TRAIN SIMULATOR USING P.I.C MICROCONTROLLER

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Abstract

This final year project performs the basic movements and operations of a Train Simulation system by employing a P.I.C microcontroller. Programming technique, digital system design, structural and mechanical designs were developed to suit the operation of the train simulation itself. The heart of this project is the PIC16F877A chip. A final comment on the prospect of the development is presented.

Keyword:
Peripheral Interface Controller, PIC16F877A

Introduction

General
Microcontrollers are general purpose microprocessors which have additional parts that allow them to control external devices. Basically, a microcontroller executes a user program which is loaded in its program memory. Under the control of this program data is received from external devices. A microcontroller is a very powerful tool that allows a designer to create sophisticated input or output data manipulation.

In the train simulation system, the microcontroller reacts as the brain for all its operations. As trains are widely used when travelling and transferring people or equipments from one place to the other, there is a need to study and program the system so it can be a benefit to the mankind. However there are many factors need to be taken into account before it can be design and constructed.

Basically there are two important consideration and features of the train simulation operation. First, a mechanical and motor system will move the train from station 1 to station 2. Next, a display will indicate the destination of the train that travels along the rail.

With all the consideration in mind, the designation and construction of the project will be commenced. At the end of the project, it will be useful to go deeper into the studies towards user friendly application and enhanced the system through the programming and design modeling.

Objectives

1. To understand many applications covering software and hardware using microcontroller, covering knowledge of digital electronics i.e.: sequential logics, memories, decoders and Boolean algebra.
2. Able to design programming instruction for interfacing between hardware and software and to study the type of port that to be used, either parallel or series and the effects of using either one.
3. For future prospect, the knowledge of PIC can be applied to the industrial area regarding engineering application such as in instrumentation since microcontroller is a basic level language which can be modified to improve the system in certain real life applications.
4. To observe the microcontroller programming instructions as the basic language and the effects it has on the circuit or hardware during interfacing at the same time to see how the routine functions are performs, the data structures that to be altered and data manipulation process.
5. Hardware and software are two different areas that need to be studied and gone through separately at first. The circuit operation and its electronic concepts are taken into consideration when applying to the programming processor during stimulation to see the output.

6. To design an electrical train simulation using real life specification.
7. Analyzing and recommend the alternatives regarding the problems faced by the passengers while using the train.

A microcontroller is essentially a cheap single-chip computer. Single chip means the entire computer system lies within the confines of a silver of silicon encapsulated inside the plastic housing of an integrated circuit. The microcontroller contains a CPU (central processing unit), RAM (random access memory), ROM (read-only memory), I/O (input/output) lines, serial and parallel ports and timers

The PIC microcontroller chip will be programmed in specification of the train simulation function based on the idea that will be created with auto control or semi control configuration.

The specification of the PIC microcontroller chip is 5Vcc, direct voltage. The parallel pins port may get some input or give some output of the data or signal.
Once, the PIC specification 5Vcc, surely the other device to construct the structure of the autonomous robot is 5Vcc so that the entire device may activate itself respectively at the optimum voltage level.

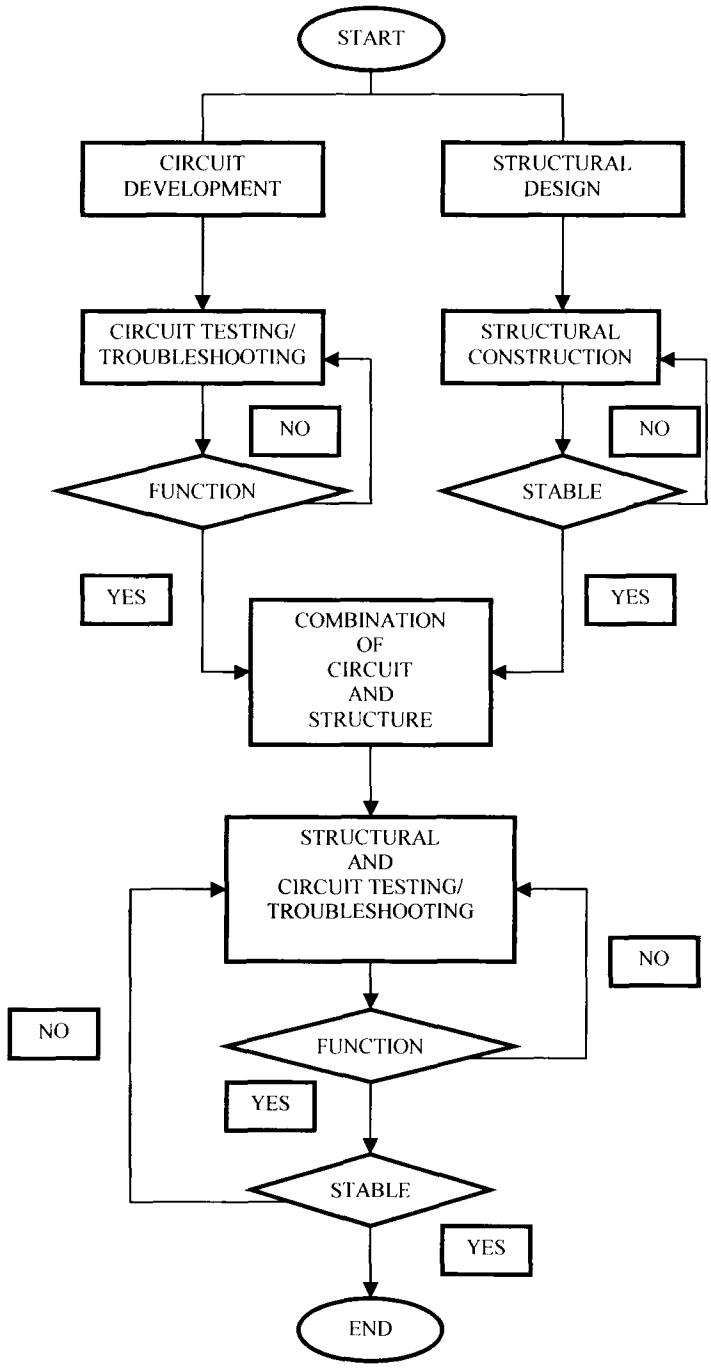
In this train simulation project, the P.I.C microcontroller will be connected to the outputs consisting of the 16X2 LCD display, seven segment displays, 9V motor driver, and multiple switches.

Hardware Methodology

The train simulation project consists of hardware section as well as the software section. Each of the section compliments each other to become a successful project.

In designing the suitable electronics application for the train simulation projects, there are several key factors that need to be considered. This is important so that the development of the electronic appliances will interface with the microcontroller as well as work within the structural design of the hardware architecture. In this area, ones true engineering experience, knowledge and critical thinking is put to test.

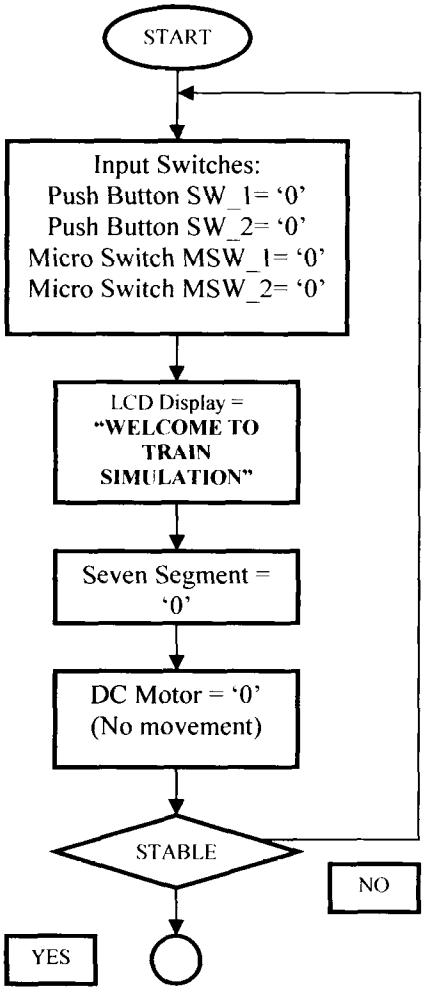
Flowchart

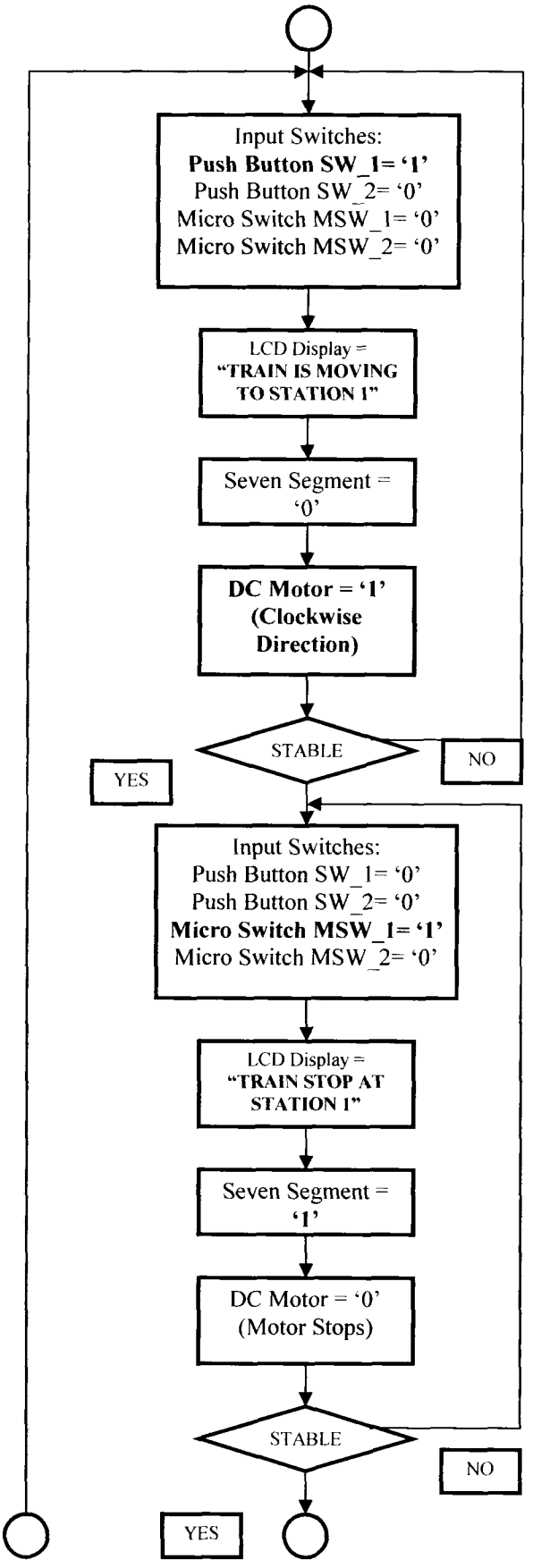


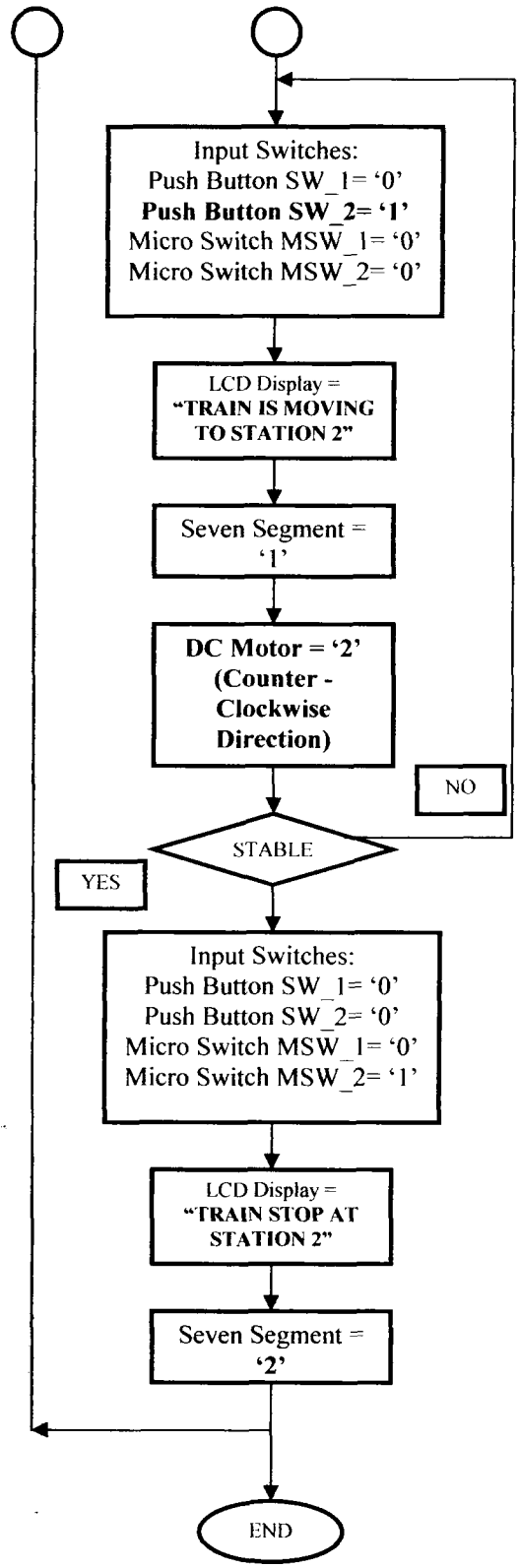
Software Development

MPLAB Integrated Development Environment (IDE) is a comprehensive editor, project manager and design desktop for application development of embedded designs using Microchip PICmicro and dsPIC microcontrollers. MPLAB is used to create, edit and simulate the programs for this project. More than just a text editor, this IDE includes a simulator and extensive debugging tools to help test the operation of application programs. It also links to the PICSTART PLUS Development Programmer to download the program to the microcontroller.

Flowchart







Movement Principle

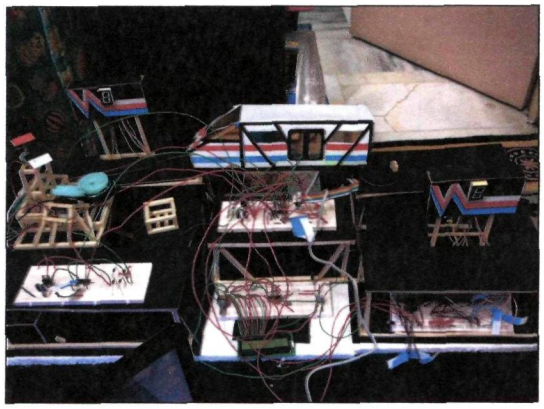
When a passenger arrived at either of the station, one at a time, the first person standing will push the button (SW1). If the train is already at one of the station, no action should be taken. At the initial stage as voltage being supplied, the seven segment display will show '0' number and the LCD will display **"WELCOME TO TRAIN SIMULATION".**

Then the passenger from the other side will push the button (SW2) to move from one side to the other side and bring these passengers to the opposite station which is their destination. During this transition, the motor will move forward and reverse. Forward will bring the train towards station 2 and reverse will bring back the train to its original station 1. In this period of time, the LCD display will display **"TRAIN IS MOVING TO STATION A"** or **"TRAIN IS MOVING TO STATION B".**

In the process of the train is moving forward and reverse, the sensor at each station will detect if the train has arrived at the station or the otherwise. When the sensor (Micro-switch 2) is triggered at station 2 that means the train has arrived at station 2 thus the seven segment display will show '2'. In this period of time the LCD display will show a sign of **"TRAIN STOP AT STATION 2"** .Vice versa when the sensor (Micro-switch 1) is triggered at station 1 that means the train has arrived at station 1 thus the seven segment display will show '1'. In this period of time the LCD display will also show the sign of **"TRAIN STOP AT STATION 1".**

The rationale behind the performing this idea is to inform the passengers the location of the train at certain time. Finally, the LCD display will complete the system by showing to both station and each passenger whether the train is arriving or leaving. With the help of the LCD display, it will be easier and accurate for passengers to estimate time while waiting.

Hardware Model



Hardware Development

These are the procedures of developing the P.I.C Train Simulator:

1. Designing and constructing the structural area so that it can specify the location of each sub-circuit such as LCD display, motor driver and seven segments display.

2. Controller: PIC 16F877A chip.

Controller

Programmable Interface Controller (PIC) is the Integrated Circuit (IC) that is developed to control the Peripheral device, dispersing the function of the main Control Processing Unit CPU. The PIC is directly compatible with TTL gate level. The PIC integrates a large number of commonly used functions that are suitable for use in instrument controller or general processor application. The basis process in developing a PIC consists of 6 steps;

- Select a PIC, and Construct a program flowchart.
- Write and develop a program
- Assemble program
- Simulate or emulate the program to see whether or not it works.
- Store or download program into PIC chip. In this case the main PIC is PIC16F877A.
- Connect the PIC parallel input and output port onto constructed circuit.

PIC16F877A

EEPROM memory makes it easier to apply microcontrollers to devices where permanent storage of various parameters is needed (codes for transmitters, motor speed, receiver frequencies, etc). Low cost, low consumption, easy handling and flexibility make PIC16F877A applicable even in areas where microcontrollers had not previously been considered (Example: Timer function, interface replacement in larger systems, coprocessor applications, etc.)

In System Programmability of this chip (along with using only two pins in data transfer) makes possible the flexibility of a product, after assembling and testing have been completed. This capability can be used to create assembly-line production, to store calibration data available only after final testing, or it can be used to improve programs on finished products.

PORT DECLARATION

PORT A	FUNCTION
0	PUSH BUTTON SW_1
1	PUSH BUTTON SW_2
2	MICRO_SWITCH MSW_1
3	MICRO_SWITCH MSW_2
4	N/A
5	N/A
6	N/A
7	N/A

PORT C	FUNCTION
0	MOTOR CLOCKWISE
1	MOTOR ANTI-CLOCKWISE
2	N/A
3	N/A
4	RS PIN FOR LCD
5	ENABLE PIN FOR LCD
6	N/A
7	N/A

PORT D	FUNCTION
0	LSB BIT(A) DECODER
1	BIT(B) DECODER
2	BIT(C) DECODER
3	MSB BIT(D) DECODER
4	BIT 'D4' FOR LCD
5	BIT 'D5' FOR LCD
6	BIT 'D6' FOR LCD
7	BIT 'D7' FOR LCD

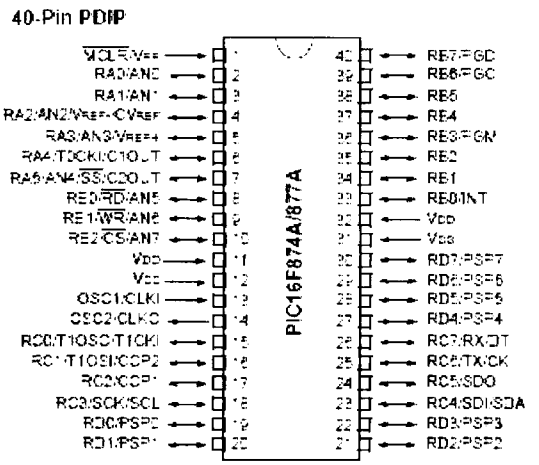


Figure 3.0: PIC16F877A Chip

Result

The results are shown by the oscilloscope to verify the signal at the input and output of the devices.

Figure (1)

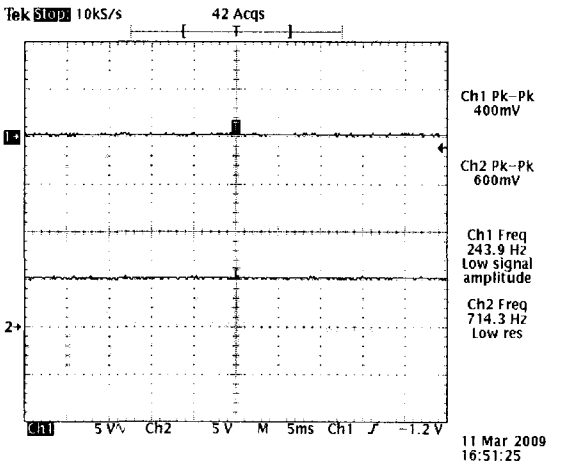


Figure 1(a) shows at the first stage, no input supplied

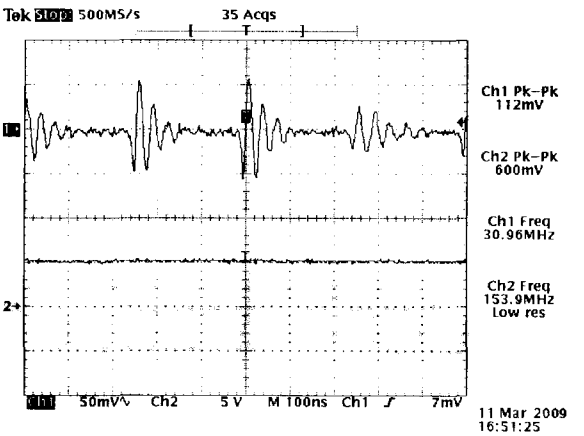
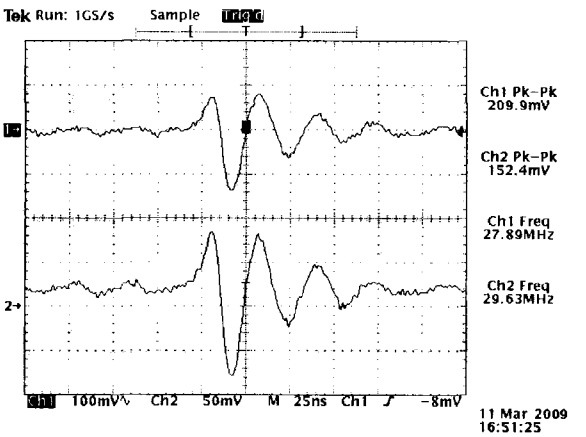


Figure 1(b) shows when the Push Button SW_1 was given HIGH and LOW inputs



Figures 1(c) show the inputs for Micro-Switch MSW_1 and Micro-Switch MSW_2 was given HIGH inputs

Figure (2)

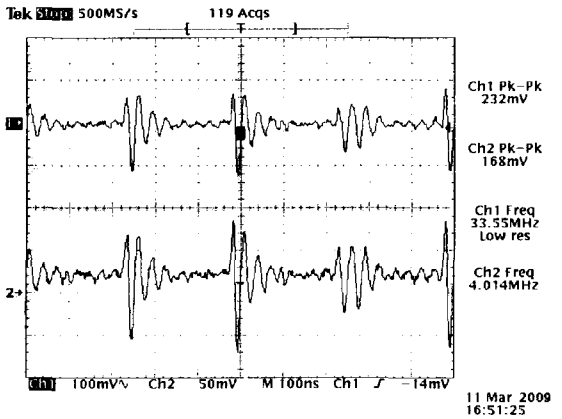


Figure 2(a) shows Push Button SW_1 and the Motor Clockwise

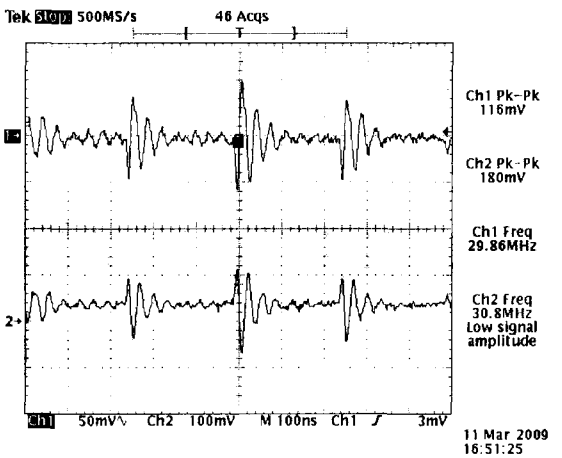


Figure 2(b) shows Push Button SW_2 and the Motor Counter-Clockwise

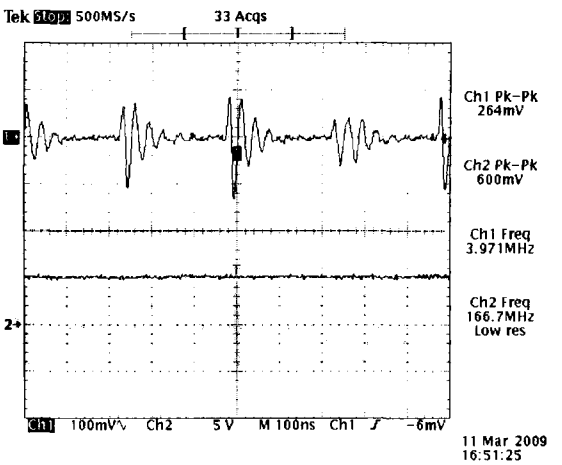


Figure 2(c) shows Micro-switch MSW_1/ Micro-switch MSW_2 and Motor Stops

Discussion

During the implementation of this project, there are a lot of problems. But these problems made a challenge out of me and I manage to turn it into a solution that finally brought me into developing this train simulator project.

a) Hardware Model

The station model is made from a balsa wood and card board structure. These materials are handy made materials and could be saving in terms of the cost compared to the steel. It can be easily cut and designed. In order to design the structure, one should have the structural knowledge and skills otherwise, the model could collapse easily. On the first model, the structure could not bare the weight of the circuit and also the LCD display causing the whole model to collapse. With the help of a structural engineer, I manage to design the structure properly and all the weight of the circuit can be supported. The materials chosen also reflected how strong the structure would cope with the weight and the tensile of the train simulator.

b) Electrical Model

The train simulator is divided into several sub-circuits. The master circuit is the one which controls the PIC16F877A. In order to be sure that the train simulator is functioning well, all the sub-circuit must be working synchronized to the master circuit. On the first trial, all the circuit did not perform well. Then, there are several series of troubleshooting session. It starts off with the self test of each sub-circuit and then it will be connected to the master circuit and connection to the PIC16F877A.

There are also possibilities of error that occur due the PIC microcontroller. PIC microcontroller is a sensitive device. We need to measure and control the voltage value that connected to it. Next, the pins should always connected to the right locations otherwise its will damage some of its pins and functions. On the first PIC used, the PIC16F628A microcontroller is chosen. Everything was working properly until the LCD display was to be included in the master PIC. The problem is that there are no sufficient pins to be reserved for the LCD display. That is when the whole project needs to be restructured back. Thus the biggest PIC16F877A microcontroller is chosen as a solution.

During the troubleshooting session, the bread board was used to integrate all the circuit together and in terms of the handiness it is easy to use. The real assessment is on the printed circuit board (PCB). The problems are due to the software problems. We need to design each of the components because there is a lack of library items in the PROTEL software. The designing really consumes a large amount of time. Therefore, I tried to implement it on top of the veroboard. It also creates problem that couldn't be solved maybe due to the quality of my soldering or the components that did not get along with the connectivity on the veroboard.

c) Successive Result.

At the end of the day, this train simulator project made a headline when it was performing well and follow all the programming instructions. Up to this stage, its time to have a coffee and this project hit the end button.

Conclusion

As a conclusion, the Train Simulation system successfully performs its basic operation by employing the P.I.C microcontroller. This includes the movements from one direction to the other, display information and also call in switches.
This train simulation system performs all of its operation using electronic circuit. It can control the motor, seven-segment and LCD display manually by using a single microcontroller PIC 16F877A.

Future Development

This train simulator can be improved further in terms of its functions and performances. There are so many development can be made such as follows:

1. Inserting a weight sensor(involving strain- gauge)
2. Timer Functions at each stations
3. Show time for departure and arrival
4. Auto-Station Tracking
5. Mechanical Motor for railway system

Acknowledgement

I would like to express a special gratitude to my project supervisor, Pn Norhazlin Khairuddin for the guidance, advice and support throughout the development of this project. I would also like to express my utmost gratitude to my mentor, Mr Langga Anak Rimon @ Mohd Zulkifli B Abdullah for his experience and never ending quest toward this project. Not to forget to all who have been involved directly or indirectly. I also would like to give my sincere thanks to my family for their support. A million thanks also to all my friends for their moral support and guidance. May Almighty Allah bless and reward them for their generosity.

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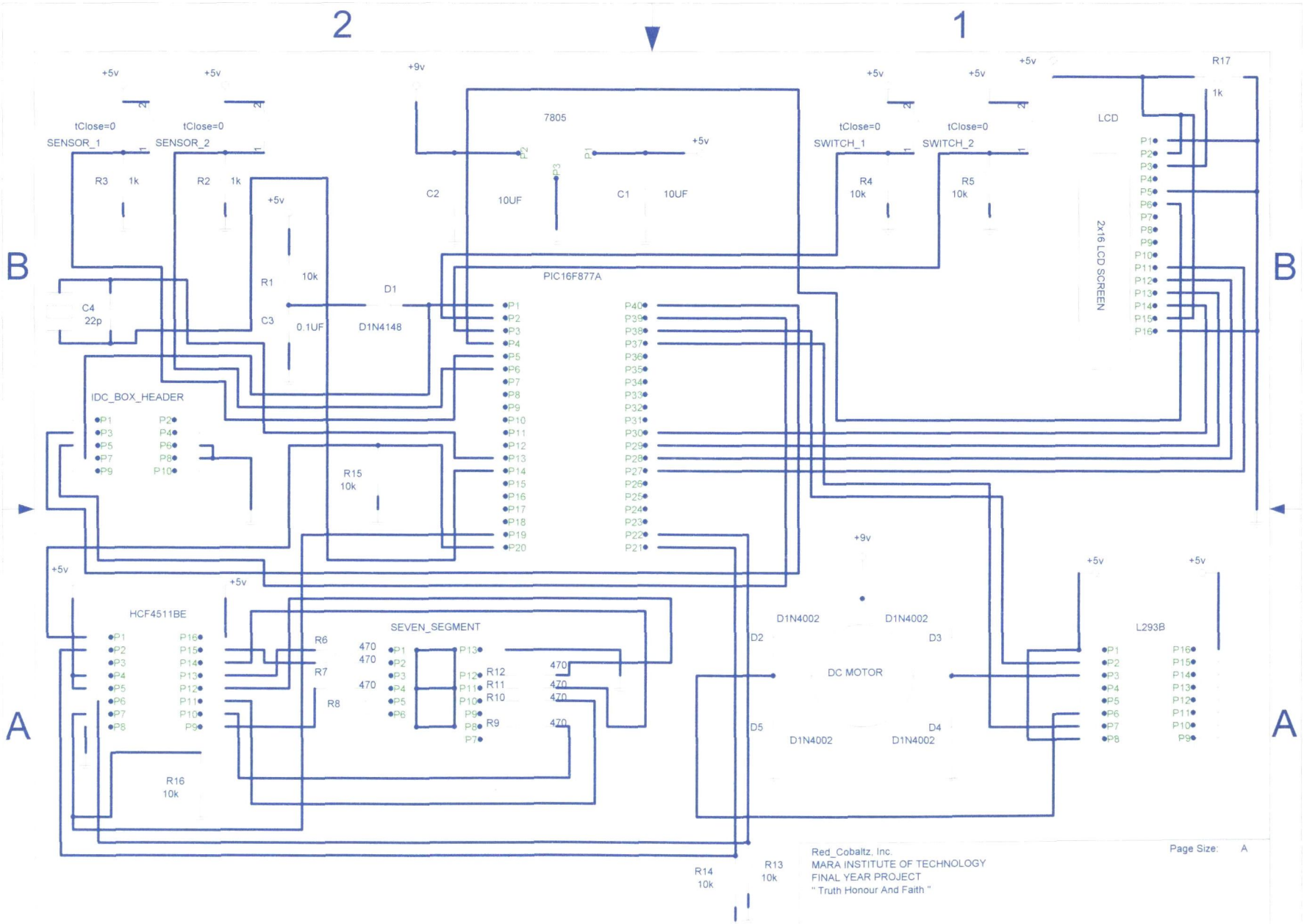
2
1
B
A
+5v
+9v
tClose=0
SENSOR_1
SENSOR_2
SWITCH_1
SWITCH_2
R1 10k
R2 1k
R3 1k
R4 10k
R5 10k
R17 1k
C1 10UF
C2 10UF
C3 0.1UF
C4 22p
7805
D1
D1N4148
PIC16F877A
LCD
2x16 LCD SCREEN
IDC_BOX_HEADER
R15 10k
HCF4511BE
SEVEN_SEGMENT
R6
R7
R8
R9
R10
R11
R12
470
R16 10k
R14 10k
R13 10k
D1N4002
D2
D3
D4
D5
DC MOTOR
L293B
Red_Cobaltz, Inc.
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