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Micro Python Powered Smart Street Light using IOT

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ABSTRACT

The proposal for a smart street lighting system is being considered. In this project, the street light system, in which lights are turned on when needed and turned off when not needed. Street lighting which is turned on when it gets dark and turned off when it gets bright, currently consume large amounts of electric energy around the world. This is the world's largest energy waste and should be changed. The smart street light system consists of an LED light, an ultrasonic sensor, a motion sensor and a short-distance communication network. The lights turn on when pedestrians and vehicles come and turn off or reduce power when there is no one. It will be convenient for pedestrians and drivers of vehicles to travel, since our smart street lamps will turn on when they come. The present status and the future prospects of our smart start light project will be reviewed. This system will aid in conservation of energy through automation.

Keywords: Smart Street Light, Automation, Electric Energy, Sensor, Conservation of Energy

I. INTRODUCTION

Energy is the capacity to do work. There are many types of energies in this world such as light energy, sound energy, electric energy, magnetic energy etc. Each energy is unique and is very important for the balance of earth. Our Mother Earth is providing us all resources of energy. So, we should use it efficiently and wisely. According to the law of Conservation of energy," Energy can neither be created nor destroyed; it is just transformed from one form to the other." It is our duty to use energy to serve the mankind. It is also our duty to conserve energy. Since energy is an Inexhaustible resource, it doesn't mean we unlimitedly use it inefficiently and waste it. We must always try to conserve energy as much as possible.

Light is a form of energy. Light is dual in nature. It exhibits both particle nature and wave nature.

Sun is the biggest natural source of light. But we receive its light only during the daytime. But we need to function even during the night time.

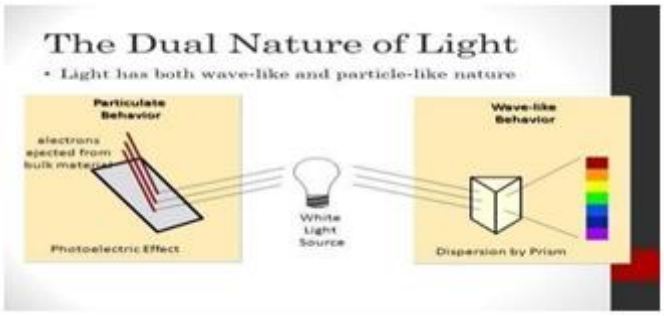

Fig.1. Dual nature of light

So, we need artificial sources of light such as LED's, tube lights, bulb, torch etc.

For transportation and travelling purpose we require street lights on road. Street lights are lights illuminating the road. The working of a traditional street light is as follows:

The street lights which are usually made of LED's are mounted at top. The lights contain switches which must be turned on and off manually by an in-charge person. It is difficult to figure out lights that are not working and other problems related to it.

Fig.2. Conventional street lights

There are many disadvantages of traditional street lights:

- It must be turned on/off manually.
- If the person does not turn it on for one day, the masses will have difficulty that night.
- The lights are constantly on throughout the night irrespective of vehicles, people moving around. This is wastage of energy.
- Also, it causes light pollution which can cause irritation to the eyes and headache.

There are flaws in the current system that can be addressed. So, in order to address this, we devised the concept of a smart street light. The sensors in this smart street light detect any movement of animals, cars, or people. The lights are turned off. The light gets brighter as the object goes closer to the light pole, and dims as the object moves away from the pole. This eliminates the need for street lights to be turned on unnecessarily. This principle aids in light energy conservation.

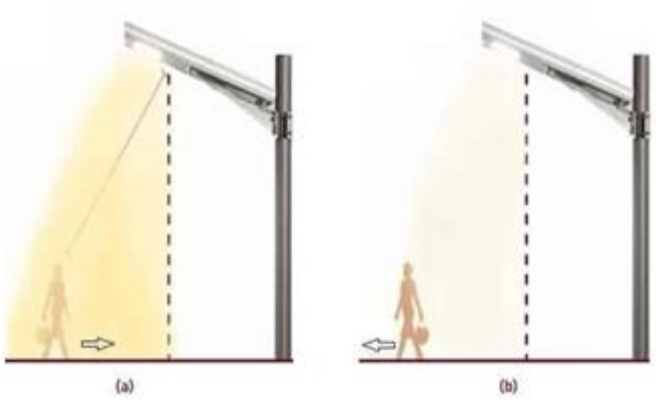

Fig.3. Smart Street Light

II. LITERATURE SURVEY

A. "Study on IoT based Smart Street Light Systems"

The proposed system [1] is able to decide how it can manage brightness. The most important idea of this study is to use surveillance cameras and mount them on top the street light, these cameras will then monitor the traffic and street lights over the internet. A panic button is installed on the pole of the street light so that if a danger ensues it can be used to send an alert to the police station nearest. The lights can be turned on/off using the net.

The footage of the camera is stored into an external server [2]. Raspberry Pi is the controller used for this project because it has very low power consumption. It's the size of a debit card but includes educational software. Other equipments such as robots, portable radios, home based devices and motors using PIC microcontrollers also use RPI, this is because RPI controls the functioning of the embedded systems.

Arduino UNO's analogue and digital I/O (input/output) pins can be connected to evolution boards and other circuits. STK500 protocol is used in

building the interface. This project also includes a variety of sensors that are used such as temperature, proximity and Ultrasonic sensor.

Through this project they seem to handle many issueslike energy wastage, crime detection, lowering the maintenance costs, proper light disposal etc. Additionally, road safety and violence against women are also consequential benefits to this project. The user finally decides where to apply this mechanism. It proves to be a home safety solution as well.

Taking a look at configuration [3] we see that a single phase is used to mainly power the streetlight. The system is as follows: the data collected from camera is sent to Arduino (the brain), an IR proximity sensor detects the motion of a human being within a certain limit, the Arduino then orders the street lights to reduce the brightness.[18]

The IDE of Arduino is a software (free) that enables code making and uploading rather simple and straight. It runs on a plethora of operating systems such as Windows, Mac OS etc. Core written in Java but it can be used without having a JRE or JDE.

LDR is a light dependent resistor and it is a function of the electromagnetic radiation. Hence, they are photo sensitive devices.

IR sensor: it's an electrical device that detects objects by emitting its rays onto its surroundings. It also detects motion and temperature of objects.

B. "Internet of Things Based Intelligent Street Lighting System for Smart City"

The proposed system [5] intends on being able to design an innovative system and implement this embedded system into a project that serves as an energy saving solution to the common street light problem. Presently our system is on a manual basis where a human being turns on the lights during daytime and turns off when dusk begins. However, there are obvious drawbacks to this contributing to human errors such as timely act of turning on/off.

The aim is to save electricity and this is achieved by detecting an incoming vehicle using an IR transmitter and receiver to sense a movement and tells the micro controller to turn the lights on/off [8].

This is a low – energy alternative to our current system. The status of on/off of the street lights can be checked anywhere and anytime via the internet. The sensors will recognize any object.

Upon detection of an obstruction/obstacle/human being/other animals the street light turns on within a given duration of time. At the same time when there is no movement detected the lights are turned off automatically. This system used an embedded system (smart) to control their lights in a similar way an organism responds to stimuli. The data that is stored from the IR sensors are stored on an offline server and is made accessible to the required parties over the internet.

The real time status of the lights being on/off can also be seen from any location.

C. "Advanced Adaptive Street Lighting Systems for Smart Cities"

The defined system [9] actually tries to define an intelligent public street lighting infrastructure that ensures that the maintenance of the system can be a relived of human beings and thus focuses on micromanaging the energy wastage that happens. This particular system believes that automated management of the lights will help us in focusing our energy elsewhere, instead of combing through hours' worth of data and debug them.

The following is proposed by this system: Remote and automated management of the street lighting system. Intelligent control established by the following:

- We provide the required light intensity at each lamp or a group of lamps.
- Each of this light intensity is proposed as a function of the daily time, recorded weather conditions, trending rates of human interference.

- Pedestrian presence and human activity are also provided as data for the intelligent system to analyze and make conclusive decisions.

The [16] infrastructure concept which provides the services and facilities listed below:

- An advanced system that controls a single/group of lighting interfaces.
- A local communication network of devices based on IEEE 802.15.4 specifications and implemented the Zigbee protocol.
- Monitoring of emergency circumstances and traffic (e.g. Traffic jams or accidents)
- ·Consumption assessment is provided.
- ·Web application provides access to all capabilities and remote control for establishing monitoring alarms and daily lighting routines.
- ·3G/4G/Wi-Fi connections are used for remote application. Communication between smart phones and the web – internet.

D. "Intelligent Street Lighting System for Smart City"

The implied system [10] is primarily an IOT-based and automatic street lighting system which uses a unique counting system that is used for counting vehicles. Its design and code is established by utilizing an embedded system. A method known as Auto-switching has proven to be energy saving and highly efficient is used in this system. The AVR microcontroller that has more functionality has been used with this project. This is to enable auto switching between new applications connected to the smart street light. By actually constructing and designing the LDR the vehicle count detector sensor and the vehicle exit count detector sensor both U-sensors are implemented. Based on the entry/exit of the vehicle auto switching can be implemented based on light intensity of the street light. This automatic on/off switch will work irrespective of the daytime or night time. The exchange of data from the nearest street light is stored via Bluetooth to monitor the status of the smart street lighting system.

E. "Smart street light system looking like usual street lights based on networks"

The current paper proposes that an intelligent street light system works on a network ofsensors that behave like regular street lights. There are a lot of advantages to this system but it is difficult to deploy. This study focuses on the implementation issues. Now we'll start

[13] building an algorithm for controlling the on/off of street lights. We'll also put the method into practice and assess it through trials.

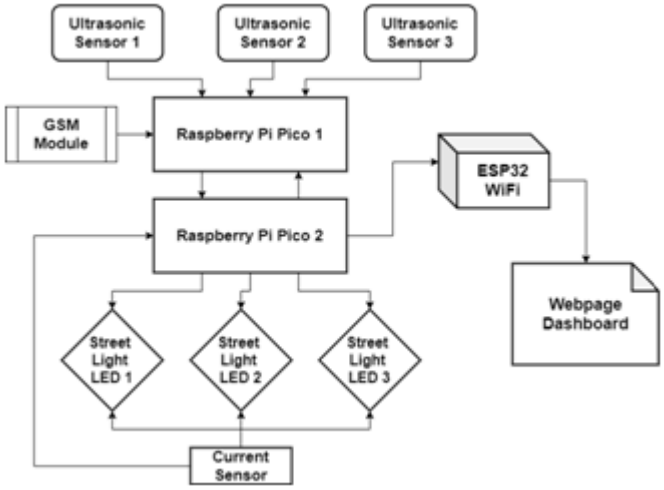

Fig.4. Block Diagram

Fig.5. Use case Diagram

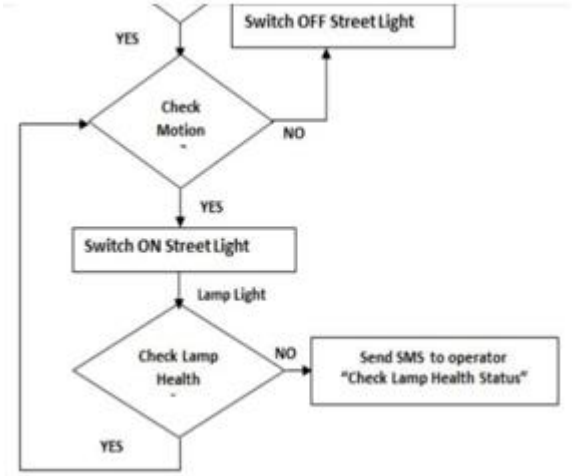

Fig 6: Flowchart

III. METHODOLOGY

The smart street light system for energy conservation using IOT is an effective method, primarily designed for energy conservation along with other added benefits.

Fig.7. Working model

A. Existing System

Streetlights are an essential component of roadways and are constantly put to use whether or not they are required at times. This results in a number of after-effects and disadvantages that the existing system carries:

- Excessive energy consumption as the lightshas to be continuously on when it's dark, whether or not it's being used attimes.
- Wastage of electricity due to the lights remaining on during the daytime as a result ofnegligence.
- Notverycosteffectivebecauseofthehigh cost due to excessive consumption ofresources.
- Leads to excessive Light pollution and thus disrupting the natural wildlife pattern and increasing the amount of carbon dioxide in the atmosphere.
- Manual operation of the lights such as switching on and switching off.
- Manual check on maintenance due and regular checks of working of the lights.
- Lack of automation for improved efficiency.

B. Proposed system

The proposed system [11] involves implementation of a smart street light system is automated in such a way that initially the street lights would be turned off and it would have sensors embedded [12]for detecting object movement and the next few streetlights will automatically be turned on based on this detection. In case if a particular light stops functioning, a message would be sent to the main controlling hub so that it can be rectified at the earliest. The features of the proposed system eliminate the disadvantages of the existing system.

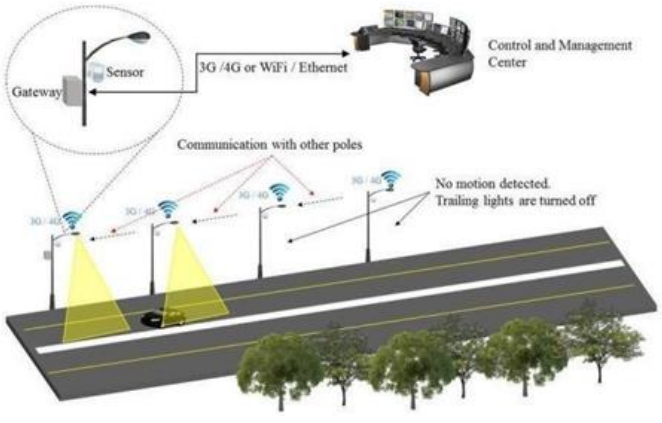

Fig. 8. Proposed Scenario

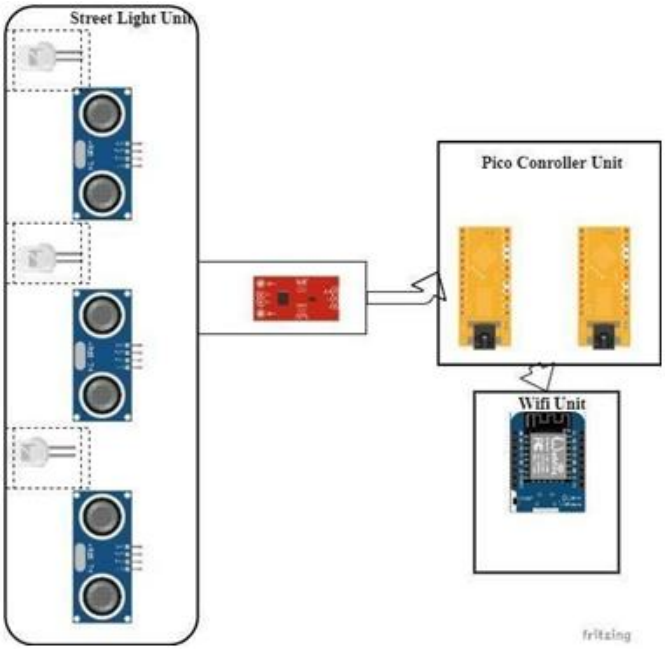

Fig.9. Experimental setup

C. Components included in the proposed system:

a) Raspberry Pi Pico:

It is a small, flexible and versatile MCU board built using RP2040. Pico is a brand- new microcontroller chip designed and developed by Raspberry Pi, that has various I/O peripherals. It runs Micro Python which is a very beginner and user- friendly language.

b) ESP32:

It is a chip that provides Wi-Fi and other necessary functionalities such as networking, data processing and P2P connectivity in embedded systems.

c) GSM Modem:

It is the Global System for Mobile Communication that uses mobile telephone technology to provide data linkage to a remote network.

d) Ultrasonic Sensor:

It is an instrument that measures the distance to an object using ultrasonic sound waves.

e) LED lights:

The small LED lights are used to show the implementation of the real project in a smaller version. The LED lights are a simulation of the street lights.

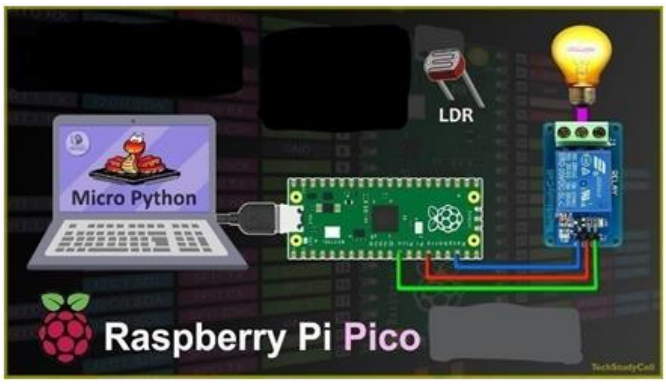

Fig.10. Components

IV. ALGORITHM

Srep 1: Start
Srep 2: Object detection using ultrasonic sensor.
Srep 3: Upon successful detection, street lights turn on.
Srep 4: Once the object has passed, street lights turn off.
Srep 5: Object not detected - street lights remain off.
Srep 6: Any malfunction in streetlight, streetlight does not turn on even when object passes.
Srep 7: Message is sent to the hub regarding the malfunctioning of the street light so that it is rectified at the earliest.
Srep 8: Upon successful rectification, street lights start functioning normally.
Srep 9: Stop

V. RESULTS AND DISCUSSION

The outcome of this project is to implement the automation of a street light, also known as the Smart Street light using internet of things. This would majorly facilitate in the conservation of energy and would thus prove to be a smarter alternative that could implement the conventional existing mechanism of streetlights.

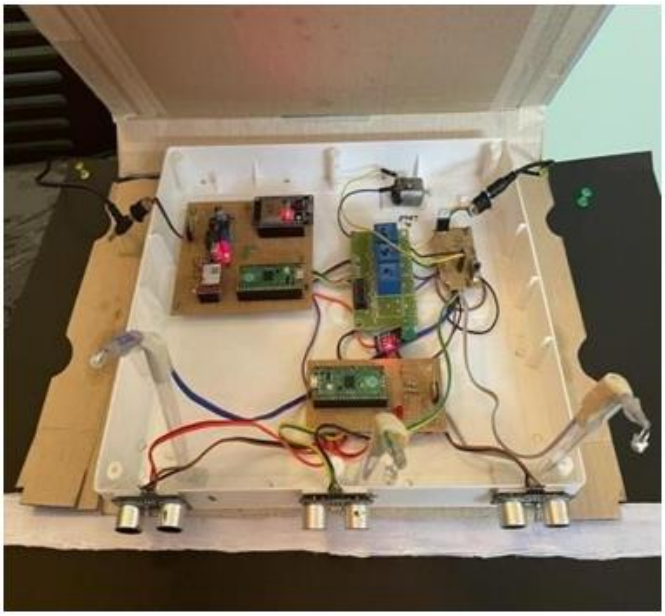

Fig.11. Hardware Set-up

The workflow of this system starts with the detection of any object movement by the ultrasonic sensor. This is done by setting the minimum distance to a certain value and if the ultrasonic sensor detects the object to be at a distance lesser than the set value, then the LED light (street light) is turned on. The logical implementation of this concept is done using MicroPython coded on Raspberry Pi Pico. The system also consists of other LED lights to showcase the communication between the hardware components.

A. Salient Features of the system

In order to scale up the automation in the system, there is an implementation of a message alert in case of any damage in any of the street lights. This can be elaborated i.e., once a damage is detected in any of the LEDs or the LED is not turning on due to some reason, then a message is sent to the mobile device of the administrator using the GSM modem, so that an immediate action can be taken to rectify or repair the light. This eliminates the need for manual checking of the streetlights and also fosters a quick resolution through automation.

This system uses ultrasonic sensors for object detection, whereas the existing systems use infrared sensors. The reason behind selecting ultrasonic sensors for this system, instead of the conventional infrared sensors, is to make the entire smart street light system more cost effective and reliable.

The programming language used to code the system logic is MicroPython, which is a very simple and coder- friendly language and is easy to understand. This is significantly more efficient for the smart streetlight system when compared to the other programming languages already used for this system.

This system uses Raspberry Pi Pico which is physically smaller compared to its other alternatives and much more cost effective and is very efficient for the functionalities that it is used to perform in this system. It has lower power consumption and power saving modes.

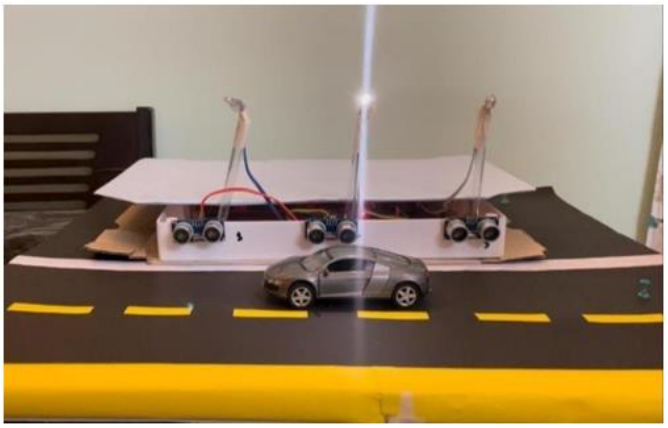

Fig.12. Implementation Set-up

VI. CONCLUSION

The MicroPython powered Smart Street Light system has been implemented to overcome the drawbacks of the existing system and significantly provide better alternatives for making this system more reliable, sustainable, cost effective and efficient when compared to other such systems that are already existing.

VII. FUTURE ENHANCEMENT

The smart street light system as of now is just a proposed system. There is no real time

implementation of this system anywhere in India. Initially, we cannot expect many extraordinary features from this system when it comes in to real time implementation. There may still be many drawbacks which can be eliminated slowly and system upgradation happens with time by people's feedbacks and suggestions.

As of now, implementing the smart street light system practically would be the biggest accomplishment. However, there are still many drawbacks of this entire system.

Some of them are as follows:

- The system is not that efficient during rain. The sensors may not be able to sense objects in a precise manner when it is raining.
- The system cannot be implemented in places where there is heavy snowfall. The snow canget accumulated over the sensor because of which the sensor cannot sense objects precisely.
- This system cannot be implemented in a few countries like Norway where there is complete darkness for months. This is because the main motive behind this entire system is to conserve energy where there is wastage. In Norway like countries, there is necessity of light all the time. So there is no point in implementing this system and conserving energy.
- The automatic street light system requires a higher initial investment in comparison to conventional streetlights.

With advances in science and technology, the future of autonomous conventional streetlights seems quite promising. Demand for power affects human life in many ways. Finding strategies to preserve energy is not only vital, but also necessary, in order to avoid depleting resources. Switching to a smart automatic street light system will also reduce the amount of energy wasted by traditional streetlights.

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