passive device that decreases resistance when the incident light intensity is high (i.e., it exhibits photoconductivity) [12]. In the dark, the resistance of the sensor increases to several Mega ohms whereas during daytime the resistance falls to a few hundred ohms.

ii) IR sensor- An Infrared sensor or IR sensor is an electronic component that measures and detects infrared radiations in the surrounding environment. [18] IR's wavelength is longer than the visible light hence its invisible to the human eye. Any object which has a temperature above or around 5-degree kelvin gives off IR. Passive and Active are the two types of IR sensors.

a. Passive IR or PIR sensor- They do not emit IR but detects Infrared radiations. It consists of- two strips of pyroelectric material, an infrared filter-which blocks all other wavelengths of light, a Fresnel lens-consumes light from many angles into a single point, and a Housing unit- which protects it from humidity and other environmental variables. The PIR sensor is most commonly used in a motion-based detection system.
b. Active IR sensor- A receiver and Light-dependant diode or LED makes the Active IR sensor. The sensor both detects and emits infrared radiation. When any object comes close to the sensor, the LED emits infrared light which the receiver detects. Applications of Active IR sensors are- proximity sensor and obstacle-detection systems (robots).

iii) LED- LED, which stands for light-emitting diode, is a semiconductor light device that emits light when current passes through it. In the semiconductor, the electrons recombine with the electron holes which leads to the release of energy in the form of photons.

3. RESISTORS: Resistor is a two-terminal electrical component which provides electrical resistance to the circuit elements. In an electronic circuit, resistors provide opposition or reduce the current flow, divide voltages, stops transmission lines, adjust signal levels, etc. Resistors are the most common components used in an electronic circuit.

IV. CONCLUSIONS

From this survey, we can conclude that IoT is growing rapidly. One of the major parts that uses IoT concepts is the Smart Street Light System. Critical Problems like crime detection, energy waste, maintenance cost, of incandescent lamps etc., can be clearly tackled by the Smart Street Lighting System. The Security and Traffic Safety to the people is ensured by the above system which can stop from burglaries, further intimidations and women annoyance. Dynamic Street Lighting System has been proposed in order to overcome the traditional method. This system creates a safe environment and is entirely adaptable to the externals requirements. Simple software with minimum hardware is the basic requirements to this approach. Overall, it is also possible to avoid negligence factors by human activities and all the decisions to control the street lights are taken by the system itself that helps us in making our city as the smart city.

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