DEVELOPMENT OF SOLAR POWERED
SMART TRAFFIC LIGHT SYSTEM

MOHAMAD FIRDAUS BIN ARIFIN

Bachelor of Electrical Engineering
(Power Industry)

June 2014

"I hereby declare that I have read through this report entitle '*Development of Solar Powered Smart Traffic Light System*' and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature   : ....

Supervisor's Name   : Dr. Abdul Rahim bin Abdullah

Date   : ....

DEVELOPMENT OF SOLAR POWERED SMART TRAFFIC LIGHT SYSTEM

MOHAMAD FIRDAUS BIN ARIFIN

A report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2013

"I declare that this report entitle '*Development of Solar Powered Smart Traffic Light System*' is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree."

Signature   : ....

Student's Name   : Mohamad Firdaus Bin Arifin

Date   : ....

To my beloved mother and father

ACKNOWLEDGEMENT

In preparing this report, I was in contact with many people, researchers, academicians and practitioners. They have contributed towards my understanding and thought. In particular, I wish to express my sincere appreciation to my main project supervisor, Dr. Abdul Rahim bin Abdullah, for encouragement and guidance. I am also very thankful to my co-supervisors Cik Hazahsha Binti Shamsudin for his guidance, advice and motivation. Without their continued support and interest, this project would not have been same as presented here.

My helpful lecturers should also be recognised for their support. My sincere appreciation also extends to all my friends and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family members.

ABSTRACT

Congestion is a normal situation in our daily lives. People need to face this problem especially when driving during peak hours in big cities with lots of traffic lights. They still can plan their route earlier to avoid traffic jams, differently with emergency vehicle with unpredictable time travel. The purpose of this project is to develop and design a new technology that will overcome this problem. The current study used sensor to detect the number of cars on each side of the junction and gives long time for green lamp of traffic light to reduce the congestion. However, there is still no priority given to the emergency vehicle by the system. Thus, this project will introduce a bypass system with the development of GPS and XBee wireless communication to make sure that emergency vehicle keeps moving at a traffic light junction although they have longer queue due to saturation of traffic flow. GPS installed in the emergency vehicles will capture their current coordinate and XBee will transmit it to the nearest traffic light controller that also use XBee receiver. The traffic light controller will be triggered to the keep green light ON and at the same time turning ON the red light for the other phase of the junction until the emergency vehicle passes through traffic light. The system in this project is portable and can be easily used or transferred into different types of emergency vehicle. In order to support the green technology, this device is equipped with a battery and a solar panel to auto re-charges its battery when in used.

ABSTRAK

Kesesakkan lalulintas merupakan suatu pekara yang normal dalam kehidupan seharian. Masyarakat akan berdepan dengan masalah ini apabila memandu pada waktu puncak terutamanya didalam bandar besar yang terdapatnya banyak lampu isyarat. Pengguna boleh merancang perjalanan mereka lebih awal bagi mengelakkan kesesakan lalu lintas tersebut. Kajian terkini menggunakan pengesan *'sensor'* bagi mengesan bilangan kenderaan di setiap persimpangan dan memberikan fasa hijau yang lama untuk mengurangkan kesesakkan lalulintas. Walau bagaimanapun, sistem tersebut masih tidak memberi keutamaan kepada kenderaan kecemasan. Oleh itu, projek ini akan memperkenalkan sebuah sistem dengan pembangunan *GPS* dan komunikasi tanpa wayar *XBee* untuk memastikan kenderaan kecemasan ini dapat terus bergerak dengan lancar walaupun berdepan dengan kesesakkan lalulintas yang teruk. Sistem *GPS* yang dipasang pada kenderaan kecemasan akan menentukan koordinat terkini kenderaan kecemasan tersebut, *XBee* pemancar akan menghantar isyarat kepada pengawal lampu isyarat terdekat melalui *XBee* penerima. Pengawal lampu isyarat tersebut akan mangaktifkan lampu hijau pada laluan tersebut dan dalam masa yang sama mengaktifkan lampu merah pada laluan yang lain sehinggalah kenderaan kecemasan tersebut melepasi persimpangan. Sistem yang dibangunkan ini adalah mudah alih dan sesuai untuk pelbagai jenis kenderaan kecemasan yang lain. Dalam menyokong teknologi hijau, sistem ini akan dimuatkan dengan bateri yang dicas oleh panel solar apabila digunakan.

TABLE OF CONTENTS

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

This chapter discusses about the project background, project motivation, problem statement, project objective, project scope and the expected result. This chapter also shows the view of the research work.

1.1 Project Background

Nowadays, the increasing number of cars on roads has created many problems, such as traffic congestion, the huge number of people who get killed in car accidents, and has a negative impact on the environment due to the huge amount of fuel consumption especially in highly congested traffic areas etc [1]. Traffic light control is a common feature throughout the world, controlling number of vehicles. Their main goals are improving the traffic safety at the intersection, maximizing the capacity at the intersection and minimizing the delays. However, there is still no priority given to the emergency vehicle by the system [2].

Emergency vehicles such as ambulances, police force vehicles and fire fighting vehicles are required to reach their destination as quickly as possible [3]. Any unnecessary delays experienced on them along their way could eventually cause dangerous events leading to damages in lives or properties. One of the most important delays is the time that is consumed on travelling between the starting point and the destination point of these emergency vehicles and in intersections with traffic lights especially when these intersections are congested. In development of this project will discuss the design and implementation of an automatic pre-emption traffic light control system, based on the development of XBee wireless communication system and GPS system. The primary objective is to identify the

emergency vehicle and track its location so that we can provide a green light to the emergency vehicle. It ensures the arrival of emergency vehicles to their destinations on the minimum time possible. The results indicate that the proposed system has an optimum solution for the delay time experienced on the emergency vehicles along their path.

1.2 Problem Statement

Since the earliest times, emergency vehicles approaching intersections have depended upon sirens, horns, or other types of audible or visible warning devices to alert other people in the intersection. As we know, every emergency vehicles such as ambulances, police force vehicles and fire fighting vehicles are required to reach their destination as quickly as possible. Traffic congestion is the main problem faced by emergency vehicles because of blockage by other road users. After that, conventional traffic light controller system in Malaysia helps in reducing the traffic congestions but does not provides priority for emergency vehicles. This matter makes difficult for emergency vehicles to arrive at the location early.

Unfortunately accidents involving emergency vehicles often occur at intersections due to confusion, impaired hearing, inattention, noise conditions or overly aggressive drivers want to clear the intersection before the arrival of the emergency vehicle [4]. Figure 1.1 [5], and Figure 1.2 [6] shows an accident involving an emergency vehicle and others road users.

Figure 1.1: Ambulance crashing at intersection of MYDIN Ayer Keroh

Figure 1.2: Other road users crashing when giving priority to ambulances

1.3 Objectives

The objectives of this project are

1. To design and develop a solar power smart traffic light system.
2. To integrate the system with hospital by using wireless communication system.
3. To analyze the performance of the proposed system.

1.4 Scope of Work

This project is divided into two major parts which are software and hardware system. Both of systems have its own criteria and scope of the project. The scope of the project are shown below:

Hardware system

1) Understand the operation of the XBee wireless communication, Arduino Uno as microcontroller and GPS module.
2) Design suitable circuit parameter for the transmitter and receiver system.

Software system

1) Write Arduino coding language for transmitter and receiver system
2) Using Arduino compiler to program the Arduino Uno as a microcontroller
3) Simulate the circuit by using Proteus and choose the suitable parameters for the circuit

CHAPTER 2

LITERATURE REVIEW

In this chapter, the literature has been studied to collect the idea and information that related to the system development corresponding to the project. This kind of information is taken from books, journals, thesis, proceeding conferences and others from previous researchers. For this chapter, it covers about the basic principles, review of previous related work, and summary of this project.

2.1 Literature Survey

The increasing number of vehicle led to occurrence extreme congestion, especially in large cities. To overcome this problem, many innovations of traffic light system are designed. One of the innovations that have been develop is call dynamic programming system (DP)[7]. This system has been developed by Tsin Hing Heung and Tin Kin Ho. This system will devided the green time delay for each junction. Each junction is equipped with a local controller and the projected traffic flow from the adjacent junction is the coordination parameter confining the possible control space. The assignment of green time to each phase of a traffic cycle is considered as a multistage control problem with a finite number of possible control actions at each stage. Dynamic programming (DP) is then adopted to facilitate coordination.

Ehsan Azimirad, Naser Pariz, and M. Bagher Naghibi Sistani make improvement by develop a system calls Fuzzy Logic Controller (FLC) [8]. The techniques used in this system which is by control the traffic light time delay. The time delays depend with the number of vehicle at each lane. Therefore when the presence of many vehicles, the time delays become

longer. By using this system, vehicle detector needs to install at the traffic light junction. It will count the number of vehicle at the junction and the data will process by microcontroller. By using this system, it will minimize traffic congestion. This system focuses in reducing the traffic congestion but do not give priority to emergency vehicles.

Nowadays, wireless communication systems are widely used. There are many types of wireless communication devices in the market which have the features and its own design. Among of wireless communication devices in the market which is Wi-Fi, ZigBee, XBee, Bluetooth and so on. S. Edwards in his studies use ZigBee as a wireless communication technology. The wireless communication technology that has been used is, to enhance the safety of road user such as car, lorry and so on. He introduced a sensor that installed inside a car that can communicate with road signboard through ZigBee wireless communication. By using ZigBee wireless communication system, road safety information that can be sent from sender to the road signboard. The main function of this system is to make sure the driver always alert along his journey. Besides that, this system are also provide detection of emergency vehicle and give the priority to the emergency vehicle when approaches to the intersection [9]. The emergency vehicle was equipped with a Smartdust WICO which broadcast a beacon message on the emergency trip. Smartdust WICOs were placed in the infrastructure to relay this message to the traffic light regulator. The traffic regulator was programmed to attend to the trigger signal provided. The traffic regulator was given time to change its status taking into account the time lost because of communication mechanisms and other time periods required.

Table 2.1: Comparison between FLC, DP and Wireless technology systems

	System	Disadvantage
Dynamic Programming (DP)	Divide the green light time delays for each junction. The organized control is extend to the adjacent junction by considering the coordinate parameter	Traffic congestion might be reduces, but this system still did not gives priority for emergency vehicle.
Fuzzy logic controller (FLC)	Install a sensors at intersections to detect the number of vehicles, and extend the green light time delays when the presence of many vehicles on the route	This system can reduce traffic congestion, but cannot detect the presence of emergency vehicle
Wireless technology system	Introduced a sensor that install inside a vehicle that can communicate with road signboard via ZigBee, to help road users always alert during travelled	Only to enhance road user safety by sharing road safety information

Table 2.2: Comparison between Bluetooth, XBee and Wi-Fi

	Bluetooth [10]	XBee	Wi-Fi
Range	Small coverage range (10m)	Wide coverage range, (<100m)	Middle coverage range (>100m)
Application focus	Cable replacement between device	Monitoring and control	Web, Video Email

Table 2.1 shows the differences between the previous system and mostly all the system did not gives priority to the emergency vehicle. Table 2.2 shows the difference between wireless communication system among Bluetooth, XBee and Wi-Fi. XBee wireless communication systems provided wider range for transmitting a signal which is more that 100m. It will detect the emergency vehicle further distance compare with others. This is one of the advantages XBee wireless communication system.

2.2 Literature of Microcontroller

Nowadays, there are many type of microcontroller that can be used. By manipulating the input signal, various types of output can be produces. The famous microcontrollers which commonly use are PIC and Arduino microcontroller. Among of these two types microcontrollers have their own advantages and disadvantages. Figure 2.1 and 2.2 shows the design of PIC and Arduino microcontroller. The advantage of Arduino microcontroller which is it has been designed for beginner who has no software or electronic experience. Arduino is capable to make an electronic project that can give output application that responding from input given.

Table 2.3: Advantages of Arduino

Advantages	Details
Inexpensive	Arduino is more cheaper compared to other microcontroller.
Cross-platform	The Arduino software can be run on variety of operating system which is Windows, Macintosh OSX, and Linux. Most microcontroller's software are run only limited on Windows platform.
Open source and extensible software.	The Arduino software is open source and available for extension by experienced programmers. The language can be change or add through C++ libraries, and people who want to understand the technical details can make the leap from Arduino to the AVR-C programming language on which it's based. Similarly, the AVR-C code can be add directly into Arduino programs if needed
Easy to use	Experienced circuit designers can make their own version of the module or inexperienced user can make the module on the breadboard to understand how it work and reduce cost.

Arduino can response to light intensity, sound, movement, touch and others by depending on sensor attach at the Arduino and from the input sensor, Arduino can give out an output such as variable speed of dc motor, brightness of the LED movement of robot and so on. Arduino is a hardware and it need software to program it. Both hardware and software are called Arduino. Furthermore, it's included a lot of example code to demonstrate how to use Arduino board's facilities. It make easy to people who is beginner in microcontroller which is he or she can refer to the example code while doing code for their project work. There are a lot of Arduino advantages that shown in Table 2.3. In addition, there have Arduino community which is always active and supportive. It can be access through Arduino forum known as Arduino Playground which provided example and solutions to problems. The forum can give a few inspiration and assistance to continue the code of the project.
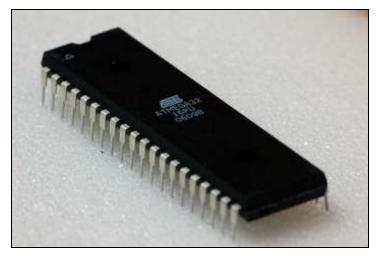
Figure 2.1: PIC microcontroller

Figure 2.2: Arduino microcontroller

CHAPTER 3

METHODOLOGY

This chapter discusses the methods used in the development of this project. Based on study that have been done by reference of thesis, journals, IEEE articles and several theories the development of this project become clearer. In this topic also will explain that there are several important parts in the development of this project including project planning, the principle, equipment, and components that have been used.

3.1 Project Planning

Project planning is important in ensuring the flow of the project running smoothly. Project planning should be done before a project is started. The main purpose designing of project planning as a guide to the overall action to make it more structured and organized. There are various method of project planning that can be used. In development of this project, gantt chart is used as a method of project planning that have shown in Table 3.1.

Table 3.1 Project Gantt Charts

Week	FYP 1													
	1	2	3	4	5	6	7	7	9	10	11	12	13	14
TITLE SELECTION	█													
FYP BRIEFING		█												
LITERATURE REVIEW		█	█	█	█	█								
HARDWARE DEVELOPMENT (DESIGNING CIRCUIT)			█	█	█	█								
SOFTWARE DEVELOPMENT (PROGRAM SKETCHING)			█	█	█	█	█	█						
HARDWARE DEVELOPMENT (TESTING AND TROUBLESHOOTING)					█	█	█	█						
REPORT PROGRESS						█	█	█	█					
SEMINAR 1 (PRESENTATION)										█				
FYP 2														
SOFTWARE DEVELOPMENT (PROGRAM TESTING)	█	█	█	█	█	█								
HARDWARE DEVELOPMENT (TESTING AND TROUBLESHOOTING)	█	█	█	█	█	█								
COMBINING ALL ELEMENTS (TESTING)			█	█	█	█	█	█						
BUILD MODEL								█	█	█	█			
FULL REPORT			█	█	█	█	█	█	█	█	█	█	█	█
SEMINAR II (FINAL PRESENTATION)														█