DEVELOPMENT OF AN INTELLIGENT TRAFFIC CONTROL SYSTEMS USING ARDUINO MICROCONTROLLER

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I strongly dedicated this project to my beloved father (Mohammad Nordin Bin Hashim), mother (Sarina Binti Din) and my siblings (Mohamad Nabil, Mohamad Najib, Nafeesa, and Nuha Fahada), with their sincere prayers and endless support afforded me to successfully accomplish this thesis.

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ABSTRACT

Increasing number of vehicles on the road becomes a concern to road users since it causes massive traffic congestion especially at the junction. It is not only happen in Malaysia, but also around the world. Traffic congestion has contributed to low productivity, pollution and energy losses. In addition, user loss time, environment quality and road safety are also affected by traffic congestions. Most of the existing traffic control system installed in Malaysia is proven not intelligent enough to make smooth traffic flow in minimizing waiting time of vehicles and maximizing number of vehicles flow in the respective lane. In this study, a new design concept of traffic control system is studied. An intelligent traffic control system using Arduino Microcontroller and Infrared proximity (IR) sensor are used together to simulate the traffic flow at three junction road. Program code in Arduino Integrated Development Environmentally (IDE) software was used to communicate with the sensors. These systems use sensor to detect the absence and presence of vehicles and sent the signal to the microcontroller. The decision was made based on the queue length of vehicles at each road. A longer period of green signals will be given to the lane which have long queue of vehicles. WITNESS software was used to simulate and validate the performance of the proposed system. The cycle time is reduced allowing more vehicles flow through the traffic and average waiting time of vehicles for new system also decreased compare to current system. Current traffic light shows average waiting time for vehicle at Traffic 1, Traffic 2 and Traffic 3 is longer which are 10, 7 and 3 seconds compare to the new traffic light system which reducing the average waiting time to 5, 2 and 1 seconds.

ABSTRAK

Semakin banyak kenderaan di jalan raya yang menjadi kebimbangan kepada pengguna jalan raya kerana ia menyebabkan kesesakan lalu lintas terutama di persimpangan. Ia bukan sahaja berlaku di Malaysia, tetapi juga di seluruh dunia. Kesesakan lalu lintas telah menyumbang kepada produktiviti yang rendah, pencemaran dan tenaga kerugian. Di samping itu, masa kerugian pengguna, kualiti alam sekitar dan keselamatan jalan raya juga dipengaruhi oleh kesesakan lalu lintas. Kebanyakan sistem kawalan lalu lintas sedia ada yang dipasang di Malaysia terbukti tidak cukup bijak untuk membuat aliran trafik yang lancar dalam mengurangkan masa menunggu kenderaan dan memaksimumkan jumlah kenderaan mengalir di lorong masing-masing. Dalam kajian ini, satu konsep reka bentuk baru sistem kawalan trafik dikaji. Sistem kawalan trafik bijak menggunakan Arduino mikropengawal dan kedudukan berhampiran inframerah (IR) sensor digunakan bersama-sama untuk simulasi aliran trafik di tiga jalan simpang. Kod program dalam Pembangunan Bersepadu Arduino alam perisian (IDE) telah digunakan untuk berkomunikasi dengan sensor. Sistem ini menggunakan sensor untuk mengesan ketiadaan dan kehadiran kenderaan dan menghantar isyarat kepada pengawal mikro. Keputusan itu dibuat berdasarkan tempoh barisan jenis kenderaan di setiap jalan. Tempoh isyarat hijau yang panjang akan diberikan kepada lorong yang mempunyai barisan panjang kenderaan. Perisian WITNESS digunakan untuk mengsimulasikan dan mengesahkan prestasi sistem yang dicadangkan. Masa kitaran dikurangkan membolehkan lebih banyak kenderaan mengalir melalui masa lalu lintas dan purata menunggu kenderaan untuk sistem baru juga menurun berbanding dengan sistem semasa. Lampu isyarat semasa menunjukkan purata masa menunggu untuk kenderaan di Traffic 1 , Trafik 2 dan Trafik 3 lebih panjang iaitu 10 , 7 dan 3 saat berbanding dengan sistem lampu isyarat baru yang mengurangkan purata masa menunggu hingga 5, 2 dan 1 saat.

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LIST OF SYMBOLS

PLC	- Programmable Logic controller
VA	- Vehicel Actuation
CO2	- Carbon Dioxide
RFID	- Radio Frequency Identification
I/O	- Input/Output
CPU	- Central Receiving Unit
GPS	- Global Positioning System
USB	- Universal
PWM	- Pulse Width modulation
GND	- Ground
AREF	- Analog Reference
TX	- Transmit
RX	- Receive
IC	- Integrated Circuit
AC	- Alternating Current
DC	- Direct Current
V	- Voltage

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Traffic lights also called as traffic signals, traffic lamps, stop lights and robots [1]. Technically, traffic light acts as a traffic control signals device that plays an important role to the road users by giving signal at road intersections, pedestrian crossings and other locations [2]. This signal used to control the traffic flows at the road for smooth flow of vehicles.

Although traffic lights look simple and can be seen everywhere, their presence is important for ensuring the safety and minimize waiting time for the road users. It is proven that growing use of traffic lights to smooth the traffic flow can reduce the number of accidents [3]. Traffic lights usually placed at town streets and highways, and critically at the junctions. Functionality of the traffic light is usually based on the pre-set time cycle or control mechanism like timer and computerized system.

Traffic lights works by changing the light signal for the road users either to stop or move [4]. There are three colours normally used which are green, red and yellow [5]. Each colour gives difference meaning. The green light means the road user can continue driving pass through the traffic light if there is no obstacle. The red light means the road users need to stop their vehicle while yellow light warn the road

users to prepare for stopping. Driving without stopping at the red light is an offence and the road user will be compound for that action [6].

There are three types of traffic light control commonly installed in Malaysia which is the Timer, Programmable Logic Controller (PLC) and also Microcontroller [7]. Timer is commonly used for controlling traffic flow at small town which has low traffic flow. PLC usually used for setting fixed cycle time of traffic and microcontroller is suitable for heavy flow traffic. The uses of PLC and microcontroller systems are more complicated than the timer.

However, there are several limitations with microcontroller system such as it requires more maintenance, higher installation cost by two or three times of preset cycle time and also needs more inspection. On the other hand, PLC have some disadvantages such as the need of skill programmer to program, debugging the PLC sometimes consumes a lot of time and also PLC is designed by semiconductors, which depends on thermal characteristics working condition [8]. This project focused on Arduino technology which operates similar to the PLC and microcontroller system to control traffic light switching sequence. It has been reported that Arduino system is very much cheaper than PLC and microcontroller in terms of initial cost as well as in maintenance. However, its capability has not been explored fully to control traffic light.

1.2 Problem Statement

Traffic congestion has been one of the major problems encountered in large cities. Traffic congestion usually depends on parameters such as season, weather, time, day and also unpredictable situations such as construction activities, special events or accidents [9]. All these measure should be taken onto the account so that traffic congestion will not create bottleneck and delays such as long waiting times, loss of fuel and money to the road users.

As the cities become more developed, there will be more difficult in monitoring and controlling of city traffic [10]. Many methods has been studied and develop to reduce traffic congestion such as the construction of a new roads and flyovers in the middle of the city, building of several rings such as inner ring road, middle ring road and outer ring road, introduction of city trains such as the light rapid transit (LRT), and monorails, restricting of large vehicles in the city during peak hours, and also development of sophisticated traffic monitoring and control systems [11].However, traffic congestion still happen especially in the bigr cities during peak hour due to the limited infrastructure and mismanagement of the traffic control systems.

Currently, traffic light control system that commonly installed in Malaysia are timer, programmable logic controller (PLC) and microcontroller. They are installing on the street based on the situation of the road or junctions. The problems that usually faced by the current traffic light systems are [11]:

i. Heavy traffic light in the morning, before office hour and in the evening

   Immediately, after office hour, increasing number of vehicles in the road causes heavy traffic jams. This situation usually happens at the junctions on main road. This causes long waiting time in the popular direction. The timer is not intelligent to sense the presence of vehicles and thus the sequence of traffic light remains the same following the preset time on the timer.

ii. No traffic, but still need to wait

   Traffic light control functions according to the time that has been set in the systems. At the certain junction sometime, when there is no car, but the road users still need to wait for the signal to change from red to green. This contributes to long waiting time for no reason.

iii. Emergency car stuck in the traffic jam.

During peak hour, the emergency vehicle also will stick in traffic flow due to the road user need to wait for the traffic signalto change from red to green. This problem is more critical and should be avoided since it involves with life and death issue.

From the above scenario, an alternative solution is needed to solve or reduce the above problems. The proposed system should be relatively cheap to maintain and yet reliable to handle traffic flows with minimum queue time/ length.

1.3 Project Objectives

The objectives of this project were as follows:

1. To develop a traffic control program based on Arduino microcontroller system.
2. To validate functionality of the developed program using a physical circuit model and confirm the performance via witness simulation software.

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