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A STUDY OF AN ECO-FRIENDLY STREET LIGHTING SYSTEM FOR A SUSTAINABLE FUTURE

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ABSTRACT

The fundamental goal of this research is to create something that is long-lasting, environmentally friendly, and energy-efficient for everyday consumers. As a result, the concept of an automatic green street lighting system was proposed, addressing the issue of needless road illumination and, in particular without energy wastage. Street lighting when it is not required is a waste of resources and electrical energy in general. Modern civilization has adopted the philosophy of "Going Green," which is emphasized at all times, particularly in the engineering field. Engineers come up with novel ways to save energy while improving the efficiency of their goods. One of these methods is to use a smart system, which has applications in numerous areas of society, such as at home, at work, and so on. Our main goal is to reduce energy while maintaining user-friendliness. Smart systems, created years ago, are still the foundation and are used to this day, improving as time goes on and striving for even greater development.

Keywords: Eco-friendly, Engineering, Technology, Microcontroller, Programming

1.   Introduction

The term "smart street lighting system" refers to a street lighting system that is both intelligent and an illumination speed controller that must turn on at the appropriate time and work together seamlessly. Many methods have been proposed that selectively switchoff/dim lights to improve energy efficiency, but only little consideration has been given to the effectiveness of the resultant street lighting system [1,2].The purpose of a city's street lighting is to ensure safer traffic and pedestrian conditions environment, and it has the potential to make a significant difference [3].

The architectural, touristic, and commercial output of the city by programmable lowering illumination and ON/OF is implemented in this system. It becomes simple to change the street lights and we can choose from our pre-programmed programs or create our own system. It makes on our own to automatically control every street lamp. This technology assists in dimming the lights in a specific area or during a specific time period where lighting needs to be reduced. For example, dimming the lights is the best approach if foot traffic drops dramatically during 1:00AM and 5:00AM.. When no person or vehicle is identified, the lighting of the street lights is reduced to 20%. Thereby we will significantly cut energy usage and CO_2 emissions, as well as city lights and overall environmental effect.

2.   System Architecture

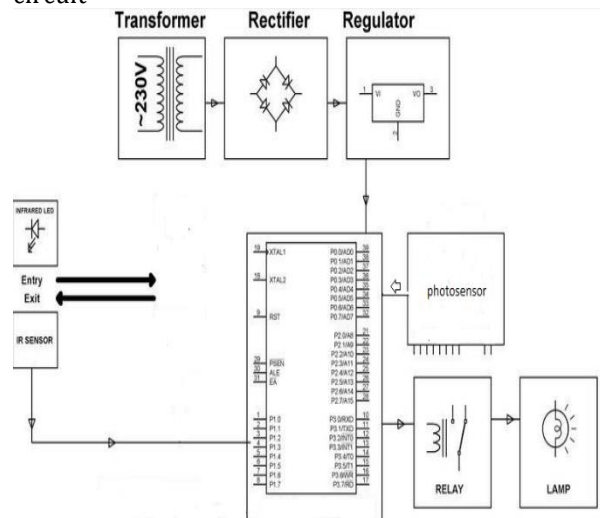Below is the basic circuit diagram of the proposed circuit

Fig.1. Proposed circuit diagram

An intelligent system is highly and functions with a variety of sensors, responding to environmental changes it observes. Because this change in scientific information must be acted upon, a control system is required. A control system contains the incorporation of a variety of devices, which are utilized for detecting, regulating, and actuating operations. Simply described, a gadget that can operate in response to events. One of the most effective ways to save money is really to turn out the lights when not in use. Most roadways now have lights even when there are no vehicles on the road; we can alleviate this problem with automatic lighting. This simply means turning on the streetlights when there is a vehicle present and shutting them off when there isn't. Our system is built in such a way that it may be readily adjusted and applied. The goal is to establish a public lighting system that saves energy and prioritizes its availability if streets are being built with new lighting systems. Design and construct an energy-saving street light including main cooperating sensors and controllers that are integrated with one another in order to conserve as much energy as possible and to create a lighting system that can be readily updated and expanded. Finally, to create a system that is both technologically and environmentally friendly.

2.1.Methodology

The first step is by doing research into the related sensors, and control units, followed by the how they were to be implemented together and then put together into a working prototype model.
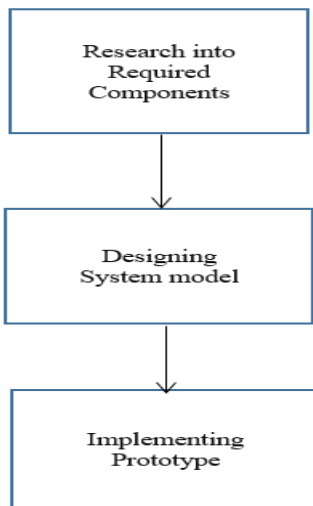

Fig2. Summary of methodology inflow diagram

2.2 Circuit Designing and Programming

In this section, some brainstormed ways to design a circuit that would perform the required task, hence a block diagram of what needs to be done was created. The proposed street light system is essentially an intelligent system that is designed to turn street lights on and off automatically based on the amount of sunshine using a fairly common and simple features . In the present system, we have used LDR (Light Dependent Resistant) which is a type of light sensor. LDR can also be used to recognize any light that isn't working properly, in the system and transmit the information to the GSM/GPRS wireless connection that connects the command center. The intensity control of the second specialized feature is LEDs which are dim and brightening in street lighting. Then the automatically activating method for detection of any object in motion. This feature is made possible with the use of PIR (Passive Infrared) sensors. PIR sensors are examples of motion sensors.
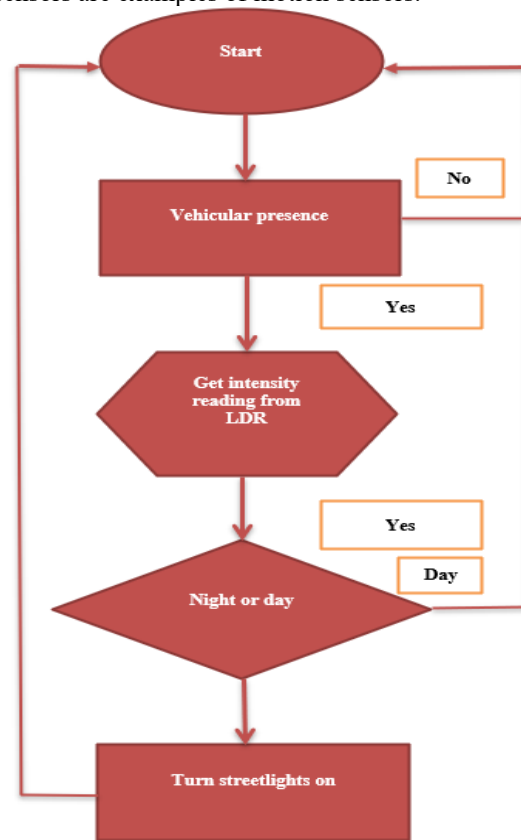

Fig.3 Block diagram

2.3 Vehicle Detection Module

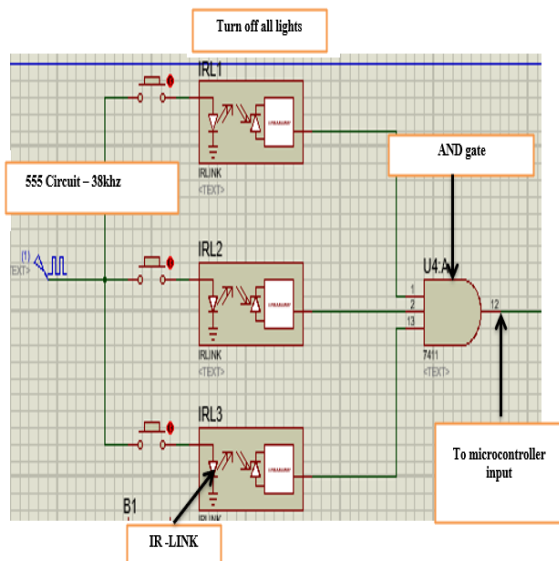As mentioned earlier, decided to use multiple IR links;

Fig 4. Configuration of IR link

2.4 Day/Night Detection Module

In an analog to digital converter, using the digital output we can simply connect it to one of the many input pins of the microcontroller. An inbuilt photocell enables the day/night functionality by registering the brightness of ambient light and activating when illuminance approaches the pre-set level. Brief fluctuations in light levels produced by clouds, automobile lights, lightning, and other sources will not trigger the LED, as it is programmed to check for misleading ambient light and therefore will not be engaged by them. This day/night LED offers up to a 30,000-hour life span, compared to its CFL counterpart which only provides 8,000 hours.[4] The benefits of a longer lamp life are obvious; this is further boosted by the electricity savings associated with LEDs," . "This lamp can provide users with electricity savings of up to 80%. It truly is an environmentally friendly product that offers users the greatest possible return on investment."

2.5 Lighting output

: The output of the microcontroller is given to a 5v relay which turns on the power for the specific set of street lights that need to be turned on.
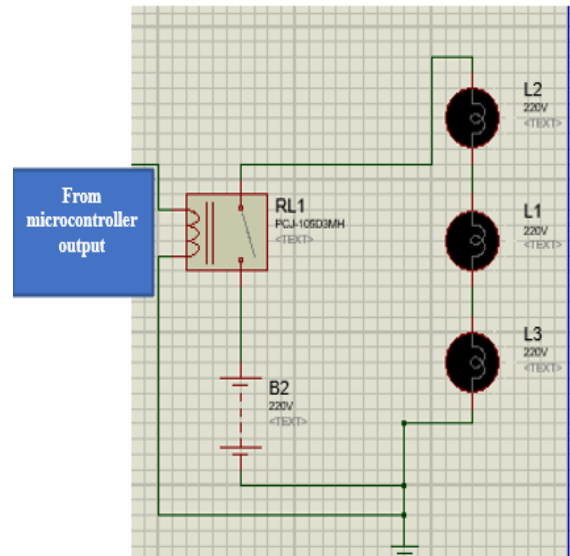

Fig 5. Relay circuit configuration

2.6 Crystal clock oscillator:

A microcontroller requires a clock signal that keeps everything working in sync with each other henceforth a crystal clock oscillator needs to be used.
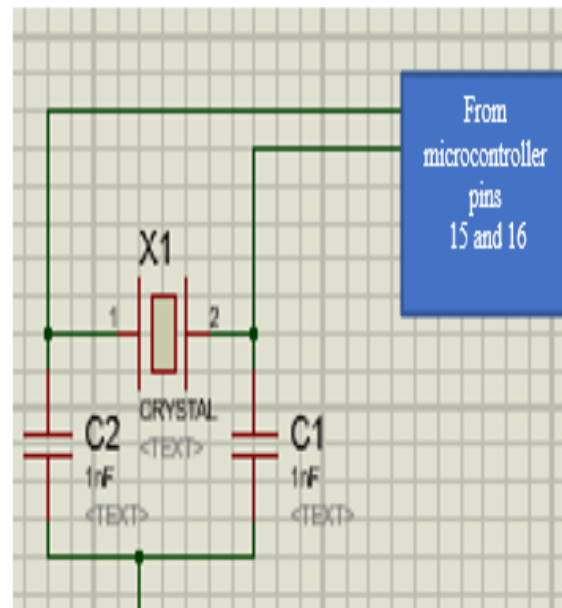

Fig 6. Crystal oscillator connection

3.   Final and Confirmed Design

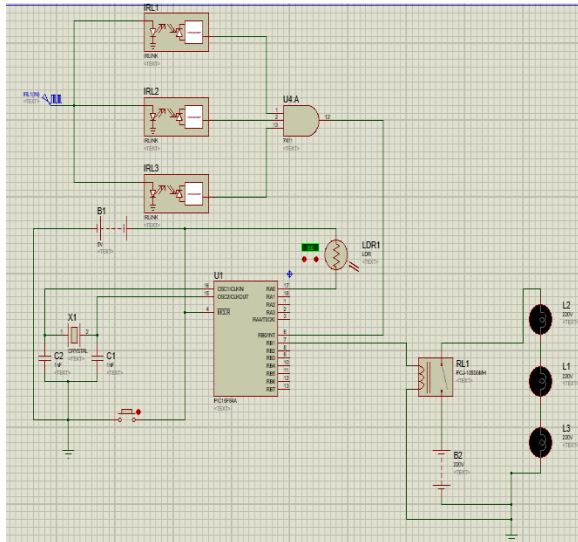The final circuit design is as follows.

Fig 7. Final circuit design

3.1 Vehicle Presence Detection

3.1.1 Ultrasonic Sensor:- Ultrasonic sensors, are transducers that generate electrical signals from the conversion of ultrasound waves or vice versa, these devices work in sync with ones used in air traffic radar and naval sonar systems. It detects environmental changes by detecting reflected radio or sound waves. The ultrasonic sensor used in the prototype is shown below[5]
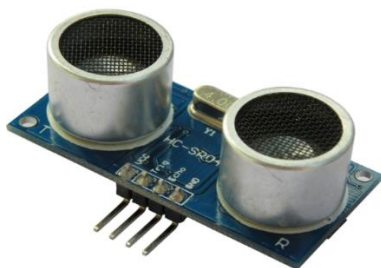

Fig 8. Ultrasonic Sensor

3.1.2 Pressure sensors: - Pressure sensor is one that acts like a large-scalable push button. It detects a force

that is large enough to be a vehicle and sends a signal to the control unit.

Fig 9.An example of one such pressure sensor[6]

3.1.3 IR Sensor: - Infrared beam sensors can be used to detect vehicles as they pass through whilst cutting the IR beam. This in turn is divided into two subcategories
Transmitter and Receiver.

3.1.4 Transmitter:- The transmitter is time sensitive as the receiver can only detect short burst pulses of 38 kHz. Thus, it is connected to a timer circuit.
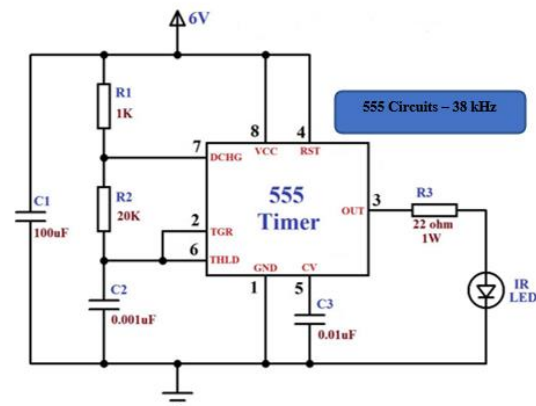

Fig 10.IR transmitter which creates an IR beam[7]

3.1.5 Receiver: Anything from a TS1738-6038 can be used. These are commonly used infrared receivers in remote-controlled devices. Picks only a very specific signal, which is the one derived from the transmitter circuit above.
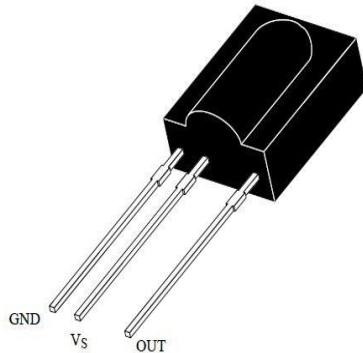
Fig 11.IR receiver

4.Light Intensity Detection

4.1 Electro-Optical Sensors :

Is one that detects a change in light intensity and converts it to an electronic signal.

Figure 12. UV sensor [8]

4.2 Light Dependent Resistor (LDR) is the commonly used sensor that is sensitive to light falling on it. The changes its resistance which in turn causes the logic of the digital output to change. This acts as a switch to the microcontroller to carry out its functionality.
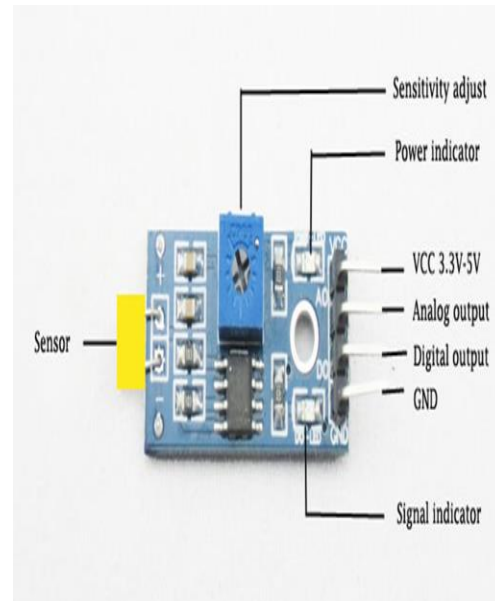

Figure 13. Light Dependent Resistor[9]

4.3 Type of Microcontroller needed

It was deemed that an 8-bit microcontroller was enough to do this task, hence forth we opted for a,

PIC 16F84A:-
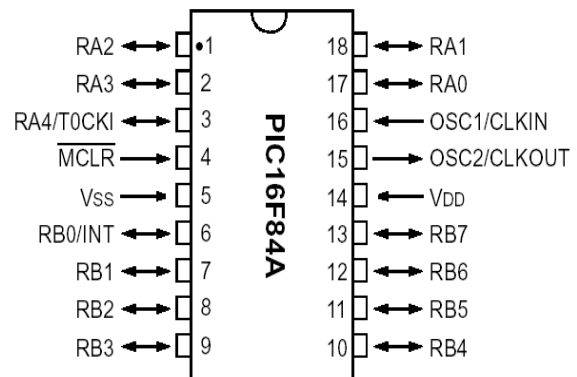Here is a summary of the specs[10]

Fig 14. Pin diagram of Microcontroller

The most energy-efficient bulbs types are to be used and their comparison with other types of lamps are given below.

	LED	CFL	Incandescent
Average Life Span	25,000+ hours	8,000 hours	1,200 hours
Watts Used	8-12 watts	13-15 watts	60 watts
Kilo-watts Used*	44 KWh/yr	55 KWh/yr	219 KWh/yr
CO₂ Emissions*	45 pounds/yr	56 pounds/yr	225 pounds/yr

* Per bulb, based on 10 hours a day, 365 days a year

Fig 15. Available Bulb types[4]

5. Programming languages: Assembly Language:- An assembly also known as assembler language, which is often abbreviated as, is a low-level programming language for computers, or other programmable devices, where there is a strong correspondence between the language and the device's machine code[11].

5.1 MPLAB MPLAB is a software program that runs on a PC, and is used to develop applications for microcontrollers and digital signal controllers. What makes this software special is that it is an Integrated Development Environment also known as an IDE), because it allocates a single integrated environment where one can develop code for embedded microcontrollers.

6. Results and Discussion
This designed methodology, as detailed in the study, would successfully save power by lowering power consumption as needed. Since it is a camera-based system, it is self-contained and automated. Faults could be quickly discovered and corrected in this system using LDR, which is generally overlooked in the existing method. However, the technology is also adaptable to any future modifications or expansions, such as the addition of new sensors, the connection of a security camera, and so on. This Intelligent Street Light System project is a cost-effective, practical, environmentally friendly, and safe solution that would

save energy. It effectively saves energy by replacing traditional bulbs with LEDs and automatically switching/dimming LEDs as needed. The upfront outlay and upkeep are the main disadvantages of this technology. However, large-scale deployment of the proposed technology will greatly decrease the project's overall cost. Other applications for the project include providing illuminating in bus stops, parks, and carparks of retail malls or marketplaces.

7.Future Advancements & Improvements.
This system can be modified by using use new and renewable energy sources and by replacing regular LED modules with solar-powered LED modules. We can fulfill the same objective of automatically operating the street lights more successfully by using the latest technology and advanced sensors, both in terms of cost and labor. The project's major goal is to conserve energy so that we can light a few more homes. With a few tweaks, this model might be used as an income generator and a wireless charging pad for electric vehicles.

The first improvement would be to add additional sensors and refine the program so that lights can be switched on and off depending on vehicles passing. If the external light intensity is detected adjustments can be done on their own to switch the lights with the required light intensity to fulfill visibility. Connect these systems to an external expert system to detect patterns and increase the efficiency in the current supply to different parts of the grid at different times.

8. Conclusions The proposed system is especially suitable for road lights in urban and rural areas. The conventional systems are exorbitantly highly-priced, and hence this street lighting system would be definitely beneficial for this modern world. The system is flexible, extendable, and totally adjustable as per the consumer's requirements.

Abbreviations
IR –LINK - Infrared Radiation Link, IR Sensor – Infrared Radiation Sensor, IR Transmitter - Infrared remote control Transmitter, IR beam – Infrared break-beam senor, UV Sensor - Ultraviolet sensor

Author contributions

Rayantha Anthony Sinnathamby made the initial preparations for writing the research and doing the programming of model. Rashmi Wimansa Neelawathura and Sahan Dharshana Siriwardena made adjustments in writing, correcting it, and producing the final results of the   model.. Sanduni Ruwandika did the final review. All authors read and approved the final manuscript.

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