DEVELOPING A CONTROL PROTOCOL ALGORITHM FOR STIMULATING THE STREET LIGHT SYSTEM

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2017

DEVELOPING A CONTROL PROTOCOL ALGORITHM FOR STIMULATING THE STREET LIGHT SYSTEM

by

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Thesis submitted in partial fulfilment of the

requirements for the degree of

Bachelor of Engineering (Electronic Engineering)

JUNE 2017

ACKNOWLEDGEMENT

First of all, I would like to deeply express my gratitude to my supervisor Encik Ahmad Nazri Ali for giving me a lot of ideas, guidance, advice and comments that help me to complete my final year project. I am glad that my supervisor can listen to my explanation of my project details patiently and provide some valuable suggestions that help me to solve my problems.

I am glad and feel much honoured that Dr. Aftanasar bin Md.Shahar can be my examiner for my final year project. I would like to say thank you to my examiner for providing me precious evaluations and advices during my progress viva. This evaluation helps me a lot in handling my mistakes and errors that I have done in my progress viva. At the same time, the advices also help me a lot in improving my project to a better standard and quality.

Lastly, I would like to say thank you to the lab assistant that supplies the components for the hardware part of my project and those friends who give me the comments on my project bugs and errors that may occur.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

MENGEMBANGKAN ALGORITMA PROTOCOL KAWALAN UNTUK MENGENDALIKAN SISTEM LAMPU JALAN

ABSTRAK

Tesis ini membentangkan reka bentuk algoritma protokol pintar untuk merangsang dan mengawal lampu jalan dalam kawasan perumahan. Sistem lampu jalan ini telah membawa keadaan yang jelas dan selamat kepada kawasan perumahan. Berdasarkan penyelidikan dan kerja sebelum ini, sistem lampu jalan secara automatik ini hanya melibatkan penggunaan perintang depandat cahaya untuk mengaktifkan sistem tersebut. Sistem sebelumnya hanya mempertimbangkan waktu untuk mengaktifkan sistem lampu jalan dan kurang memberi tumpuan kepada bagaimana untuk mengawal lampu jalan bagi setiap jalan dan persimpangan di kawasan perumahan. Pada masa yang sama, sistem sebelum ini juga tiada struktur algoritma yang telah ditetapkan untuk kawalan lampu jalan. Oleh itu, algoritma protokol pintar dibangunkan untuk menggantikan sistem sebelumnya. Reka bentuk baru sistem lampu jalan ini akan dirangsang untuk mengawal lampu jalan bagi lebih banyak persimpangan dan jalan berdasarkan kehadiran penduduk dan kenderaan dengan menggunakan sensor inframerah. Prototaip terakhir ini telah dibangunkan dengan menggunakan algoritma protokol kawalan untuk mengaktifkan sistem dan mengawal semua lampu jalan secara serentak berdasarkan kehadiran objek. Prototaip sistem lampu jalan diuji untuk dibangunkan dengan baik dan berfungsi dengan baik dengan menggunakan beberapa jenis keadaan dan kes.

DEVELOPING A CONTROL PROTOCOL ALGORITHM FOR STIMULATING THE STREET LIGHT SYSTEM

ABSTRACT

This thesis presents the design of the smart protocol algorithms for simulating and controlling the residential street light. The automatic street lighting system will provide a clear and safe environment to the residential area. Based on the previous research and previous works, the automatic street lighting system is only considered by using Light Dependent Resistor (LDR) to activate the system. The previous system only considers the time to activate the street light system and less focus on how to control the street light for each street and junction in the residential area. At the same time, there is no stated or predefined algorithm structure used for the street light control. Thus, smart protocol algorithm is developed to replace the previous system. The new design of the street light system will be stimulated to control the street lights more junctions and streets based on the presence of the residents and vehicles by using infrared sensors. The final prototype is developed by using the control protocol algorithm to activate the system and control all the street lights simultaneously based on the presence of objects. The street light system prototype is tested to be well-developed and well-functioned by applying a few type of conditions and cases.

CHAPTER 1 INTRODUCTION

1.1 Overview

Nowadays, all residential area are now installed with street lights along the road in order to provide a clear view for residents or vehicles at night[6] and increase the security of residential area in order to provide a safety environment to protect residents from any crime such as snatch-theft, kidnapping, murder or robbery. It can also reduce the traffic cases such as accidents, traffic crashes, injuries or fatalities.

However, the use of street light is mainly focused on the night time. Hence, a smart street lighting system is built by using Light Dependent Resistor (LDR) to ensure that the street lights can distinguish the needs to activate the system during the night time. If the street light is not placed at a strategic location, this will lead to a waste of electricity or energy of the system[1].

The weakness of this system brings to the need to develop a more advanced and intelligent street light control system[8] that can automatically control the ON and OFF of street light during night time. This smart control system depends on the IR sensor to detect the presence of the residents or vehicles that passed by the streets at the residential area[2].The reflective concept is used in IR sensor to detect obstacles such as human beings or vehicles that present on the junction and the road in the residential area[4].

Besides that, the smart street light control system uses increment counter to manage the time that requires to light up the street light while a decrement counter uses to manage the time requires to switch off it after the residents or vehicles left the particular places or junctions.

1.2 Problem Statement

From the previous works, the street light system is mainly focused on the use of LDR as the only main switch to activate the system. Some of the system is still limited to the control of every street lights for each street and junction in the residential area. There is also a lack of predefined protocol algorithm being used to develop the street light system. Hence, an intelligent street light control system is needed to develop by designing the smart protocol algorithm in order to replace the previous street light system so that the system can control each of the street light that involves more junctions and streets in the residential area.

1.3 Objective

1) To develop a smart protocol algorithms for simulating and controlling the residential street lights.

2) To design a street light system that can differentiate between the day time and night time in order to activate the system by using light dependent resistor.

3) To design a street light system that can detect the presence of the residents and vehicles by using the infrared sensor.

1.4 Project Limitation

1) The design of the smart protocol algorithm of this project is completely based on the street light system in the residential area only.

2) It involves the junctions and the streets that may be used by the residents and the vehicles such as car and motor.

3) The infrared sensor is designed to work under the case for night time only.

4) The capability of the infrared sensor may be affected by the bright light reflections.

5) The threshold value of LDR may be different for each of them to programme.

1.5 Scope of the Project

The aim of the project is to develop a control protocol algorithm for simulating the street light system in the residential area. The stimulated algorithm will allow street lights to be under control for than one junction or one street. The stimulation will then combine with the hardware prototype to become a full street light control system.

1.6 Thesis Organization

Chapter 1 gives the introduction on the function of the intelligent street light control system.

Chapter 2 gives the literature review and the summary of the previous research that has been done about the street light control system.

Chapter 3 discuss the design of the protocol algorithm that will be used in the street light system. It will also include the procedure, flow charts and block diagrams that will be used to throughout this project.

Chapter 4 discuss the results and discussion on my analysis of my project.

Chapter 5 gives conclusion and the future work of my project.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Literature review gives the summary of the previous research, work and project that has been carried out or done about the street light control system. A lot of information and concept can also be obtained through the previous research.

2.2 Design and Implementation of an Automatic Street Light Control System

This paper shows the use of Light Dependent Resistor (LDR) to control the ON and off of the street light in the project. [11]The street light will light up in darkness when there is an obvious increase in resistance value of the LDR. A 12V relay is also applied in the project as a switch to control the street light in order to discriminate the need of manual operation and waste of energy. Light Dependant Resistor (LDR) is a type of component that where its value totally depends on how much the light exposes it. The resistance of LDR will increase in darkness and decrease in the presence of light. According to the statement of this paper, the cost and energy wastage is decreased throughout this project[11]. Figure 2-1shows the block diagram of the street light control system design.

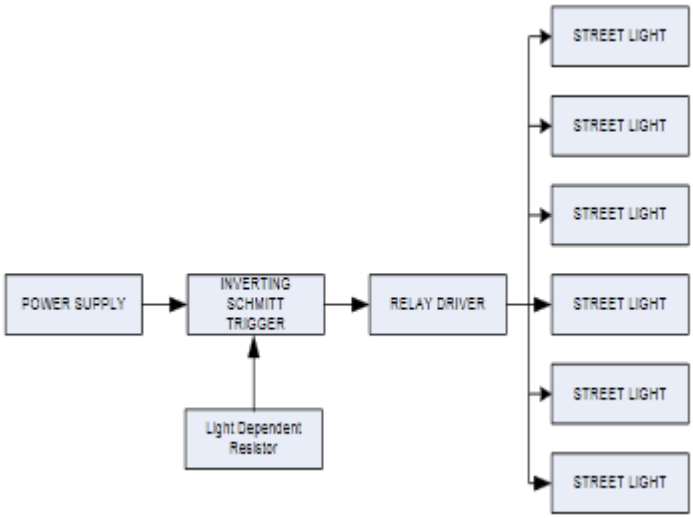

Figure 2-1: The block diagram of the street light control system[11]

2.3 Development of Street Lighting System with Vehicular Sensing at Low Light

This paper [2] shows the scheme that can use both the manual and automatic operation in the street lighting system. Light Dependant Resistor (LDR) is used as the main switch to activate the street lighting system during night time while IR sensors are used to discover the presence of vehicles in order to turn on or turn off the street light. By having this automatic street lighting system, unpredictable accidents or unexpected crime cases can be reduced greatly in the residential area and this will always place residents in safety condition with peaceful night[2]. The block diagram shows the conception of the proposed system in the Figure 2-2 while flow chart of previous work methodology shows in Figure 2-3.

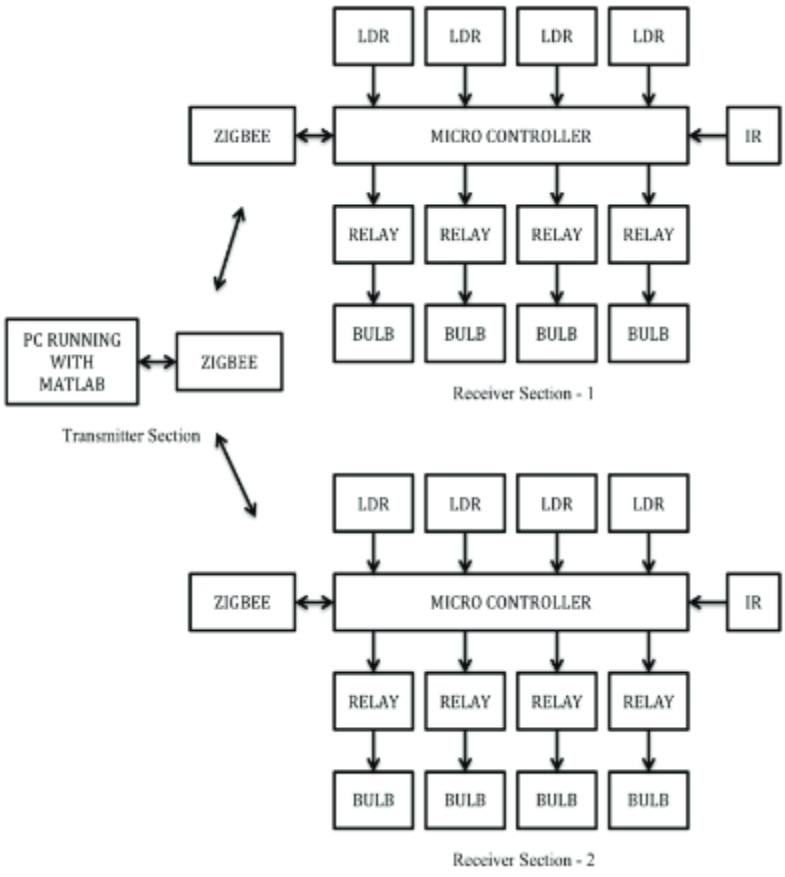

Figure 2-2: The block diagram on the conception of the proposed system [2]

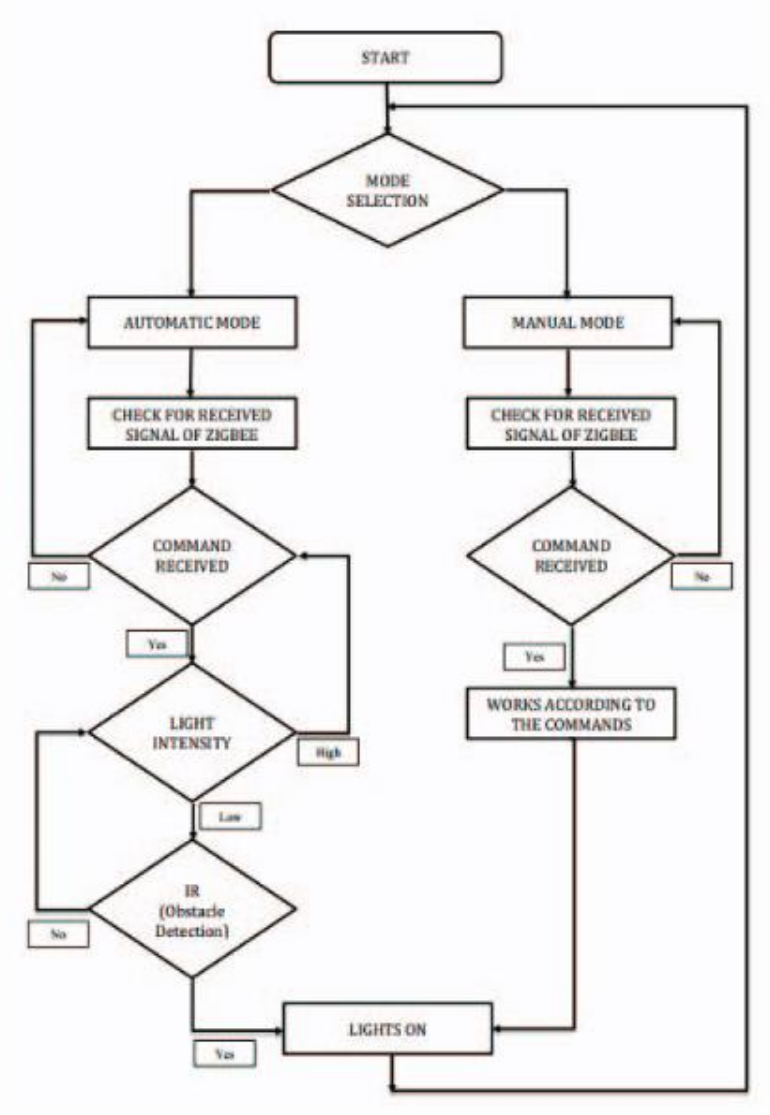

Figure 2-3: Flow chart of previous work methodology [2]

2.4 Design of LED Street Lighting Adapted For Free Form Roads

In the proposed paper[3], a suggestion is made to improve the illumination performance towards the irregular shape of the roadway. This is done by redesigned the cover plate of the Light Emitting Diode (LED) luminaire. It is designed with the material which made of micro lens array sheet to release or generate various type or shape of the light pattern to the exposed roadway. This will definitely increase the visibility safety of the street users that passed by the roadway with irregular shape or any dark and shaded areas[3].

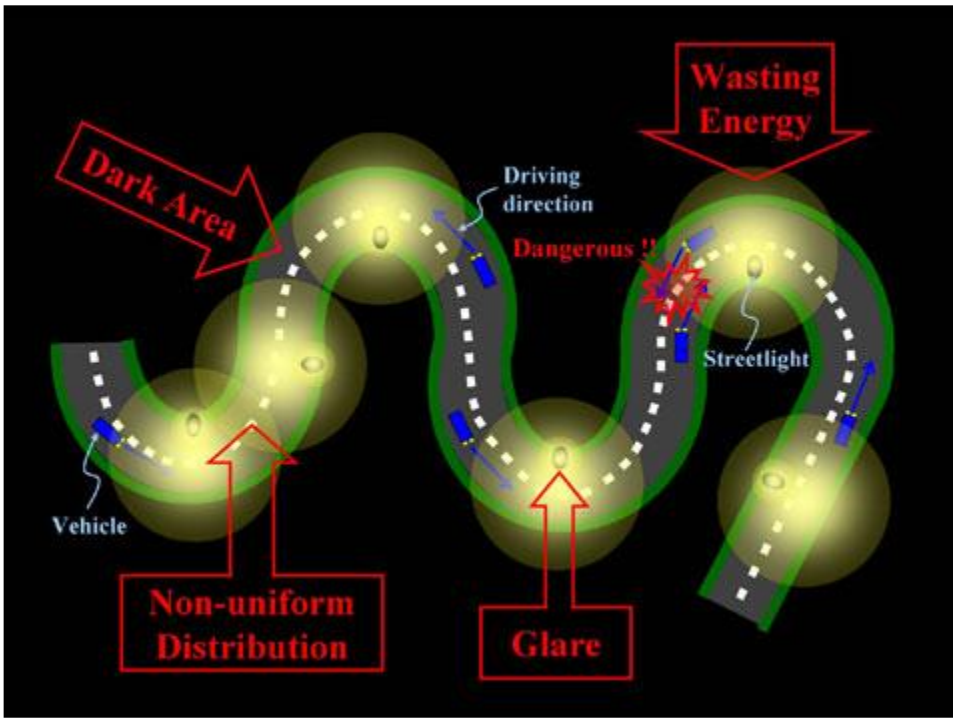

Figure 2-4: Shortcomings of traditional street lighting on roads with arbitrary shape[3]

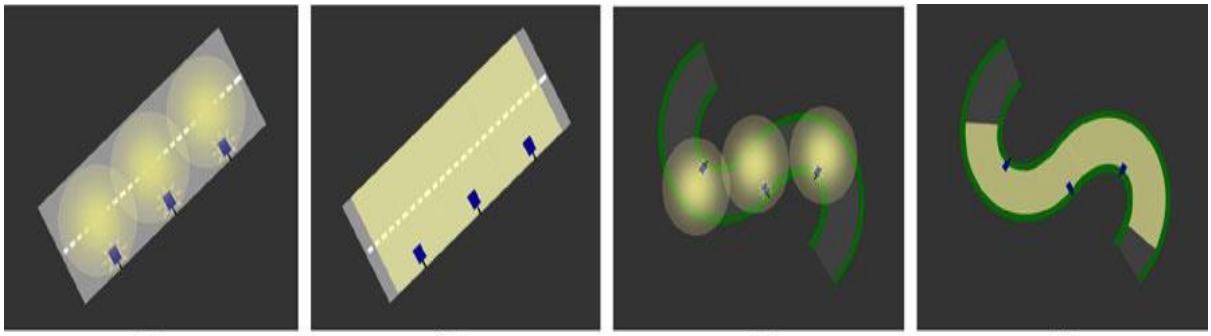

Figure 2-5: Light Distribution of straight street lights and free form street lights [3]

2.5 Obstacle-Avoiding Robot with IR and PIR Motion Sensors

The robot mentioned in [4] is developed a robot by using programming algorithm to detect the signal of obstacles and avoid the obstacles in its road path. The robot is designed based on the IR sensor PIR sensor as the main component for its censoring structure. The sensor can be used to sense the location of the obstacle and how far the obstacle from the robot and when is the time for the robot to avoid the obstacle. According to the research of the paper [4], the cost for IR sensor is low and it is a more economical sensor compares to others. IR sensor can be used to measure the range of obstacles and response in a shorter time compared to the ultrasonic sensor. It also has a lower power consumption and saves more electrical energy[4]. The Figure 2-6 shows how does the IR sensor detects an object or obstacles.

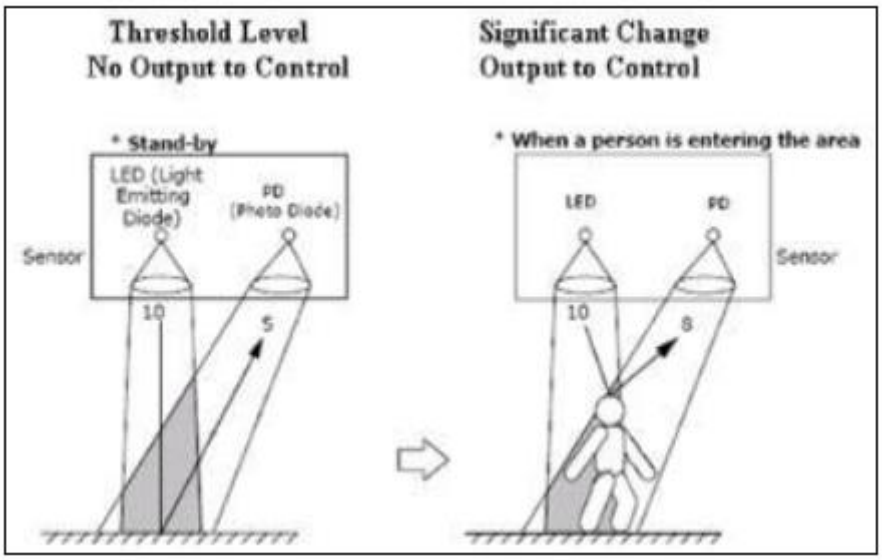

Figure 2-6: IR sensor detects an object or obstacles [4]

Infrared sensor (IR) consists of IR transmitter and IR receiver. When a set of IR sensor is powered up, the transmitter will emit the infrared light. When there is no obstacle present in front of the IR sensor, the IR transmitter will not receive any infrared

light that emits from the IR transmitter. In short, the IR receiver does not receive any data in this case[4].

In Figure 2-7, when there is an obstacle or receiver present, the infrared light emitted from the IR transmitter will be reflected and received by the IR receiver. This means that the IR receiver will receive the data and ready to run a particular program[4]. The limitation of the infrared sensor is that the capability will be reduced due to its poor tolerance towards some of the bright light reflections[4].

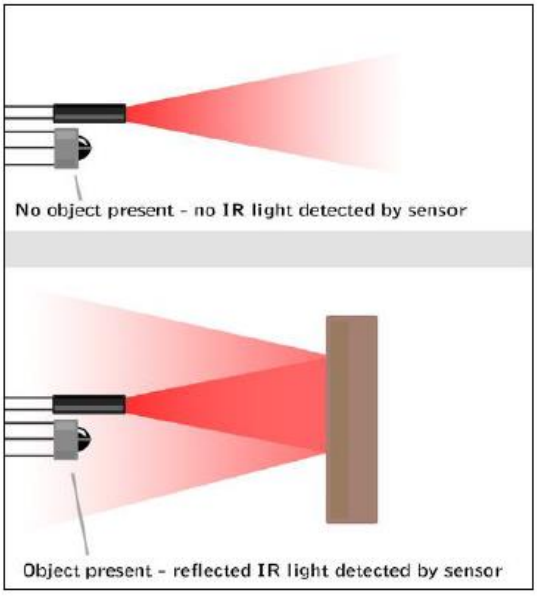

Figure 2-7: Infrared Sensor Working Principle [4]

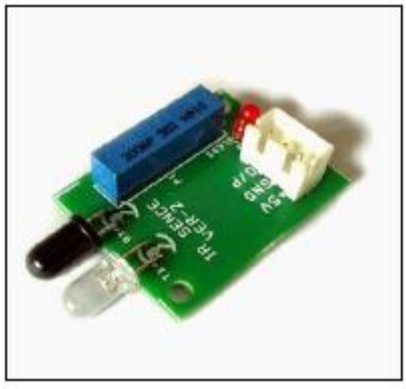

Figure 2-8: Infrared sensor for detection of obstacle [4]

2.6 Automatic Street Light Control System using Microcontroller

In order to get rid of the manual operation or manual control of the street light, Automatic Street Light control system is developed to reduce the electricity waste and power consumption. [12] LDR is used as the sensor to control the ON and OFF of the control system by differentiating the day time and night time while the photoelectric sensor is used to sense the motion of objects[12].

Automation and remote management is used as the method to control the street light more efficiently by replacing the old manual operation. The control system will be automatically turn on during night time while the street light will be automatically lighted up when there is an object passed by the photoelectric sensor[12].

The LDR is programmed to be in the ON state and OFF state by considering the status or amount of light received by the LDR. The Figure 2-9 shows the basic materials that made up a Light Dependant Resistor (LDR) while the Figure 2-10 shows the photo of the photoelectric sensor. The specification of the photoelectric sensor is shown in Table 2-1 [12].

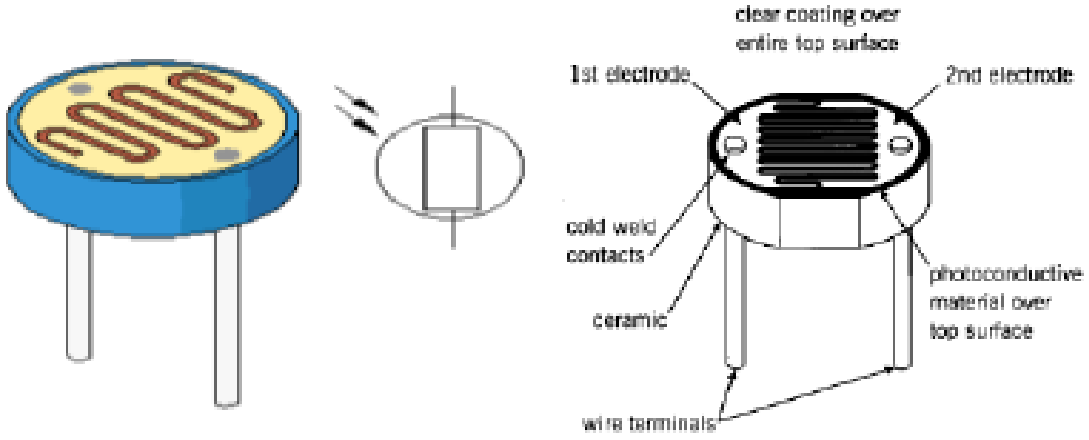

Figure 2-9: The basic materials that made up a Light Dependant Resistor (LDR) [12]

Figure 2-10: Photoelectric sensor for detecting movement of object [12]

Table 2-1: Specifications of Photoelectric sensor (MC005) [12]

Sensing range	3-80 cm
Sensing object	Translucency, opaque
Supply voltage, current	DC 5V, 100mA
Output operation	Normally open
Output	DC three-wire system (NPN)
Diameter, Length	18mm, 45mm
Ambient temperature	-25_70

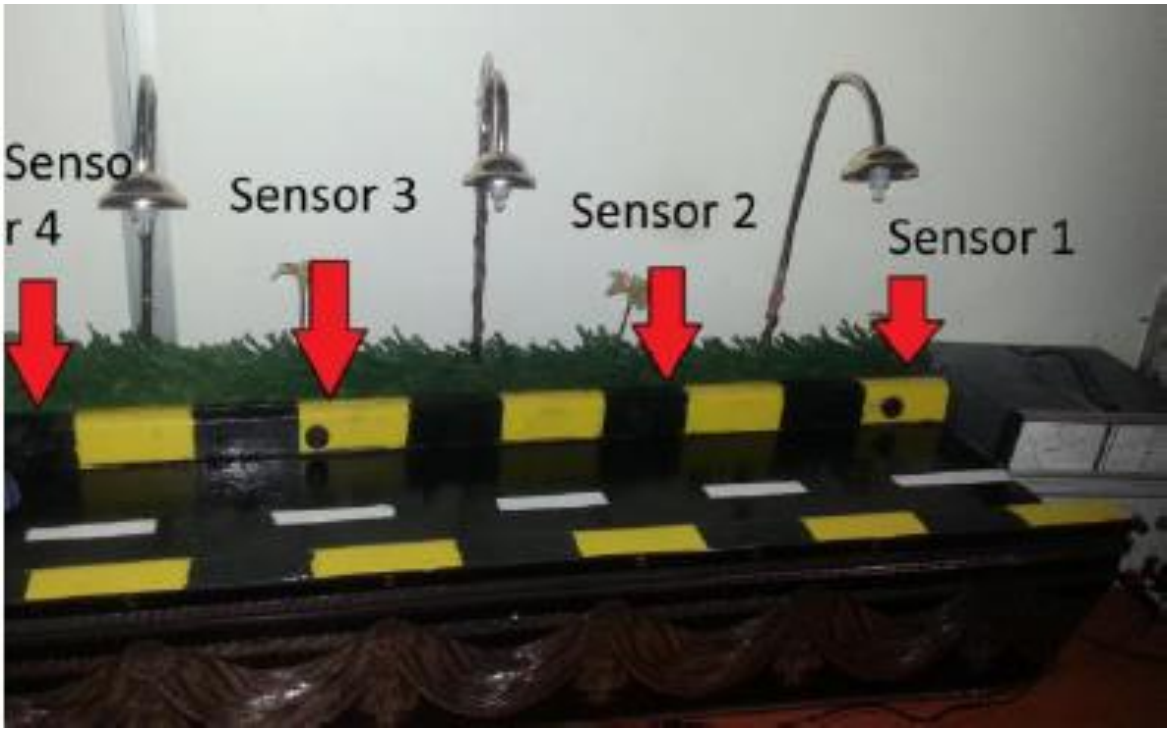

Figure 2-11: The prototype of the automatic street light system by previous work with only one street [12].

2.7 Sensor Node Development for Street Lighting Monitoring System

In this paper[5], PIR sensor is used as the component to detect the presence of the object and the street light will be lighted up when the sensor node senses the motion of the object. The light of the street light will be turned off after the object has passed through the sensor node. The maintenance cost and energy cost are assumed to be cut down by developed this system[5]. The architecture of the sensor node is shown in Figure 2-12[5] while the flow chart of the process is shown in Figure 2-13[5].

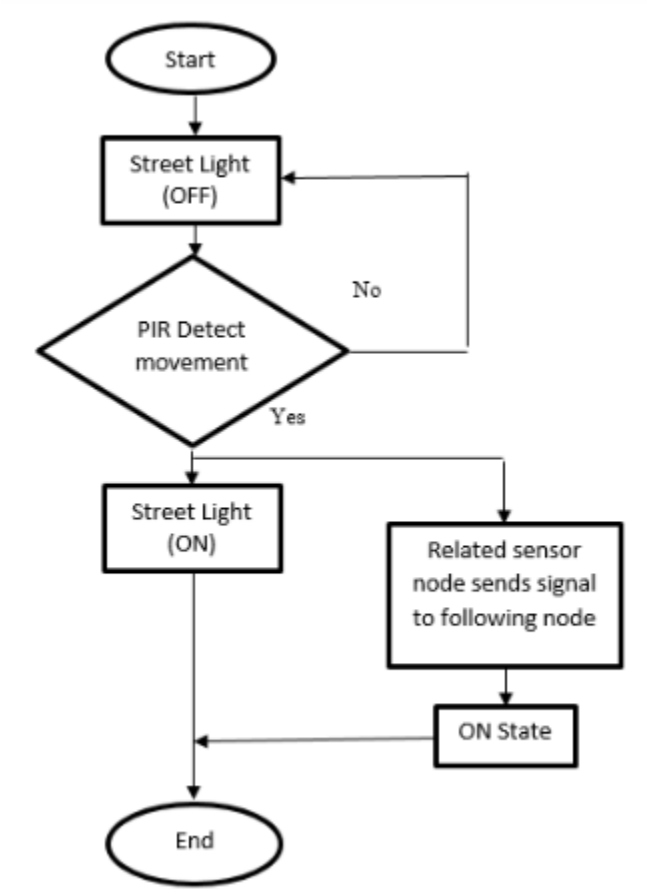

Figure 2-12: Architecture of the sensor node [5]

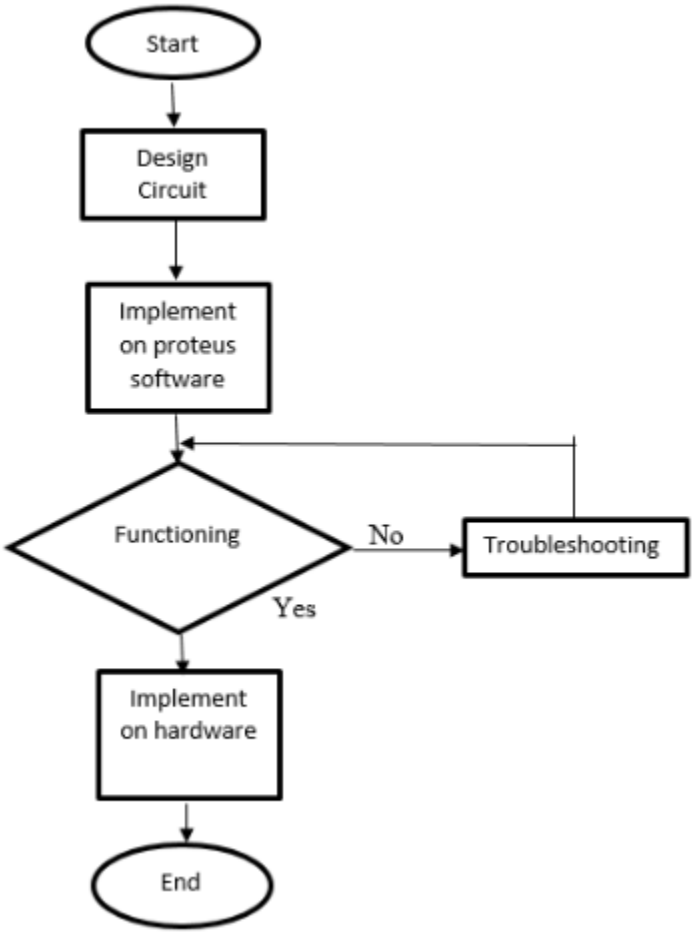

Figure 2-13: Flow chart of the process used in the automatic street light system is programmed by using the microcontroller. [5]

2.8 Smart Street Lighting Control by T-Light System

T-Light system is a type of new technology with Telematics Wireless's solution and it is used for the smart street lighting control. [13] T-Light not only reduces the carbon footprints but also contribute to the environmental sustainability. T-Light family is one of the smart lighting system that is used to control and manage the street operations. T-Light not only reduces the carbon footprints but also contribute to the environmental sustainability. The packages of the system are arranged and provided based on their coverage, features, configurations and prices. T-Light Pro, T-Light Basic and T-Light Galaxy are the type of networks provided in T-Light Family with different configuration choices. The system will sets up the wireless connection between all the

light poles while all the web-accessed efficient of light pole's operations are provided to the operator in charge. T-Light LCU, Light Control Unit**,** Light DCU, Data Communication Unit, T-Light CMS, Control and Management System are some of the elements for the system application use. The extra T-Light units such as the T-Light Cabinet Controller is as the monitoring and controlling devices installed in the streetlight cabinet. The T-Light Add-ons is another wide range features that can improve the overall system capabilities. System Scheduler is a type of programming software that is used by T-Light in the scheduling of dimming levels for the separated luminaires. [13]

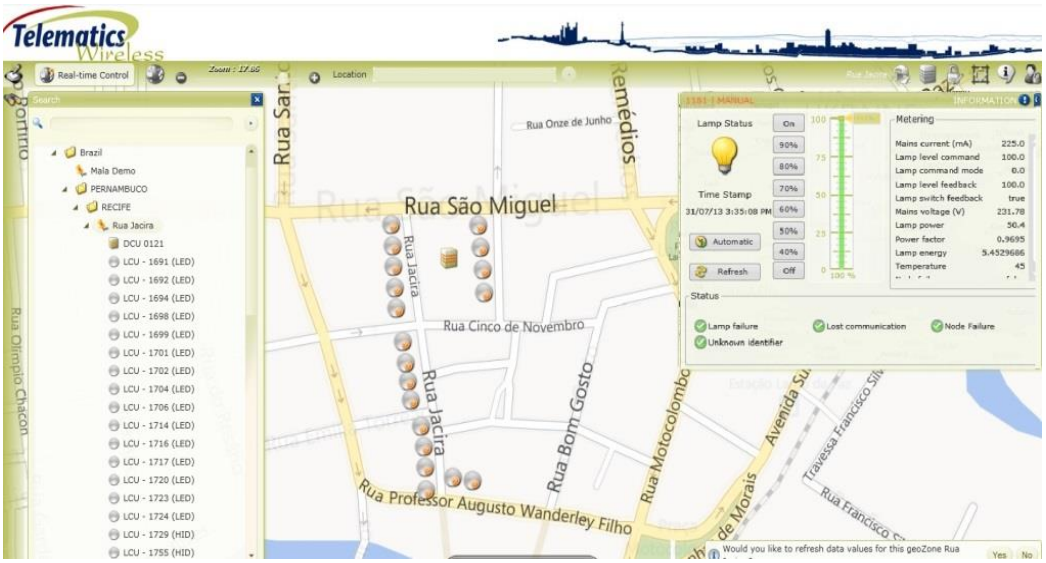

Figure 2-14: Smart Lighting Control and Monitoring Systems by T-Light Family [13]

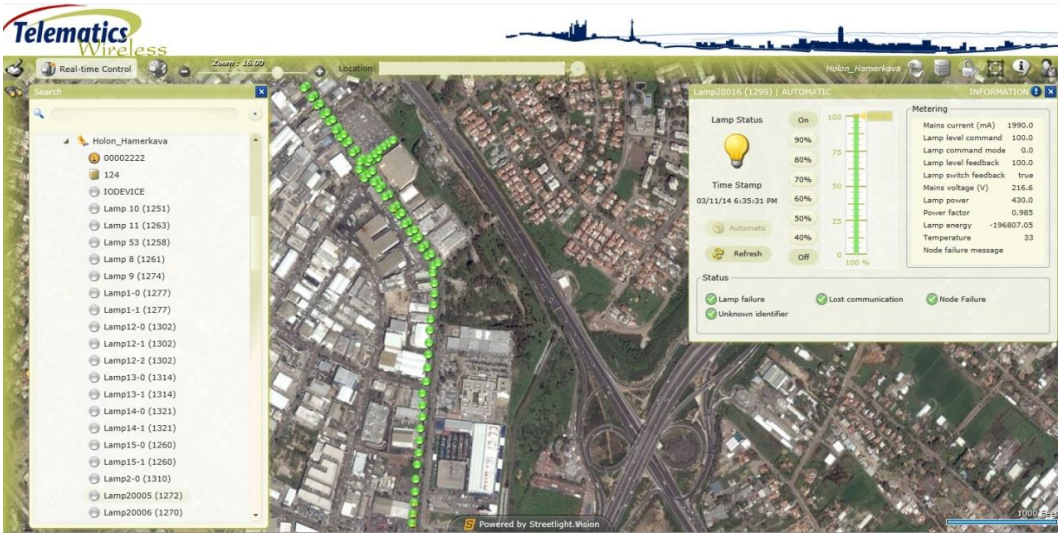

Figure 2-15: Smart Lighting Control and Monitoring Systems by T-Light Family [13]

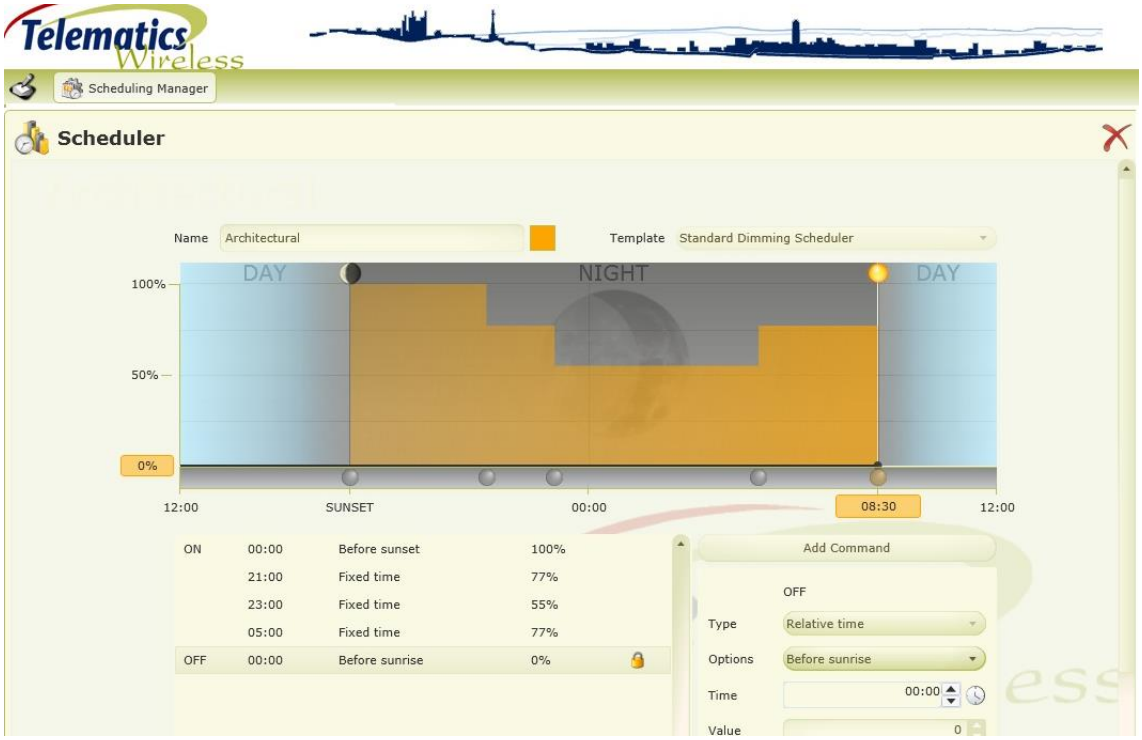

Figure 2-16: System Scheduler used in T-Light System [13]

2.9 Summary of the Literature Review

After reviewing the previous research, it is clear to see the methods and the components used by the researcher are based on LDR and different types of sensor. However, protocol algorithm is not being implemented so much into developing the automated street lighting system. Therefore, protocol algorithm can be used as the alternative way to develop this system.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter discusses the methods and the flows used to conduct this project. There are three main parts that can be summarized about the project.

The first part is to design the algorithm for the Light Dependent Resistor (LDR) part. LDR is used as the main switch to activate the street light control system. It can differentiate between day time and night time by considering the threshold value of the LDR. When the threshold value is high, it represents the day time and the street light system will not be activated. Conversely, if the threshold value is low, it represents the night time and the street light system will be activated for the residential use and this will bring to the algorithm of the infrared sensor part.

The second part is to design the algorithm for the infrared sensor (IR sensor) part that can be used to control the on and off of the residential area street light by switching between each other. When the sensor detects humans or vehicles that present at the junctions or the streets of the residential area, the street light will be set to turn on for the user until the user finish using the road. Then, the street light will turn off. Then two inputs (resident/vehicle) are detected by the infrared sensor at two places simultaneously, both the street light for particular junctions or roads can be lighted up at the same time. This procedure can continue as there are more and more inputs added into the situation while the smart protocol algorithm can deal with it without confusion.

The third part is to develop the prototype that includes the street light with LED, infrared sensor (IR) and LDR. At day time, the light dependent resistor (LDR) will be exposed to daylight and it will turn off the whole system. During night, the LDR will not detect any light and this case will activate the whole smart lighting system.

3.2 Project Implementation Flow Chart

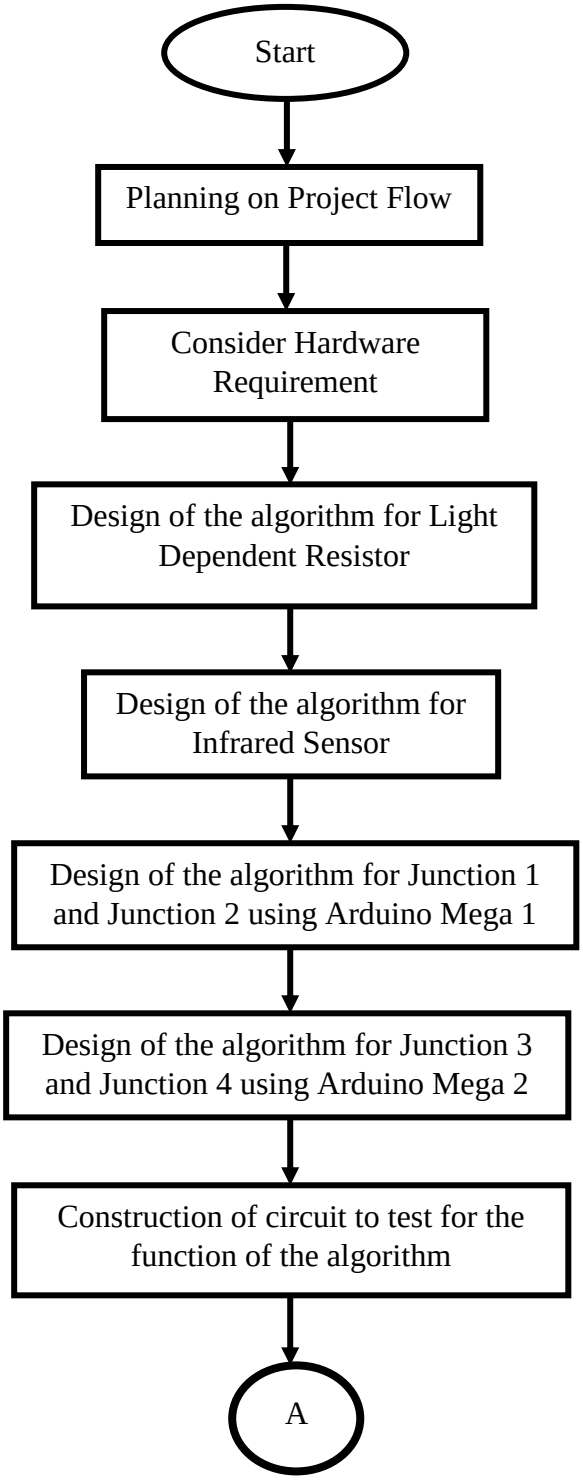

Figure 3-1: Continues…

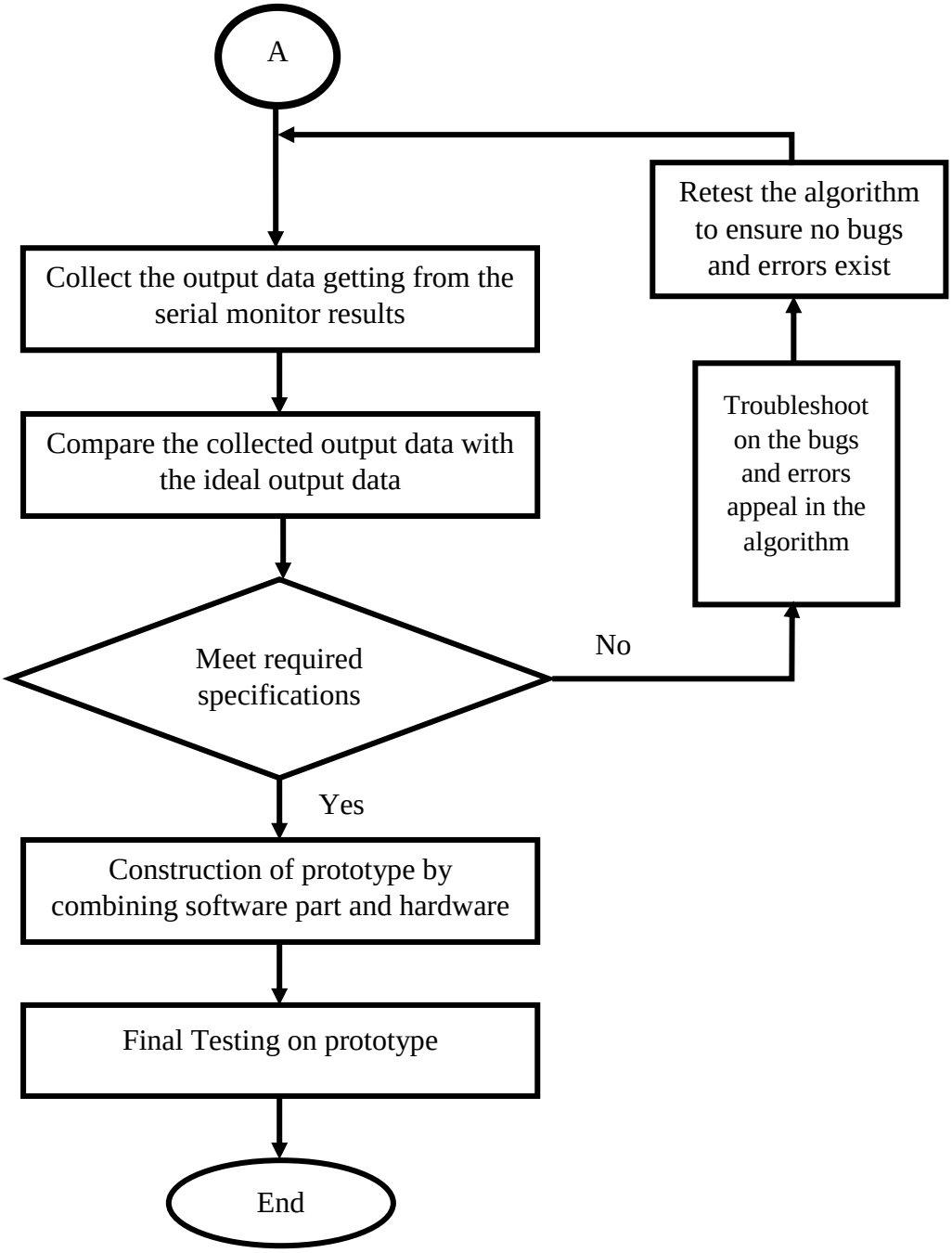

Figure 3-1: Project implementation flow chart

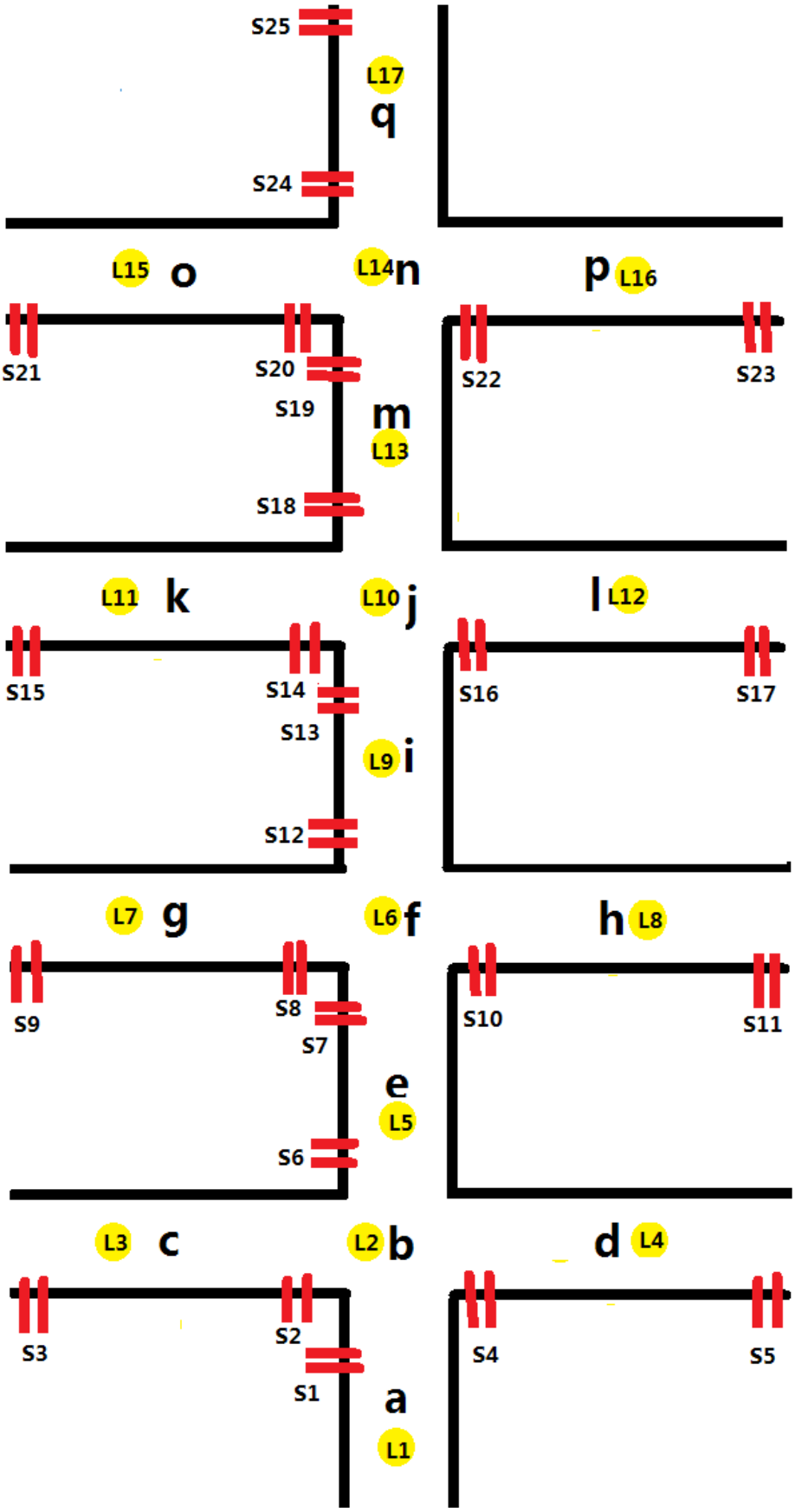

Figure 3-2: The allocation of the 25 IR sensors and 17 LEDs

Table 3-1: Description of the name for the 25 IR sensors for the Figure 3-2

Label	Component	Function	Area
S1	Infrared Sensor	detect number of users	ready to enter Junction b
S2	Infrared Sensor	detect number of users	enter Street c
S3	Infrared Sensor	detect number of users	exit Street c and Junction b
S4	Infrared Sensor	detect number of users	enter Street d
S5	Infrared Sensor	detect number of users	exit Street c and Junction b
S6	Infrared Sensor	detect number of users	enter Street e
		detect number of users	ready to enter Junction f
S7	Infrared Sensor	detect number of users	exit Street e and Junction b
S8	Infrared Sensor	detect number of users	enter Street g
S9	Infrared Sensor	detect number of users	exit Street g and Junction f
S10	Infrared Sensor	detect number of users	enter Street h
S11	Infrared Sensor	detect number of users	exit Street h and Junction f
S12	Infrared Sensor	detect number of users	enter Street i
		detect number of users	ready to enter Junction j
S13	Infrared Sensor	detect number of users	exit Street I and Junction f
S14	Infrared Sensor	detect number of users	enter Street k
S15	Infrared Sensor	detect number of users	exit Street g and Junction j
S16	Infrared Sensor	detect number of users	enter Street l
S17	Infrared Sensor	detect number of users	exit Street l and Junction j
S18	Infrared Sensor	detect number of users	enter Street m
		detect number of users	ready to enter Junction n
S19	Infrared Sensor	detect number of users	exit Street m and Junction j
S20	Infrared Sensor	detect number of users	enter Street o
S21	Infrared Sensor	detect number of users	exit Street o and Junction n
S22	Infrared Sensor	detect number of users	enter Street p
S23	Infrared Sensor	detect number of users	exit Street p and Junction n
S24	Infrared Sensor	detect number of users	enter Street q
S25	Infrared Sensor	detect number of users	exit Street q and Junction n

Table 3-2: Description of the name for the 17 LEDs in the Figure 3-2

Label	Component	Label	Component
L1	Street Light for Street a	L10	Street Light for Junction j
L2	Street Light for Junction b	L11	Street Light for Street k
L3	Street Light for Street c	L12	Street Light for Street l
L4	Street Light for Street d	L13	Street Light for Street m
L5	Street Light for Street e	L14	Street Light for Junction n
L6	Street Light for Junction f	L15	Street Light for Street o
L7	Street Light for Street g	L16	Street Light for Street p
L8	Street Light for Street h	L17	Street Light for Street q
L9	Street Light for Street I		

3.3 The Flow of the Algorithm for Light Dependent Resistor (LDR)

Figure 3-3 shows the algorithm used for the light dependent resistor (LDR) to activate the street light control system. LDR acts as the input to detect the presence of daylight in the residential area.

The LDR will receive an input from the surrounding condition and send a command to the Arduino Mega. During night time, when there is no light detected, the Arduino Mega will activate the street control system by communicating with the algorithm of the IR sensor part. Conversely, when there is light detected during day time, the street light control system will not be turned on.

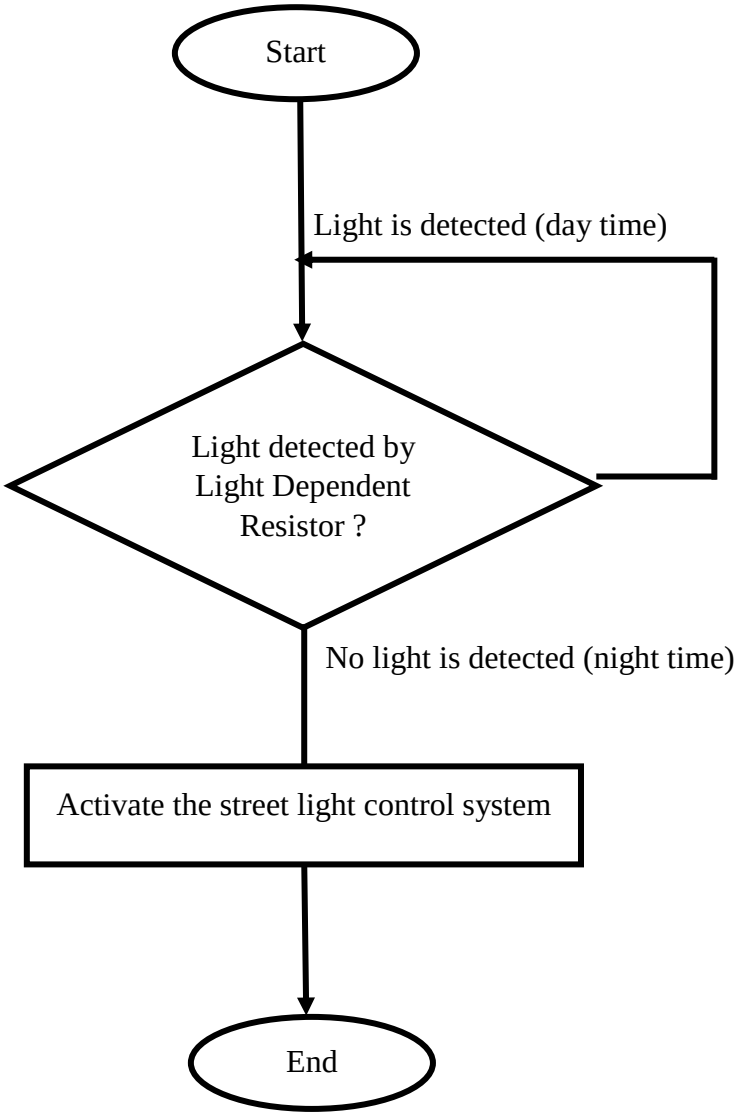

Figure 3-3: Flow chart for the algorithm of the Light Dependent Resistor (LDR)

3.4 The Flow of the Algorithm for the Street Light Control System (Include Infrared Sensor and LED)

3.4.1 Algorithm for Junction b

Figure 3-4 shows the flow chart for the algorithm of the object that enters the Junction b. When S1 receives an input, the algorithm will initiate a counter to record the number of objects that ready to enter the "Junction b". The equation "b (new value) = b (initial value) +1" is used as the increment counter to record the number of objects that enter the "Junction b". The variable "b" is equivalent to the number of objects (residents or vehicles) that detected by the infrared sensor S1 and ready to enter the area called "junction b".

For example, when a vehicle is detected by S1, S1 will receive an input. S1= 0 (with no object detected) will now become S1 = 1 (object detected), the initial value is 0, with the formulae b = b +1, the increment counter will now become "b (new value) = 0 (initial value) +1 "while the new value is now become b =1. After that, the LED (street light L2) will be turned on for "Junction b". If there is another object detected by S1, the new value of b will now increase to b =2.

At junction b, the users will consider entering "Street c", "Street d" or "Street e". The capital letter "B, C and D" that shown in the flow chart is just a representative to continue the flow chart in next page and next few pages. "B" represents the flow chart for "Street c", C" represents the flow chart for "Street d", while "C" represents the flow chart for "Street e".

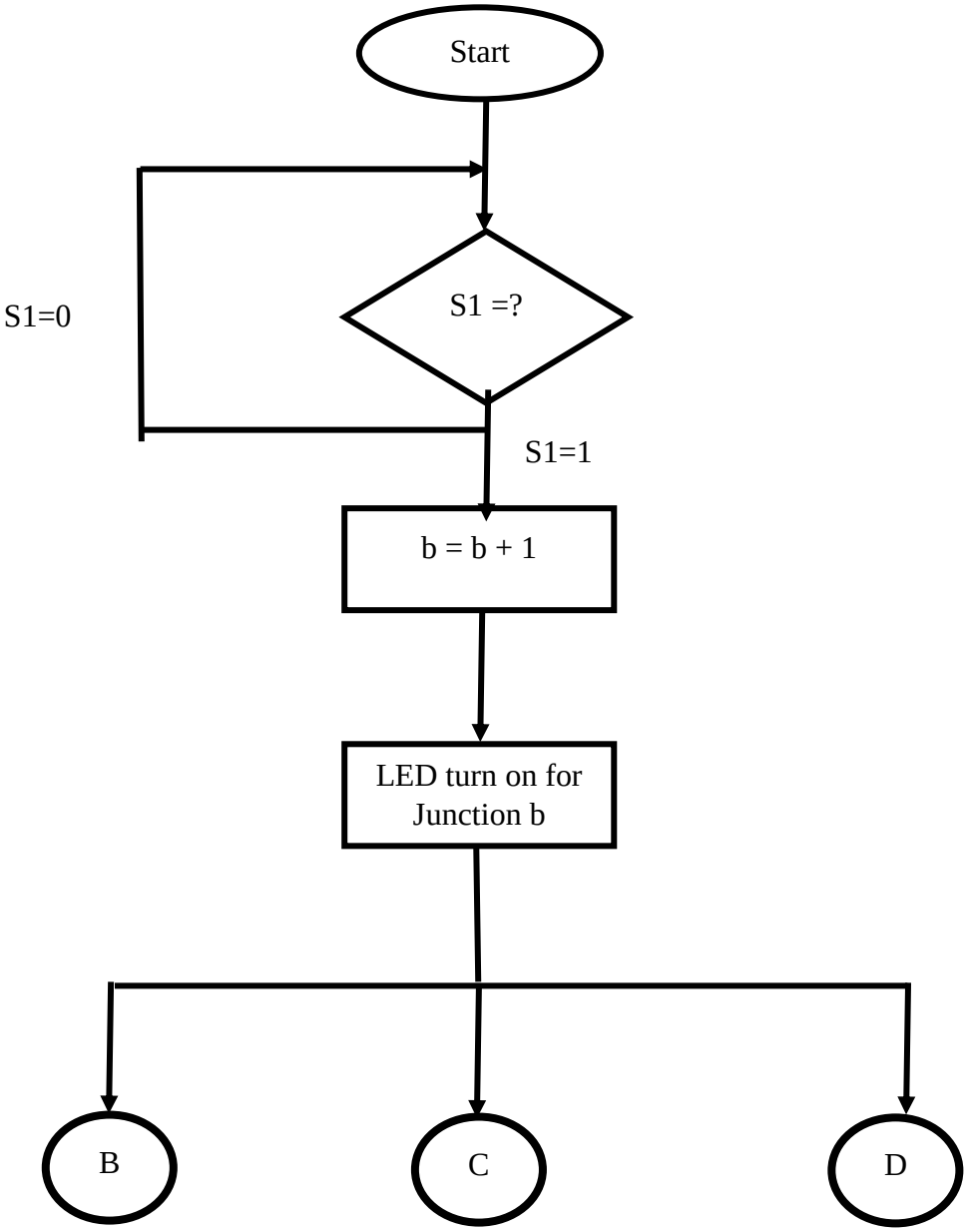

Figure 3-4: Flow chart for the algorithm of the object that enters Junction b

3.4.2 Algorithm for Street c

Figure 3-5 shows the flow chart for the algorithm of the object that enters Street c. When S2 receives an input, the algorithm will initiate a counter to record the number of objects that ready to enter the "Street c". The equation "c (new value) = c (initial value) +1" is used as the increment counter to record the number of objects that enter the "Street c" for S2. The variable "c" is equivalent to the number of objects (residents or vehicles) that detected by the infrared sensor S2 and ready to enter the area called "Street c". When the number of objects detected by S2 increases, the variable "c" will also increase.

For example, when a vehicle is detected by S2, S2 will receive an input. S2= 0 (with no object detected) will now become S2 = 1 (object detected), the initial value is 0, with the formulae c = c +1, the increment counter will now become "c (new value) = 0 (initial value) +1 "while the new value is now become c =1. After that, the LED (street light) will be turned on for "Street c". If there is another object detected by S2, the new value of b will now increase to c =2.

S2 is located at the front of the "Street c" while S3 is located at the end of the "Street c". The capital letter "E" that shown in the flow chart is just a representative to continue the flow chart of S3 part in the next flow chart.