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IoT Based Smart Street Light for Energy Efficiency and Safety

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Abstract: ***The fully automated prototype of an energy efficient and weather adaptive street light is designed for cost cutting measures. The system turns the street light ON/OFF depending upon the ambient light conditions, thus saving current consumption by brightening the lights to full intensity only when traffic or some emergency is detected. The system has a camera onboard for safety purposes. There is an emergency button placed on every pole, which when pressed triggers an alarm and emergency services will be provided with a live feed via cloud services.***

Keywords: Internet of Things, Street lights, Safety, Emergency Button, Sensor, Raspberry Pi, CCTV Camera, AWS, Amazon Web Services

1. Introduction

The current street light setup costs the city 50% to 70% more than what smart street lights would potentially cost. In developing countries implementation of smart street lights can bring in a lot of change. The LED lights used in the smart street lights are intensity adjustable. They can also save energy in low traffic environments. The incorporation of sensors like LDR ensures that street lights are turned on only when required,thusproviding full automation in the street light infrastructure. All the sensors are controlled using Raspberry Pi microprocessor, whichconsumes less power and can control multiple light poles at once.

The system takes care of emergency situations by informing the emergency services when the emergency button is pressed. The system has a camera for monitoring the activities on the road. The camera feed is sent to emergency services by using cloud services (AWS). When the emergency button is pressed the feed from these cameras is sent to emergency services and the alarm is triggered. Along with the alarm the intensity of all the lights will be set to maximum to alert. This can be used mainly for the safety of women.

2. Objective

In developing countries electricity is a luxury. Usage of regular street lights results in its excessive electricity consumption, consequently, increasing the electricity charges. This project helps decreasing the wastage of electricity by efficient street light control automation. This could help cut down electricity consumption to a great extent. The emergency button function will also bring about a safety element to the existing systems.

3. Problem Definition

Street lights are one of the major consumers of electricity today. Although most cities have moved on to using LED street lights, there still exist many localities that use incandescent lights. By switching to LED lights, a large fraction of their electricity costs could be saved. Unlike LED's the incandescent lamps are not dimmable. Incandescent bulbs are already huge electricity consumers, and them being non-dimmable just worsens the scenario. And moreover, this project requires dimmable bulbs so the undisputed option was LED bulbs.

a) Disadvantages of existing system
- Not dimmable.
- Expensive compared to LED.
- More energy consumption than LED.
- Less lumens compared to same wattage LED light.

b) Advantages of proposed system
- Fully automated switching of lights.
- Wireless communication.
- Energy efficient.
- High lumens per watt.
- Ensures public safety.

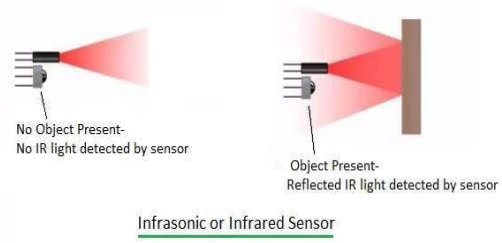
4. Resources

4.1 Raspberry Pi

The Raspberry Pi is a credit card-sized computer originallydesigned for education. The Raspberry Pi is slower than a modern computer but is still a complete linux computer and can provide all the expected abilitiesat a low-power consumption level. Raspberry has built-in Wi-Fi and Bluetooth Modules.

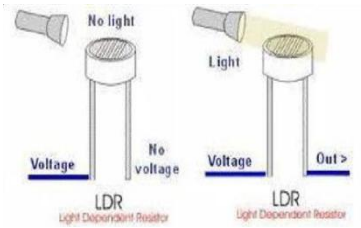
4.2 Infrared Sensor

An infrared sensor is an electronic device that emits infrared waves in order to sense motion in the surrounding. The IR light is transformed into an electric current, and this is directly detected by a voltage or amperage detector.



4.3 LDR (Light Dependent Resistor)

An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. Photo conductivity is an optical phenomenon in which the materials conductivity gets reduced when light is absorbed by the material. This allows them to be used in light sensing circuits. An LDR works on the principle of photo conductivity.



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4.4 Emergency Button

An Emergency alarm is an electronic device designed to assist in alerting somebody in emergency situations where a threat to persons or property exists.

4.5 Camera

The camera will capture photos after certain interval and when the emergency button is pressed. The photos will be uploaded to amazon web services, S3 bucket.

4.6 Alarm Speaker

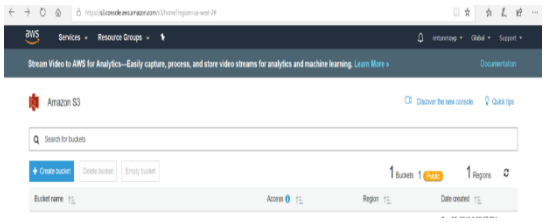
Piezoelectric speaker is used as a alarm which will be triggered when the emergency button is pressed.

4.7 LED

A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it. The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength.

4.8 Cloud

Used to store the images captured by the camera on the pole. Images will be stored in Amazon web services- S3 bucket. S3 stands for Simple storage service. S3 provides up to 5TB of storage. Emergency services can access the camera feed from S3 storage.



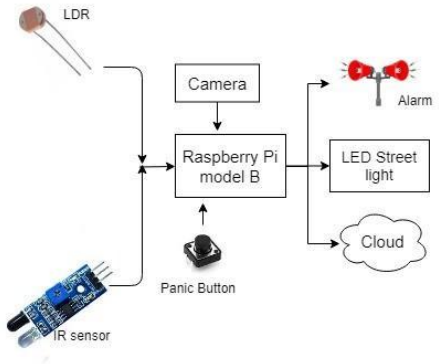
5. Working Principle

System architecture of the energy efficient and adaptive system consists of IR sensor, LDR sensor to sense the lighting condition and traffic conditions. The output of these two sensors is given to the brain of the system i.e. Raspberry Pi 3 (Arm cortex A-53). The LDR senses the light falling on it. As the sun light increases the resistance of the LDR decreases. Which triggers the event driven program and turns off the street lights. When sun light decreases then resistance from LDR increases which turns on the street lights to 50% intensity.

The IR sensor is used to detect obstacles, in this case traffic.Whena vehicle passes an IR sensor, it controls 2 sets of street light. The set of street lights which are preceding it are dimmed to 50% intensity and the set of street lights upcoming to current set of street lights are brightened to 100% intensity.

Emergency button triggers the alarm and camera. Alarm starts buzzing for a specified period of time. The camera sends the feed to AWS S3 bucket. Which can be accessed by authorized personnel.

Block Diagram



6. Implementation

This system was designed with three things in mind:

- Reduce power wastage.
- Ensure efficient usage of street lights.
- Have some safety mechanism provided on roads.

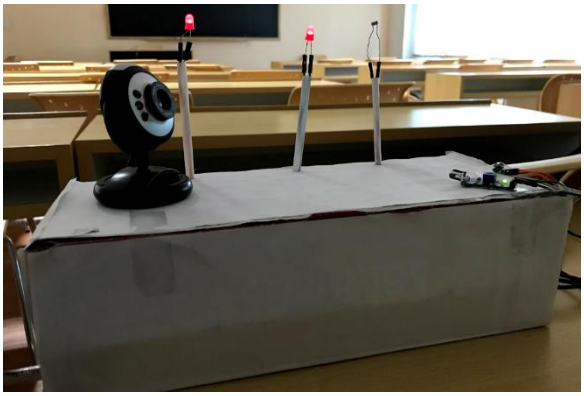
These systems have been implemented by automatic switching on and off the street lights and by introducing an emergency button, that rings an alarm and also brightens the street lights to about 100%.

Once darkness consumes the environment, LDR sensors signal the lights to turn on, and once sunlight brightens the environment enough, the LDR sensors indicate the lights to turn OFF.

Movement sensed by the infrared sensors ensure that the lights turn on to peak intensity only when there is traffic on the roads.

Emergency button ensures that any emergency situations are captured by an onboard camera present on the street poles and lights are brightened to full intensity as a precaution or warning.

Images are uploaded to the Amazon Web Services (AWS) S3 bucket, the link to which are forwarded to the concerned authorities, who can view them when required.



7. Conclusion

The below given objectives are achieved in this project:

- Reduction in Energy wastage.
- Ensuring Public safety.

The usage of LED street lights reduces the cost of energy as well as the dimming function reduces cost up to 70% as compared to conventional way.

It could also provide evidence by means of photos captured bythe onboard camera, which could be used for legal proceedings.

The system is designed to create an environment on roads which leads to considerable energy savings also providing some safety features.

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