MOVING TRAIN-CAR TRAFFIC CONTROLLER

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MAY 2008

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation & Automation)"

Signature : [signature]

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of Bachelor In Electrical Engineering (Control, Instrumentation & Automation)

Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2008

DECLARATION

"I hereby declared that this report entitled 'Moving Train-Car Traffic Controller using PLC system' is a result of my own work except for the excerpts that have been cited clearly in the references."

Signature : ____________________

Name : MOHD HAYATULNIZAM B MOHD NASIR

Date : MAY 2008

Signature : ____________________

Name : MOHD SYAHID B ALWI

Date : MAY 2008

DEDICATION

For my beloved mother, Aishah binti Haji Hamdan and father,
Mohd Nasir bin Baba, and also to lectures and all my friends.

ACKNOWLEDGEMENTS

First of all, I would like to express my thankfulness and gratitude to Allah S.W.T who has given me all the strength that I needed to complete this final year project and also to prepare this report. A lot of thanks to my partner project Mohd Syahid B Alwi for his support and cooperation to me.

With this opportunity, I would like to express my gratitude to the Faculty of electrical Engineering (FKE), Universiti Teknikal Malaysia Melaka (UTeM) generally, and especially to my supervisor Mr Mohd Ariff Bin Mat Hanafiah for the help, advices and guidance that he gave during this project.

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ABSTARCT

This project is to design and develop an intelligent system that automatically operates. The title of this project is “Moving Train-Car Traffic Controller.” Basically, this system aids are PLC, limit switch, relay and control car. Limit switch (sensor) is an input for the PLC while traffic light, crossbar, relay and control cars as the outputs for the PLC. A sensor is fixed at the track and will transmit the signal to PLC when receives a signal. Generally, this system contains a roadway, road train, traffic light and crossbar. When PLC gets a signal from the sensor, it will generate an output and transmit to the output devices which are crossbar, traffic light and cars. When the main start button is pressed, the system will start to operate automatically, the cars, traffic light and train. The train is always moving around the track and it only stop when the stop button is pressed. The cars also will always move until they get the signal to stop movement. The cars in this project are wireless control cars that using relays interfacing that get signals from roadway. The cars only stop when the traffic light turns to red and when the train is passed the roadway (crossbar closes). Then the cars will continue moving when the traffic light turns to green or the crossbar open. For the traffic light operations, the sensor will detect the car and train when they arrives near by the cross road. When the sensor contact, it will give a signal to the PLC, so that the car can stopped if the traffic light is red. The output from PLC also will contact to the relay interface and give a signal to wireless control car.

ABSTRAK

Sistem ini adalah merupakan sistem bijak yang beroperasi secara automatik dengan penggunaan asas PLC, suis, relay dan kereta kawalan. Suis sesentuh adalah sebagai masukan kepada PLC sementara relay dan kereta kawalan adalah keluaran bagi PLC. Sensor yang di tempatkan secara tetap di laluan kereta dan keretapi akan menghantar isyarat kepada PLC. Apabila PLC mendapat isyarat berkenaan, ia akan mengeluarkan isyarat keluaran dan mengaktifkan peralatan keluarannya iaitu palang, lampu isyarat, dan kereta. Secara umumnya, sistem ini mempunyai jalan raya, landasan keretapi dan palang.

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CHAPTER 1

INTRODUCTION

1.1 Definition

A control system is a device or set of devices to manage, command, direct or regulate the behaviour of other devices or systems. This project is categorized in on/off control. In most applications of on-off feedback control, some consideration needs to be given to other costs. Therefore, practical on-off control systems are designed to include hysteresis, usually in the form of a deadband, a region around the setpoint value in which no control action occurs. The width of deadband may be adjustable or programmable. Larger more complex systems can be controlled by a Distributed Control System (DCS) or SCADA system.

1.2 General Description (Project Overview)

This project is the integration between programmer logic controllers (PLC), and sensors. This project is divided into two stations, which are mechanical part and electrical part. The mechanical parts are consisting of mechanical drawing, measuring, fabrication and assembly. The electrical parts are consisting of electrical drawing, electrical wiring, testing, troubleshooting and programming. General overview of the controller system is as shown in Figure 1.1 below.

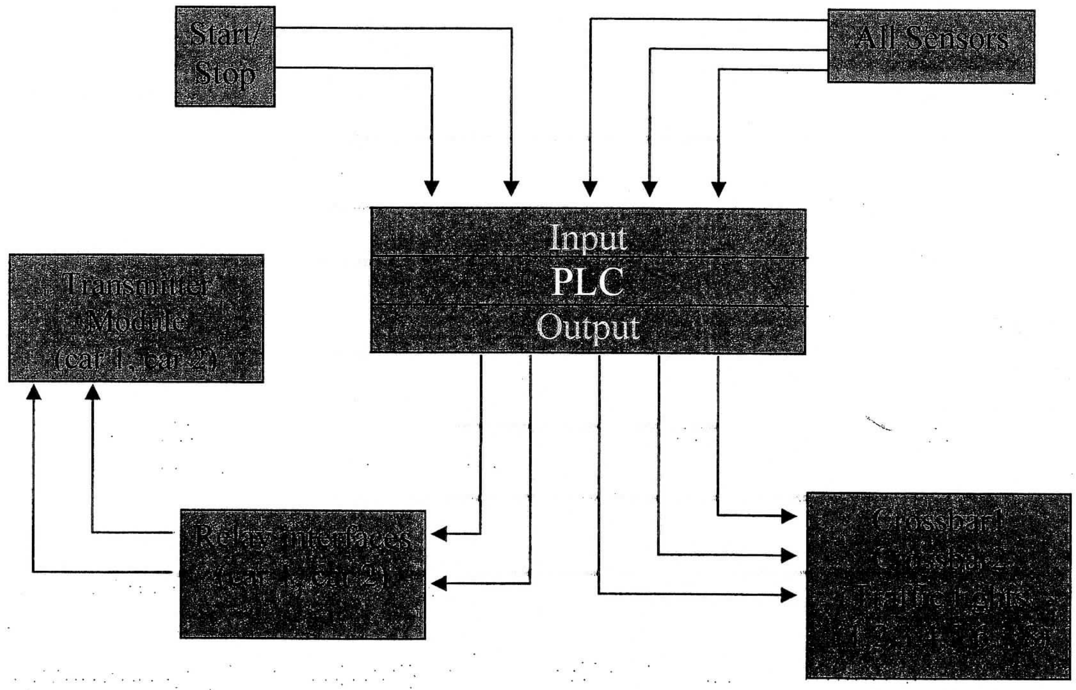

Figure 1.1: Controller System

1.2.1 Drawing and Operations

The train wills continuously operating and if it reaches near the road, the sensor will detect and give a signal to PLC to automatically close the crossbar. The cars also will always move until it gets a signal to stop. The car only stopped when the traffics light turn to red and when the crossbar closes. Then the cars will continue moving when the traffic light turns to green or the crossbar open.

For the traffic lights operations, the sensor will detect the car when it arrive near by the cross road. When the sensor contact, it will give a signal to the PLC, so that the car can stopped when the traffic light turn to red. The output from PLC also will contact to the relay interface and give a signal to wireless control for car. Once the wireless is activated or ON, it will contact to the car to make an operation.

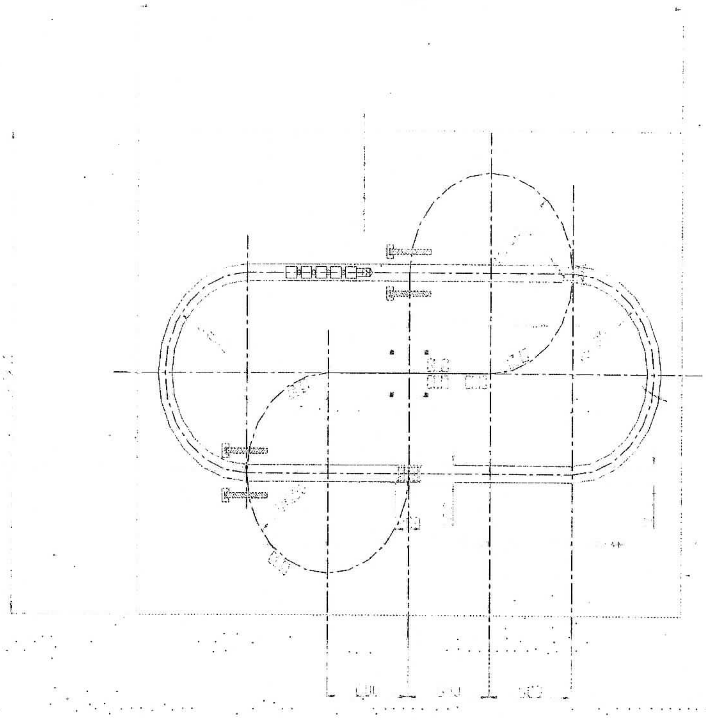

Figure 1.2: Roadway, road train, traffic light and crossbar drawing

1.3 Problem statements

- Make the car and train move as their programmed.
- Build the best and suitable PLC program.
- Control the movement of train and car.
- Wireless car transmitter and receiver.
- A constant speed of the car.
- Control traffic using Programmable Logic Control (PLC)

1.4 Objectives of the project

The project is aimed to meet the following objectives:

- To design a roadway system that can give signals to the car for operating using a PLC.
- To design a wireless control car using a relay interface that can get signals from the roadway.
- To design an automatic crossbar when the train passed the roadway.
- To design an intelligent traffic light.

1.5 Scope of the project

The scope of this project is to design a traffic simulator consists of PLC and limit switch as a sensor. The type of the PLC is OMRON with relay output. The sensor is using limit switch while the crossbar is using a cylinder. Indicator display will be use as a traffic light. Wireless controller as a transmitter device will transmit data to the car. The car receives data and move.

This project is divided into 5 major parts, which are track, train, car, traffic light/crossbar and counting display as shown in Figure 1.3.

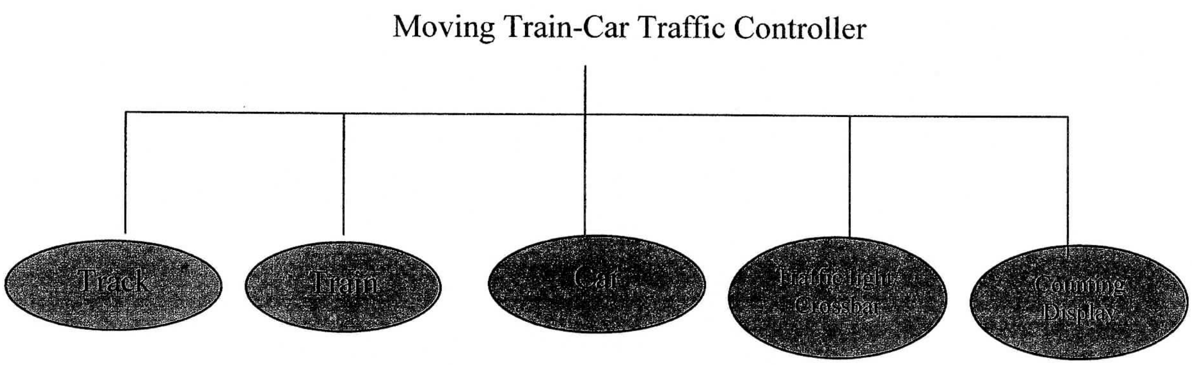

Figure 1.3: 5 major parts of the project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Several numbers of books, catalogues, technical manuals and also on-line references have to be studied in order to identify and come-up with suitable hardware, components, and software to make this project successful. The existing control systems can also be referred for further improvement.

2.2 First Review: Traffic Light System Using BASIC STAMP 2 (BS2)

Many traffic light systems operate on a timing mechanism that changes the lights after a given interval. An intelligent traffic lights system senses the presence or absence of vehicles and reacts accordingly. The idea behind intelligent traffic system is that drivers will not spend unnecessary time waiting for the traffic lights to change.

The older system uses weight as a trigger mechanism. Current traffic system react to motion trigger the light changes. Once the infrared object detector picks up the presence of a car, a switch causes the light to change. In order to accomplish this, algorithms are used to govern the actions of the traffic system. While there are many different programming languages today, some programming concepts are universal in Boolean Logic.

The traffic signal system consists of three important parts. The first part is controller, which represents the brain of the traffic system. It consists of a computer that controls the selection and timing of traffic movements in accordance to the varying demands of traffic signal as registered to the controller unit by sensors. The second part is the signal visualization or in simple words is signal face. Signal faces are part of a signal head provided for controlling traffic in a single direction and consists of one or more signal sections. These usually comprise of solid red, yellow, and green lights. The third part is the detector or sensor. The sensor or detector is a device to indicate the presence of vehicles. One of the technologies today, consists of wire loops placed in the pavement at intersections. They are activated by the change of electrical inductance caused by a vehicle passing over or standing over the wire loop. Recent technology utilization is video detection. A camera feeds a small computer that can "see" if a vehicle is present.

BASIC STAMP 2 (BS2) is used as the microcontroller of the traffic signal. The BS2, which needs to be plugged to the Board Education (BoE), is directly attached to the computer in order to program it.

2.3 Second Review: Traffic Lights Using Car-to-Car Communication

Advances in mobile computing and wireless communication have offered new possibilities for Intelligent Transportation Systems (ITS), aiming at improving driving safety and traffic efficiency. By adding short-range wireless communication capabilities to vehicles, the devices form a mobile ad-hoc network, allowing cars to exchange information about road conditions. This is referred to in the literature as Vehicular Ad-hoc Networks (VANETs).

Traffic safety is the focus of current research on VANETs and the main motivation of deploying this technology and to make it ubiquitous. However, there are a number of other applications that could improve the way we drive today.

This paper examines the possibility of deploying an adaptive signal control system in intersections, a system that can base its control decision on information coming from cars. We assume each vehicle is equipped with a short-range wireless communication device, as is a controller node placed in the intersection with traffic lights.

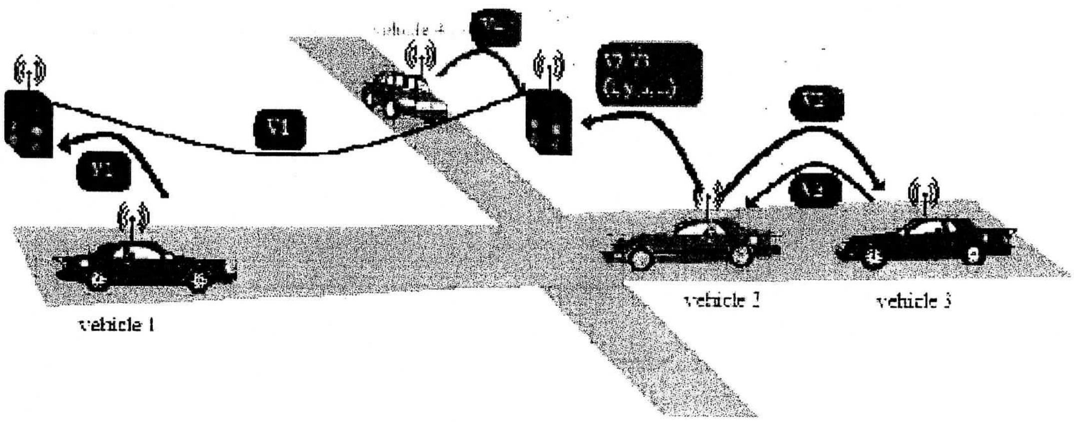

Figure 2.1

There are several goals that can be taken into consideration when designing a signal control mechanism [1], like minimizing the average delay of vehicles approaching an intersection, increasing progression by coordinating vehicle platoons between intersections, reducing the queue length of all approaches to an intersection and even reducing overall fuel consumption and pollutant emissions.

We will consider the main measure of effectiveness (MOE) for an intersection is the control delay, which is the component of vehicles' delay caused by the presence of the signal control [2]. It is measured in comparison with the travel time calculated in the absence of a control mechanism. Another relevant parameter is *v/c* or volume per capacity ratio, which reflects the degree of saturation of an approach to the intersection. For saturated intersections, the degree of saturation is calculated through the demand per capacity ratio which is greater than 1.

Minimizing the delay at intersections suggests the selection of a cycle length as short as possible in order to produce less red time and shorter queues. The intuition here is that the cycle length should be shortened until a critical value is reached, a value under which the overhead of phase changing starts to significantly influence the delay. In theory, the optimum cycle length can be approximated with the well-known Webster's equation [1], as a function of lost times and critical flow ratios:

$$\mathbf{Co} = \frac{\mathbf{1.5.L + 5}}{\mathbf{1 - 1/Xc.\ \Sigma\ Vi/Si}}$$

CO is the optimum cycle length. L is the sum of lost times for all the phases (yellow and all-red times). n is the number of critical lane groups. A critical lane group is a group of movements that can access the intersection concurrently. vi / si is the maximum flow ratio for the critical lane group i. 1 / Xc is the desired degree of intersection utilization (1.0 for operation at full capacity, usually 0.95).

Several adaptive traffic control systems have been implemented for intersections all over the world. Some of the most important ones include Split, Cycle and Offset Optimization Technique (SCOOT) [3] and Sydney Coordinated Adaptive Traffic System (SCATS) [4]. SCOOT [3] is based on loop detectors placed on every link to an intersection, usually at the upstream end of the approach. Other systems, including SCATS, have detectors placed immediately before the stop line at an intersection. Thus, they cannot get accurate data when the queue grows beyond the length of the detector, or the link is over saturated. Since they use a model based especially on occupancy, they also have difficulties in differentiating between high flows or intersection stoppage. Reported research shows poor performance when incidents occur [5].

Adaptive traffic lights based on wireless communications with the vehicles can employ greater flexibility than the ones mentioned above as they are provided with more information for the signal decision process (e.g. vehicles positions and speeds). The cost is also significantly lower considering loop detectors are usually installed in the asphalt under each lane approaching the intersections and cameras require high processing power (not to mention visibility issues). If we assume that vehicles will be equipped with wireless communication devices (as current research suggests), then all that is needed is wireless devices with some processing power in intersections.

Traffic View [6], a research project we have contributed to, is a VANET platform for data dissemination between vehicles. By making use of wireless communication and GPS, it enables vehicles to collect and disseminate traffic information and, finally, to provide meaningful data to the driver. As input for the digital maps, we use freely available TIGER files [7]. Vehicles periodically transmit