SMART STREET LIGHT SYSTEM WITH AIR POLLUTION MONITORING

R.Bhuvanandini
Computer Science and Engineering
Kamaraj College Of Engineering and Technology
Vvirudhunagar, TamilNadu

M.Kadarkarai Pandiselvi
Computer Science and Engineering
Kamaraj College Of Engineering and Technology
Vvirudhunagar, TamilNadu

C.Vaishnavi
Computer Science and Engineering
Kamaraj College Of Engineering and Technology
Vvirudhunagar, TamilNadu

A.Anandh ., Associate Professor
Computer Science and Engineering
Kamaraj College Of Engineering and Technology
Vvirudhunagar, TamilNadu

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION TO THE TECHNIQUES:

Internet of Things (IoT) is an ecosystem of connected physical objects that are accessible through the internet. The 'thing' in IoT could be a person with heart monitor or an automobile with built-in-sensors, i.e. objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention. The embedded technology in the objects helps them to interact with internal states or the external environment, which in turn affect the decisions taken. We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory. It enables devices objects to observe, identify and understand a situation or the surroundings without being dependent on human help.

The street lamps are relatively simple but with the development of urbanization, the number of streets increases rapidly with high traffic density. There are several factors needed to be considered in order to design a good street lighting system such as night-time safety for community members and road users, provide public lighting at cost effective, the reduction of crime and minimizing it is effect on the environment. At the beginning, street lamps were controlled manually. After that, optical control method using high pressure sodium lamp is used. Nowadays, this method is widely used in the country. But this method has several disadvantages like more manpower, high expense, high electricity consumption, wastage of electricity etc.

Smart lighting can be used to solve these issues. Here the traditional street lamps are replaced using the LED lights which are more efficient and less polluting when compared with the traditional ones. The LEDs are switched ON and OFF automatically depending on the intensity of light available in the external surrounding and the lights are switched ON only when there is a necessary. The automation of street lights is dome using arduino and various sensors.

Another major concern of the world is air pollution which is increasing at an alarming rate. The urban areas majorly air polluted due to more usage of vehicles and industries which use technologies which are harmful to the environment. The data reagding the concentration of air pollutants vary in different areas. Thus by measuring the amount of air pollutiion we can create awareness among the people. The data collected can be used to design pollution maps, personalised maps and route planning.

1.2 SOCIAL IMPACT:

a) Reduced Maintenance Cost:More accurate as failures are noted immediately and maintained. So maintenance cost is less.

b) Environmental Impact:This system has ecology values. It also paves way for greener and pollution free environment.

c) Light Intensity Control:Adjusting the light intensity is more energy efficient when compared to other techniques.

d) Mapping:The data measured in air pollution can be used to draw pollution mapping more accurately.

e) Life Span:The life span of LEDs is more when compared with the traditional lights.

f) Expendable Infrastructure and Scalability:Smart lighting system automatically incorporates new network nodes. Moreover, additional smart automation systems such as temperature and pollution sensors may be integrated and supported easily.

g) Social Benefits:It provides improved visibility and safer environment for pedestrians and vehicles.

h) Dynamic Usage:Smart lighting systems are not restricted to street illumination. They are a highly effective solution for other outdoor and indoor areas like parks, parking lots, businesses, health facilities, educational institutions, residential buildings and special electric light applications distributed throughout the town.

1.3CHALLENGES:

The performance of LEDs degrades over time, and this degradation is strongly affected by factors such as operating current and temperature.The general lack of standardization in the LED field is an on-going issue.

LEDs do produce heat at the semiconductor junction within the device. The wall-plug efficiency (optical power out divided by electrical power in) of LED packages is typically in the region of 5-40%, meaning that somewhere between 60 and 95% of the input power is lost as heat. Without very efficient thermal management and heat sinking this causes the junction temperature of the LED to rise, which causes the LED characteristics to change. Driving LEDs above their rated current causes the junction temperature to rise to levels where permanent damage may occur.

Although LEDs have high efficiency and consume a small amount of power, the devices produce a small total number of lumens.

1.4 LIMITATIONS:

Fabricating LEDs is a complex high-temperature process involving the growth of crystalline layers across the surface of a semiconductor wafer. The quality of these layers determines the properties of the LED. Reproducibility is difficult to achieve across a single wafer, or from wafer to wafer, or from day to day. Some LEDs processed from a wafer will yield high quality devices, while others from the same wafer will have much lower quality and will end up in low-end applications such as children's toys.

In general, there is a gap in understanding between the LED manufacturers and the lighting community. The former group do not include the latter in their product development activities and do not provide information that is directly comparable to the information available for competing light sources. The latter do not understand a huge amount about LEDs and are unfamiliar with crucial issues such as thermal management, or why white LED performance is not highly consistent.

1.5DOCUMENT ORGANISATION:

Chapter 1- Introduction consists of the formal introduction of the project, the domain used and other techniques used in the project. It briefly explains the various techniques used in the project. Next comes the impacts created by the project on the society. It specifies the benefits the society gains through this project. Then it consists of the challenges faced by the project. The difficulties faced in implementing the project are specified here. Then comes the limitations of the project. It describes the disadvantages of the project.

Chapter 2 –Literature Survey provides a survey of the prior work done related to the project

by various others and the methodology used by them, its merits, limitations and the future work or conclusion derived from the project. Then it consists of the objective of the project which specifies the main ideology to undertake this project. Next it deals with the problem description which specifies about the limitations in the existing model and the proposed system.

Chapter 3 – Requirements deals with the hardware and software requirements needed to accomplish the project successfully. Any other requirements needed to support the project is also specified here.

CHAPTER 2:OBJECTIVE AND PROBLEM STATEMENT:

2.1OBJECTIVE:

The main objective of our project is to automate the switching ON/OFF of street lights based on the intensity of light available in the external surroundings. This is done with the help of IR sensor which senses the movement of vehicles or humans. If the IR sensor senses any obstacles then the lights will be ON. If the sensor does not sense any obstacles then the lights are automatically switched OFF. LDR Circuits are used to distinguish day and night so that the intensity of light can be adjusted based on the external brightness. These smart street lights are attached with sensors that sense the concentration of pollutants and measure the amount of pollution. The data collected can be used for other usages like designing pollution maps, route deciding, etc.The main considerations in the present field technologies are Automation, Power consumption and cost effectiveness. Automation is intended to reduce man power with the help of intelligent systems. Power saving is the main consideration forever as, the source of the power (Thermal, Hydro etc.,)are getting diminished. The main aim of the project is Automatic street power saving system with LDR, this is to save the power. We want to save power automatically instead of doing manual. So it's easy to make cost effectiveness. This saved power can be used in some other cases. So in villages, towns etc. we can design intelligent systems for the usage of street lights.The air quality monitoring programme design will be dependent upon the monitoring specific objecttives specified for the air quality management in the selected area of interest. What are the expected outputs of the monitoring activity? Which problems do we need to address to? Defining the output will influence the design of the network and optimise the resources used for monitoring. It will also ensure that the network is specially designed to optimise the information on the problems at hand.The relationships between the data collected and the information to be derived from them must be taken into account when a monitoring programme is planned, executed and reported. This emphasizes the need for users and potential users of the data to be involved in planning surveys, not only to ensure that the surveys are appropriate to their needs but also to justify committing the resources.

2.2PROBLEM STATEMENT:

EXISTING SYSTEM:

Wastage of energy in any form is the current issue all over the world. The major one among this one is wastage of electricity. 19% of energy use in the world is used for lighting.The energy usage for lighting is wasted by not switching of the lights after usage. The switching OFF of lights is done manually.

Disadvantages of Existing System are

- Manual switching ON/OFF of Street Lights.
- More Energy Consumption.
- High expense.
- More manpower.

PROPOSED SYSTEM:

The proposed system performs the switching ON/OFF of street lights automatically without the help of man power. And lights are switched ON only when it is needed. This ability saves energy and provides a level of comfort and convenience. From outside the traditional lighting industry, the future success of lighting will require

involvement of a number of stakeholders and stakeholder communities.

These smart street lights are also provided with sensors to measure air pollution which is more accurate as it is measured at definite intervals and the data is provided to the users.

CHAPTER 3: HARDWARE AND SOFTWARE REQUIREMENTS

3.1HARDWARE REQUIREMENTS:

i) Arduino Uno: Arduino Uno R3 specifications are ATmega328 microcontroller, operating voltage at 5v, input voltage 7 to 12v, input voltage limit up to 20v, digital I/O pins 14, analog pins 6, DC current 40mA, flash memory 32KB including 0.5KB used by boot loader. SRAM of 2KB, EEPROM of 1KB and clock speed of 16 MHz some of the Features of Arduino UNO are power: can be USB connection or external power supply, with 7 to 12 volts recommended. The Arduino UNO provides power pins for other devices, the variants are 5v 3.3v and vin IOREF pin for optional power. Arduino Uno is a 2KB of SRAM and 1KB of EEPROM (Electrically Erasable Programmable Read Only Memory). There are various input and output pins where 14 of them are digital pins with serial transfer and external interrupts and PWM (Pulse Width Modulation) pins and 6 analog pins. Arduino differs from all the preceding boards which do not use the FTDI USB-to-serial driver chip.

ii) LDR: The theoretical concept of the light sensor lies behind, which is used in this circuit as a darkness detector. The LDR is a resistor and its resistance varies according to the amount of light falling on its surface. When the LDR detect light its resistance will get decreased, thus if it detects darkness its resistance will increase.

iii) LED Lights: 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.

iv) PIR Sensor: A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

v) CO Sensor: This is a simple-to-use Carbon Monoxide (CO) sensor, suitable for sensing COconcentrations in the air. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

vi) NOX Sensor: A nitrogen oxide sensor or NO_xsensor is typically a high-temperature device built to detect nitrogen oxides in combustion environments such as an automobile or truck tailpipe or a smokestack.

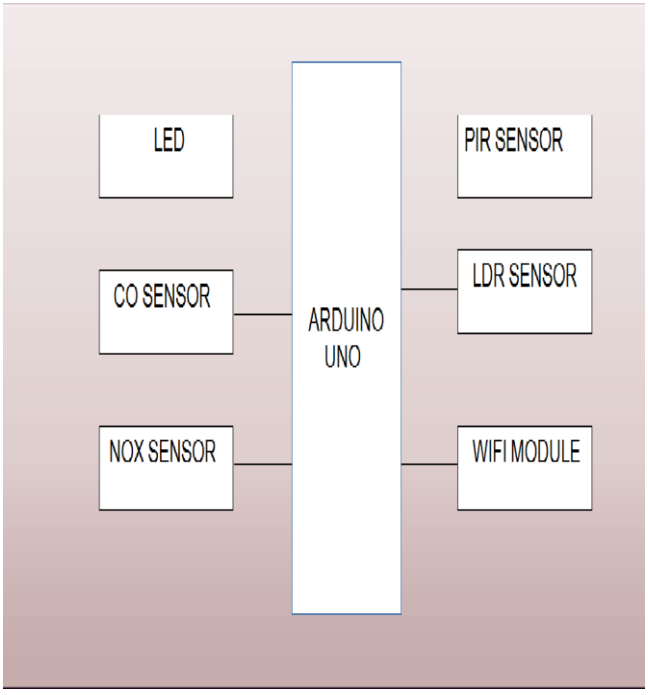
3.2SOFTWARE REQUIREMENTS:

Auduino IDE: The Arduino Software (IDE) is an open source software and it makes easy to the code and upload it to the board. It runs on the different plant from Windows, MAC OS, Linux. The environment is written in Java and before running the IDE Java software to be installed on the machine this software can be used with any Arduino board.

CHAPTER 4: SYSTEM DESIGN AND IMPLEMENTATION

4.1 SYSTEM ARCHITECTURE:

The system architecture of a smart street lighting system is shown below through a simplified block diagram. It consists of an arduino which regulates the entire sensing and controlling activity for the system. This proposed system also having different sensors for sensing various parameters, a voltage regulation circuit which regulates the input voltage for the LED module, PIR sensor for sensing any motion and LDR sensor for sensing the intensity of external brightness and WiFi module for wireless communication with the control centre.



4.2 MODULES DESCRIPTION:

4.2.1 MODULE 1: **Sensor Module**

4.2.1.1 Arduino UNO:

Arduino Uno R3 specifications are ATmega328 microcontroller, operating voltage at 5v, input voltage 7 to 12v, input voltage limit up to 20v, digital I/O pins 14, analog pins 6, DC current 40mA, flash memory 32KB including 0.5KB used by boot loader. SRAM of 2KB, EEPROM of 1KB and clock speed of 16 MHz some of the Features of Arduino UNO are power: can be USB connection or external power supply, with 7 to 12 volts recommended. The Arduino UNO provides power pins for other devices, the variants are 5v 3.3v and vin IOREF pin for optional power. Arduino Uno is a 2KB of SRAM and 1KB of EEPROM (Electrically Erasable Programmable Read Only Memory). There are various input and output pins where 14 of them are digital pins with serial transfer and external interrupts and PWM (Pulse Width Modulation) pins and 6 analog pins. Arduino differs from all the preceding boards which do not use the FTDI USB-to-serial driver chip.

4.2.1.2 Light Dependent Resistor (LDR) Sensor:

LDR stands for Light Dependant Resistor, basically optically variable resistor. In this sensor resistance and light intensity are inversely proportional. When light intensity will increase, resistance decreases and vice versa. A Light Sensor is used to sense devices the illumination level of the street light and surrounding brightness of the sunlight to a microcontroller in order to maintain the constant lighting level of the street light. Here we use two LDRs, first one is used to switch on the street light i.e., when light intensity falls on it, it turns on LDR and then the street light. One more LDR is used for fault detection i.e., if the street light intensity does not fall on LDR then there is change in resistance. This change indicates that there is some fault in the LED panel.

4.2.1.3 Passive Infrared (PIR) sensor:

PIR stands for Passive Infrared Sensor. A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. Any object in the world radiates IR rays and these rays are sensed by these sensors. The vehicle/human which passes by the street light is detected by PIR sensor. Here we are using two PIR sensors for bidirectional detection. This sensor is used for dimming purpose and the placement of the sensor is crucial. The sensor should not be placed too low (to avoiding monitoring the small animals) nor too high (can't be sense kids or children).

4.2.2 MODULE 2: **Monitoring Module**

4.2.2.1 CO2 Gas Sensor:

The CO2 (Carbon Dioxide) Gas Sensor Module is designed to determine when a preset Carbon Dioxide gas level has been reached or exceeded. Microcontroller can be interfaced with the sensor module through a 4-pin SIP header and requires two I/O pins from the host microcontroller. The sensor module is mainly intended to provide an alarm limit when the CO2 emission becomes excessive.

4.2.2.2 NOX Sensor:

A nitrogen oxide sensor or NO_x sensor is typically a high-temperature device built to detect nitrogen oxides in combustion environments such as an automobile or truck tailpipe or a smokestack. Continental Automotive Systems/NGK produce NO_x sensors for automotive and truck applications. Several automobile and related companies such as Delphi, Ford, Chrysler, and Toyota have also put extensive research into development of NO_xsensors. Many academic and government labs are pushing to develop the sensors as well. The term NO_x actually represents several

forms of nitrogen oxides such as NO (nitric oxide), NO_2 (nitrogen dioxide) and N_2O (nitrous oxide aka laughing gas). In a gasoline engine NO is the most common form of NO_x being around 93% while NO_2 is around 5% and the rest is N_2O. There are other forms of NO_x such as N_2O_4 (the dimer of NO_2), which only exists at lower temperatures, and N_2O_5, for example. However, owing to much higher combustion temperatures due to high cylinder compression and turbo or supercharging, diesel engines produce much higher engine-out NO_x emissions than spark-ignition gasoline engines do. The recent availability of Selective catalytic reduction (SCR) allows the properly equipped diesel engine to emit similar values of NO_x at the tailpipe compared to a typical gasoline engine with a 3-way catalyst. In addition, the diesel oxidation catalyst significantly increases the fraction of NO_2 in "NO_x" by oxidizing over 50% of NO using the excess oxygen in the diesel exhaust gases.

4.2.3 MODULE 3: **Communication Module**

4.2.3.1 WiFi Module - ESP8266:

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

There is an almost limitless fountain of information available for the ESP8266, all of which has been provided by amazing community support. In the *Documents* section below you will find many resources to aid you in using the ESP8266, even instructions on how to transforming this module into an IoT (Internet of Things) solution.

4.3 IMPLEMENTATION:

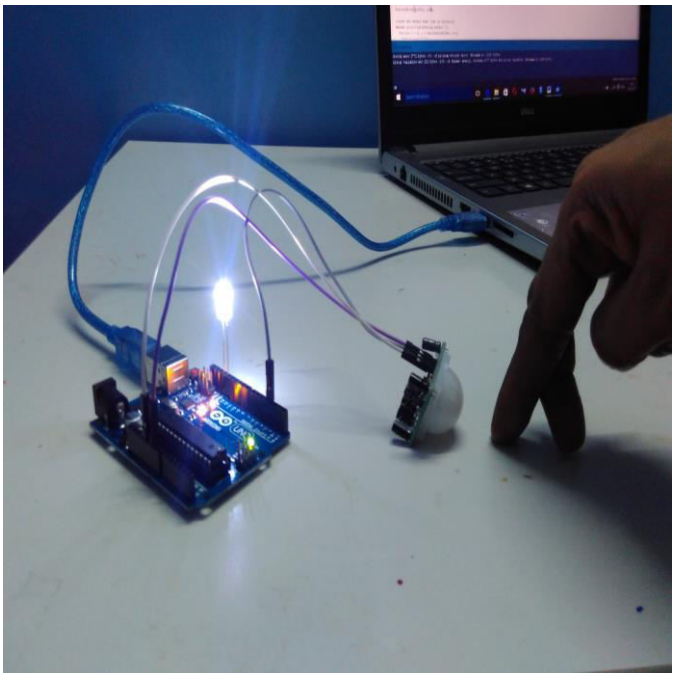


Figure 4.3.1: PIR sensor sense the motion and light is automatically switched ON.

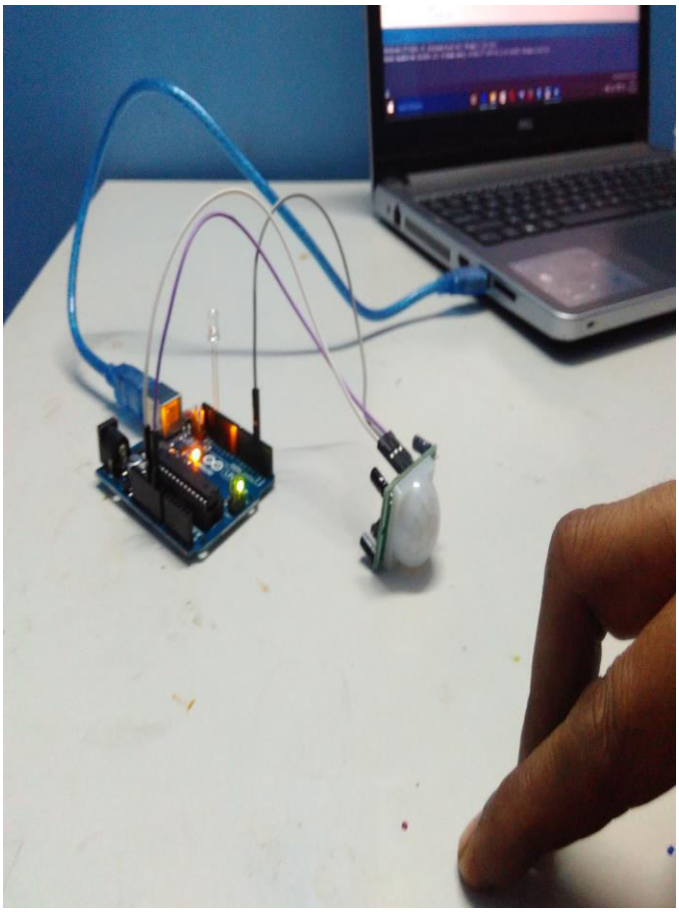


Figure 4.3.2: The motion is far away from the sensor so the lights are switched OFF.