PLATOON ROBOT

By

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

_____

SUFI BIN NORDIN

CERTIFICATION OF APPROVAL

PLATOON ROBOT

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Sufi bin Nordin

A project dissertation submitted to the
Department of Electrical & Electronic Engineering
Universiti Teknologi PTRONAS
In partial fulfilment of the requirement for the
Bachelor of Engineering (Hons)
(Electrical & Electronic Engineering)

Approved:

_____

Mr. Patrick Sebastian
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

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ABSTRACT

The main objective of this project is to improve the design of platoon robot using the on board sensor rather than external devices. This robot will use the infrared transmitter and receiver to communicate between the leader and the follower robot. The platoon robot also can differentiate the signal that the follower receives from its own leader or from another leader. When the receiver receive the signal, the robot will move according to the direction of the signal receive. This report will show the part of the robot used and how the robot reacts according to the signal receive.

ACKNOWLEDGEMENTS

First and most, I want to express my deepest gratitude to my project supervisor, Mr Patrick Sebastian who had support, guide and encourage me to successfully completed this project. He continuously challenges me to learn new things and come out with new ideas in order to produce a high quality project.

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LIST OF ABBREVIATION

PIC	Programmable Interface Microcontroller
GPS	Global Positioning System
CPU	Central Processing Unit
RAM	Random Access Memory
ROM	Read-Only Memory
I/O	Input Output
IR	Infrared
DC	Direct Current
PWM	Pulse Width Modulation
LCD	Liquid Cristal Display
LED	Light Emitting Diode

CHAPTER 1

PROJECT BACKGROUND

1.1 BACKGROUND OF STUDY

Most of the animals in nature tend to live in a group or colonies. For example, insect such as ants complete their chores by sheer number of workers. It is useful to emulate such behaviour and apply them to the robotic system.

A mobile robot is an automatic machine that is capable of movement in a given environment. Mobile robot is gaining momentum in current research as it could be of great use to the presently growing technology. Mobile robots have the capability to move around in their environment and are not fixed to one physical location.

Platoon robot is a PIC based machine which is able to follow another robot using. The aim of this project is to incorporate cooperative behaviour into a team of robot. For this project, the task set for team is to find their own leader and follow the leader movement in line.

Apart of that, PIC plays the most important role in the project. It would be loaded with appropriate coding which are acts as the main essence for the robot functionality. This robot would be equipped with various types of sensor. The sensor is used to find the leader and to maintain the distance when moving.

1.2 PROBLEM STATEMENT

There are several existing project about the platoon robot. Based on the projects, there are some areas that can be improved or innovated to increase the overall performance of the platoon robot. From observing the previous design, it is found that the previous design of platoon robot have some limitation. The previous design is using GPS or overhead camera as the robot guider to find the leader and follow the path of the leader.

By using this type of device, the robots require high computing power to work. Furthermore, this type of design also require external device to make the robot work. Platoon robot that are using GPS have to rely on the satellite to find its leader and in addition, by using that device, the robot will work poorly inside the building because it required satellites signal for its GPS to work.

It is the same for the robot that are using overhead camera as its sensor to find the leader of the platoon robot. These types of design have to rely on the camera and it makes the robot not mobile. It only can work on its platform that has been ready with the overhead camera.

1.3 OBJECTIVES

The objective of this project is to:

- Build a team of robot that consist of three robots act as follower and leader using on board sensor.
- The second robot acts as a follower and will follow the movement of the first robot.
- The third robot will follow the movement of the second robot.

1.4 SCOPE OF STUDY

The project will focus on building the platoon robot to meet its basic requirement which is to follow the movement of its leader. The study will focus on the main element of the robot which is the sensor and the transmitter to send and receive the signal. The main scope of the robot is on the integration of PIC and the part of the mobile robot in order to produce the Platoon Robot. The additional feature to be considered is to have the robot that can differentiate the signal that it will receive which is from the leader or from another follower. The first robot will act as a leader for the second robot while the second robot will act as the follower to the first robot as well as the leader to the third robot.

CHAPTER 2

LITERATURE REVIEW & THEORY

2.1 MICROCONTROLER

Microcontroller is a kind of miniature computer that can be found in almost any complex electronic device. The microcontroller is programmable, cheap, and small and can handle with small power. It has features and similarities to the standard personal computers where its primary feature is to store and run a program. The microcontroller includes a CPU, RAM, ROM, I/O ports and timers like a standard computer but it is much smaller.

The microcontroller is differing from the microprocessor which is a used to create a multi-function computer or device and requires multiple chips to handle various tasks. A microcontroller is meant to be more self-contained and independent. This is what makes the microcontroller is suitable for mobile robotic. [1]

The factors that determine the usability of a microcontroller for a specific application are:-

Speed and Availability Power Consumption Amount of on chip RAM and ROM and whether the microcontroller supports any addition of external memory, number of I/O ports and on chip timers, availability of software for programming the specific microcontroller, consideration of Cost per Unit of the specific micro controller because the embedded systems using this controller are usually manufactured on a large scale. [2]

2.2 INFRARED TRANSMITTER AND RECEIVER

Infrared (IR) radiation is part of the electromagnetic spectrum, which includes radio waves, micro waves, visible light, and ultraviolet light as well as gamma rays and X-rays. The infrared range falls between the visible portion of the spectrum and radio waves. The infrared is a radiation that is invisible to human eyes, but can detect by an infrared sensor.

Infrared sensor is divided into two parts, transmitter and receiver. The infrared transmitters emit infrared radiation while the infrared receiver detects the infrared radiation. In a typical infrared sensor, radiations enter the sensor. This sensor is being made from pyroelectric materials, whether natural or artificial. These material will generate and electrical voltage when heated or cooled. It is very common for an infrared sensor to be integrated into motion detectors or obstacle detectors. [3]

2.3 C PROGRAMMING

C is one of the most widely used programming languages of all time. It is used for creating computer programs as it allows for easy implementation. C This language creates list of instruction for a computer to follow in order to come up with a certain program. To contributes for efficiently and portability, all C programming languages is equipped with a standard library. [4]

C is a compiled language. This means that when programmers write using C languages, it must be run through a c compiler to turn the desired program into an executable that the computer can run. The C language can be used on many different types of computer platforms, including everything from small microcontrollers to desktop. [5]

2.4 PIC PROGRAMMING

The microcontroller executes the program loaded in its flash memory which consists of binary code organized in 12, 14 or 16 bit wide words. These words are individually considered as executable instruction by the CPU when microcontroller is run. [6]

The instruction that the microcontroller can recognize and execute is called instruction set. The executable code is usually represented as a sequence of hexadecimal numbers or called hex code. This code is a file format for conveying binary information. The programming languages that are supported by the microcontroller will generate a .HEX file which will be loaded to the microcontroller itself.

For PIC microcontroller, the general layout for any program is as follow:

i. Microcontroller header file which defines all the registers and peripherals.
ii. Main configuration settings of PIC such as crystal frequency, watchdog status and others.
iii. Main functions where the port initialization and input specification are set.
iv. Rest of program which depends on user application.
v. Any use of peripherals or communication modules must be configured accordingly beforehand.

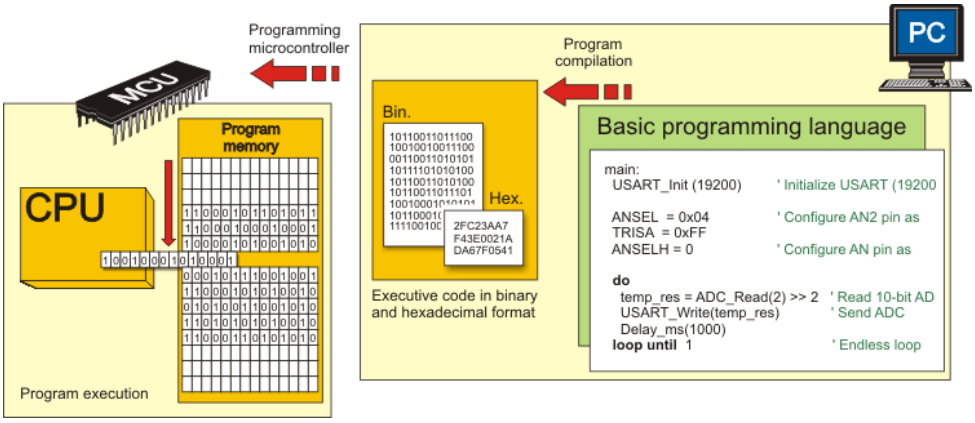

Figure 1: The programing code inside computer and microcontroller.

2.5 MOTORS

There are many types of motor used for mobile robot, but there are only two types that will be put in discussion which is the basic DC motor and servo motor.

2.5.1 DC MOTOR

DC motor uses electricity and magnetic field to produce torque which turns the motor. The DC motor construction requires two magnets of opposite polarity and an electric coil, which acts as an electromagnet. It uses the properties of magnets polarity to convert electricity into motions.

The DC motor speed is controlled using a technique named pulse width modulation or PWM. PWM control the motor power level by strobing the power and off. If the power switch is turn on and off fast enough, then it make the motor running weaker. [7]

2.5.2 SERVO MOTOR

A servo motor is having four different parts inside the motor. A servo motor is actually an assembly of a normal DC motor, a gear reduction unit, a position-sensing device and a control circuit. The function of a servo motor is to receive a control signal that represents a desired output position of the servo shaft, and apply power to its DC motor until its shaft turn to that position.

The control signal is pulse width modulated, but the duration of positive-going pulse determines the position of the servo shaft. A longer pulse makes the servo turn to a clockwise and a shorter pulse makes the servo turn to a counter clockwise. [7]

CHAPTER 3
METHODOLOGY

3.1 TASKS & ACTIVITIES PLANNED

The project starts with the preliminary research and analysis stage. This stage takes place to further understanding about the platoon robot and how the mobile robot works. The research is done to identify the current project on platoon robot and identify the possible improvements that can be made to the current project. The research is done on every part of the Platoon Robot which range from the hardware design and the software needs.

For this particular project, the initial step would be the design stage where the circuit design for the robot is carefully taken into consideration especially on the sensor portion. The next step that has to be considered is the hardware portion which is the construction of microcontroller circuit, sensor circuit and motor driver circuit.

Then the next task is to develop the software development to include all the instruction into the robot. The instruction would include the infrared detection at the follower robot, infrared send at the leader robot and also the navigation of the robot.

The last step is to implement the project which would include troubleshooting and demonstration of the project. The flow chart of the project work is shown in the next section.

3.2 PROJECT WORK FLOWCHART

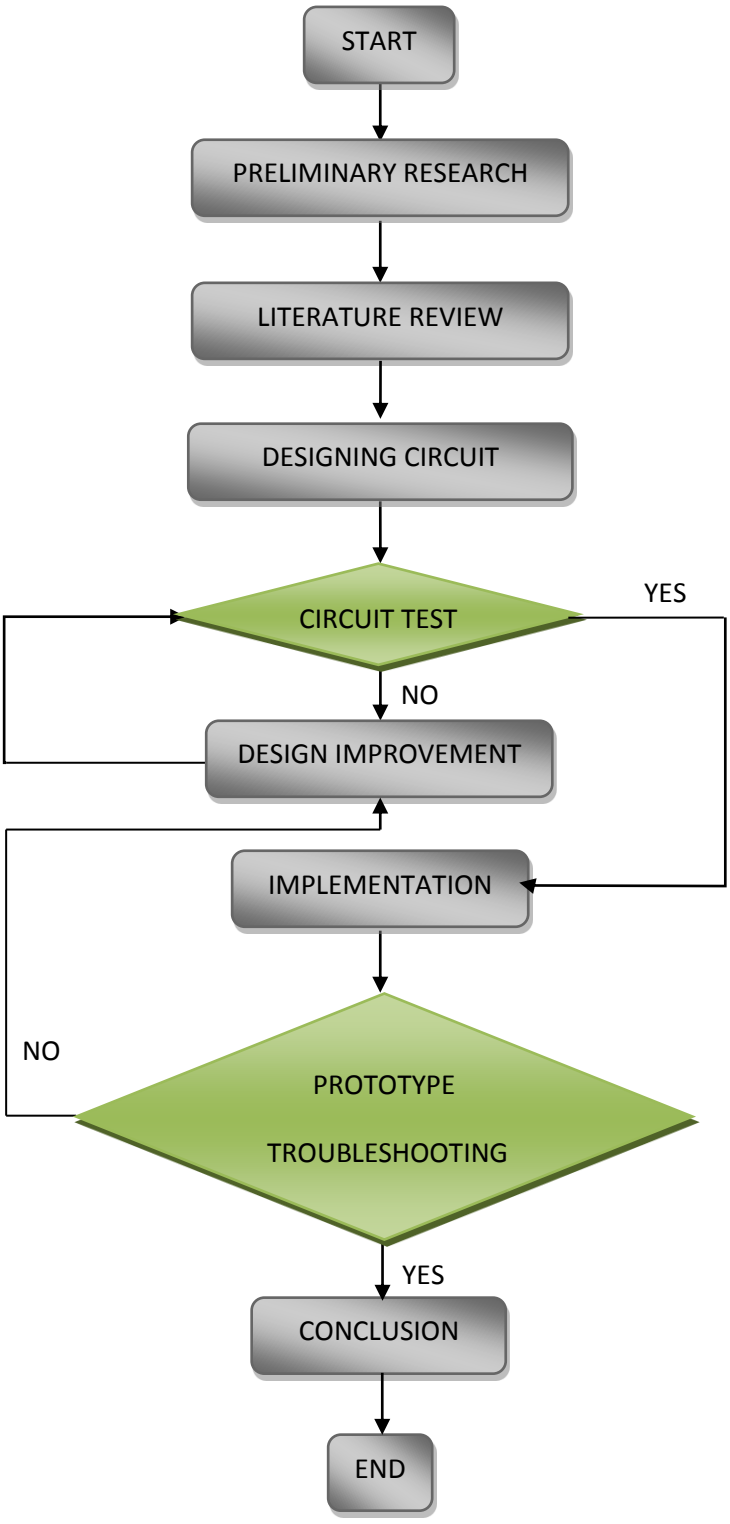

Figure 2 : Project flow chart

3.3 GANTT CHART

The following are the Gantt chart for this project in FYP 1

No	Detail / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic								Mid Semester Break						
2	Preliminary Research Work														
3	Components and Tools Identification														
4	Submission of Extended Proposal														
5	Hardware Assembly														
6	Proposal Defence														
7	Study on PIC Programming														
8	Submission of Interim Report														

Table 1: Gantt chart for FYP 1

The following are the Gantt chart for this project in FYP 2

No	Detail / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Literature study and review															
2	Research and testing on Sensor															
3	Collect the data result															
4	Hardware Assembly															
5	Robot Programming															
6	Submit FYP 2 final report															
7	Viva															

Table 2: Gantt chart for FYP 2

3.3 TOOLS

The following are required tools that will be used to complete this project which comprises of two categories, hardware and software.

3.3.1 HARDWARE

- PIC Microcontroller
- PIC Programmer
- Infrared Transmitter and Receiver Circuit
- Motor driver circuit
- Distance sensor circuit
- LCD

3.3.2 SOFTWARE

- CCS Compiler – C Compiler
- MPLAB – Assembly and C Compiler
- PIC Simulaator IDE – PIC Microcontroller Simulator

CHAPTER 4

RESULT AND DISCUSSION

4.1 Infrared Transmitter

The first method use to make the sensor for the robot to send and detect the signal of the movement of its leader is by using the Infrared emitting diode (IR LED). To differentiate the signal send from the two different robots, the transmitter will send the pulse of infrared. Each robot will have its different frequency of pulses.

The receiver robot will receive the pulses of infrared signal but the follower robots are designed to react to pulses at a set frequency.

Figure 3: Infrared Transmitter

Figure 4 :Infrared Receiver

4.2 Interface LCD

Figure 5 :Interface LCD

The LCD use in this project is JHD162A. This LCD has 2X16 characters and 16 pin. The function of each pin is shown in the table below. This LCD will show the frequency of the input receive by the receiver from the leader.

Pin	Name	Pin Function
1	VSS	Ground
2	VCC	Positive supply for LCD
3	VEE	Brightness adjust
4	RS	Select register, select instruction or data register
5	R/W	Select read or write
6	E	Start data read or write
7	DB0	Data bus pin
8	DB1	Data bus pin
9	DB2	Data bus pin
10	DB3	Data bus pin
11	DB4	Data bus pin
12	DB5	Data bus pin
13	DB6	Data bus pin
14	DB7	Data bus pin
15	LED+	Backlight positive input
16	LED-	Backlight negative input

Table 3 : LCD pin functions

4.3 Infrared Receiver

To make the follower robot differentiate the leader, the receiver read the infrared signal from the transmitter and calculates the frequency. The follower will display the frequency receive at the LCD and will be programed to follow the certain frequency and ignore the frequency that is not related.

The code below is to calculate the frequency of the signal input and show the frequency at the LCD.

```
#include<htc.h>
unsigned int i,i1,j,k,l,m,o,n,p,q,r,s;
unsigned char a[]="FREQ";
void lcdcmd(unsigned char );
void dat(void);
void lcd_init();
void del_lcd(void);

void main()
{
TRISB=0x00;                                          //PORT Configuration
TRISC=0xAF;
PORTB=0x00;
TRISD=0x00;
PORTD=0x0F;
TRISA=0x00;

T0CS=0;                                                 //TIMER0 Configuration
PSA=0;
PS2=0;
PS1=1;
PS0=1;

TMR1CS=1;                                             //TIMER1 Configuration
TMR1H=0x00;
TMR1L=0x00;

lcd_init();

del_lcd();

while(1)
{
TMR1ON=1;                                             //counter1 is started
for(i=0;i<250;i++)
{
TMR0=0x06;
while(TMR0IF==0);                                   //delay of 1 second
TMR0IF=0;
}
```

```
TMR1ON=0;                                          //counter1 is off
s=TMR1H;
r=TMR1L;
q=(s<<8)+r;                          // higher bits are shifted to left by 8 bits and then lower bits are added

k=q%10;                             // digit separation logic
q=q/10;
l=q%10;
q=q/10;
m=q%10;
q=q/10;
n=q%10;
q=q/10;
p=q%10;
r=q/10;

PORTB='F';                                          //to display  f on LCD
dat();
del_lcd();

PORTB='=';
dat();
del_lcd();

PORTB=r+0x30;                                 // sending the data on LCD
dat();
del_lcd();
PORTB=p+0x30;
dat();
del_lcd();
PORTB=n+0x30;
dat();
del_lcd();
PORTB=m+0x30;
dat();
del_lcd();
PORTB=l+0x30;
dat();
del_lcd();
PORTB=k+0x30;
dat();
del_lcd();

while(1);                                          // make it wait till all data is send

}

}
```

```
void lcd_cmd(unsigned char val)                          //lcd command function
{
del_lcd();
PORTB=val;
del_lcd();
RD5=0;
del_lcd();
RD6=0;
del_lcd();
RD7=0;
del_lcd();
RD7=1;
del_lcd();
RD7=0;
del_lcd();
}
void del_lcd(void)                                       //delay for lcd
{    unsigned int  j;
for(j=0;j<=500;j++);
}
void lcd_init()                                           //lcd initialization
{
lcd_cmd(0x38);
del_lcd();
lcd_cmd(0x38);
del_lcd();
lcd_cmd(0x38);
del_lcd();

lcd_cmd(0x06);
del_lcd();
lcd_cmd(0x0E);
del_lcd();
lcd_cmd(0x01);
del_lcd();

}

void dat(void)                                           //lcd write function
{
RD5=1;
del_lcd();
RD6=0;
del_lcd();
RD7=0;
del_lcd();
RD7=1;
del_lcd();
RD7=0;
del_lcd();
}
```

Below is the connection of the LCD to the microcontroller and the input signal.

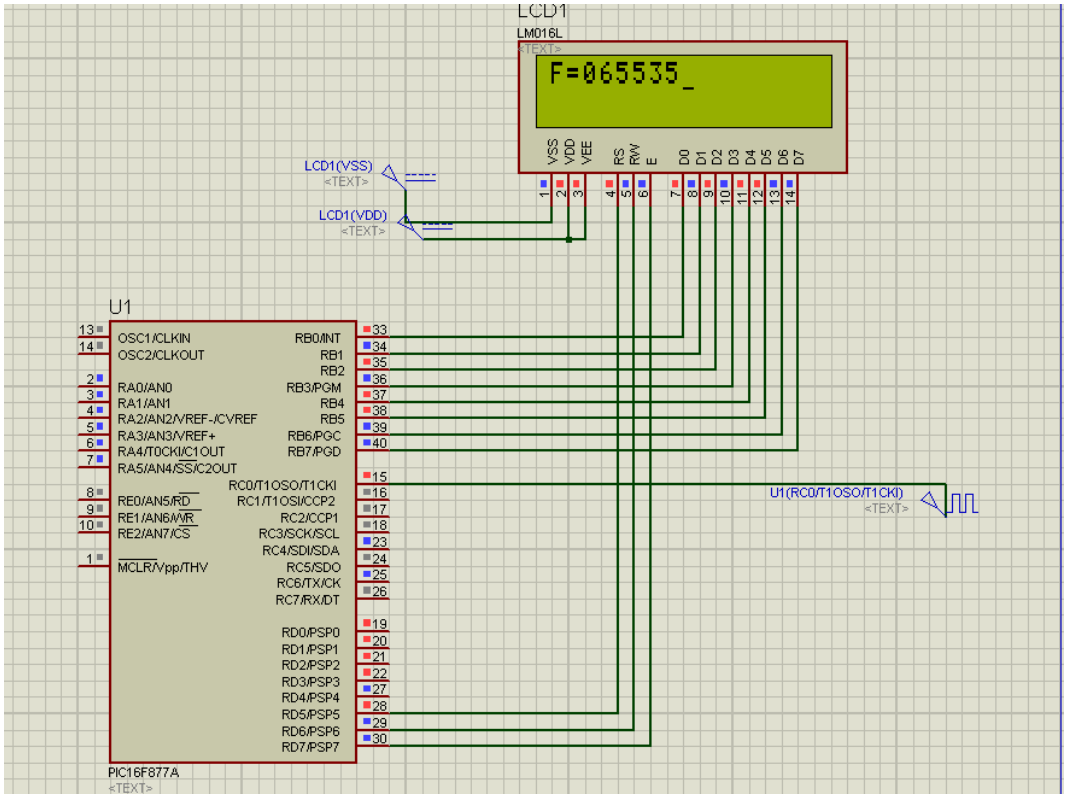

Figure 6 : LCD connection to microcontroller

The calculated frequency received by the follower robot is not exactly the same as it send. The amount of frequency is a little bit difference proportional to the distance of the transmitter and the receiver. The frequency calculated will be about the same if the transmitter is near to the receiver, but the frequency received will be smaller when the robot moved further from the receiver. It is because the infrared signal is interfere with the sunlight.

To overcome the problem, the need of range of frequency set for the follower robot to follow because the follower robot will not receive the exact number of frequency send by the leader robot.

4.4 Power Supply 5V

Most of the digital logic circuits need low power voltage. Only 5 volt of voltage needed to supply for the circuit. To make a 5 volt power supply, the LM7805 voltage regulator IC is used.

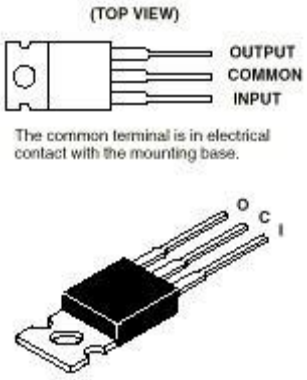

Figure 7: IC LM7805

The input supply will have noisy current. To rip out the noise and get a better 5 volt output, the capacitor is added to the power supply circuit.

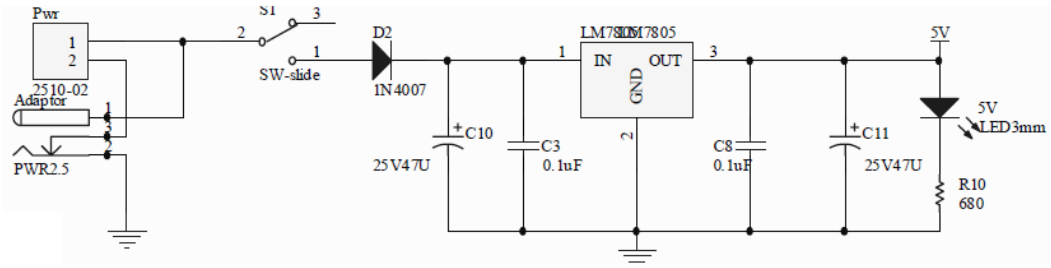

Figure 8: Schematic circuit of 5 volt power supply

4.5 Motor driver circuits

To move the motor in a direction that desired is by supplying the power to the terminal on the motor use. The changing the direction of the motor can make the robot to turn left or right by slowing one side of the wheel or make it faster than the other side of the wheel. To change the direction of the motor is by changing the polarity of the connection between the power supply and the terminal of the motor.

To change the polarity of power supply to the motor and make the direction of rotation is change, the motor is connected to another circuit called motor driver circuit. This circuit used L298D for this purpose. This external circuit can be used for both right and left motor.

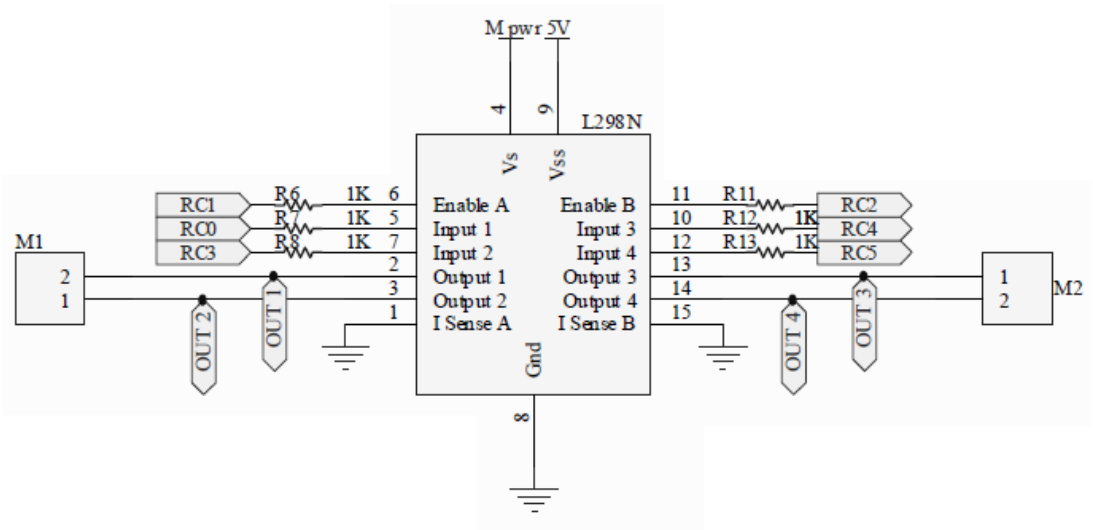

Figure 9: Motor driver circuit using L298D

The direction of the motor can be controlled through the program. The input pin will determined the direction of the motor. For example, if the input 1 pin is high and input 2 pin is low, the motor will rotate in clockwise depending on the power supplied to the motor. If the input 1 pin is change to low and input 2 pin is change to high, the motor will change its rotation direction to counter clockwise.

4.6 Programming flow

The leader robot will set continuously to send the infrared signal according to the frequency that has been set for each robot.

The receiver robot will have to calculate the frequency of signal that there are receive and display it on the LCD. After the signal has been calculate and displayed at the LCD, the program in the receiver robot will compare the frequency receive with the frequency that they have to follow.

If the frequency receive is the same as the frequency set for the robot to follow, the robot will move according to the direction of the signal receive.

Below is the flow chart of the program for receiver robot.

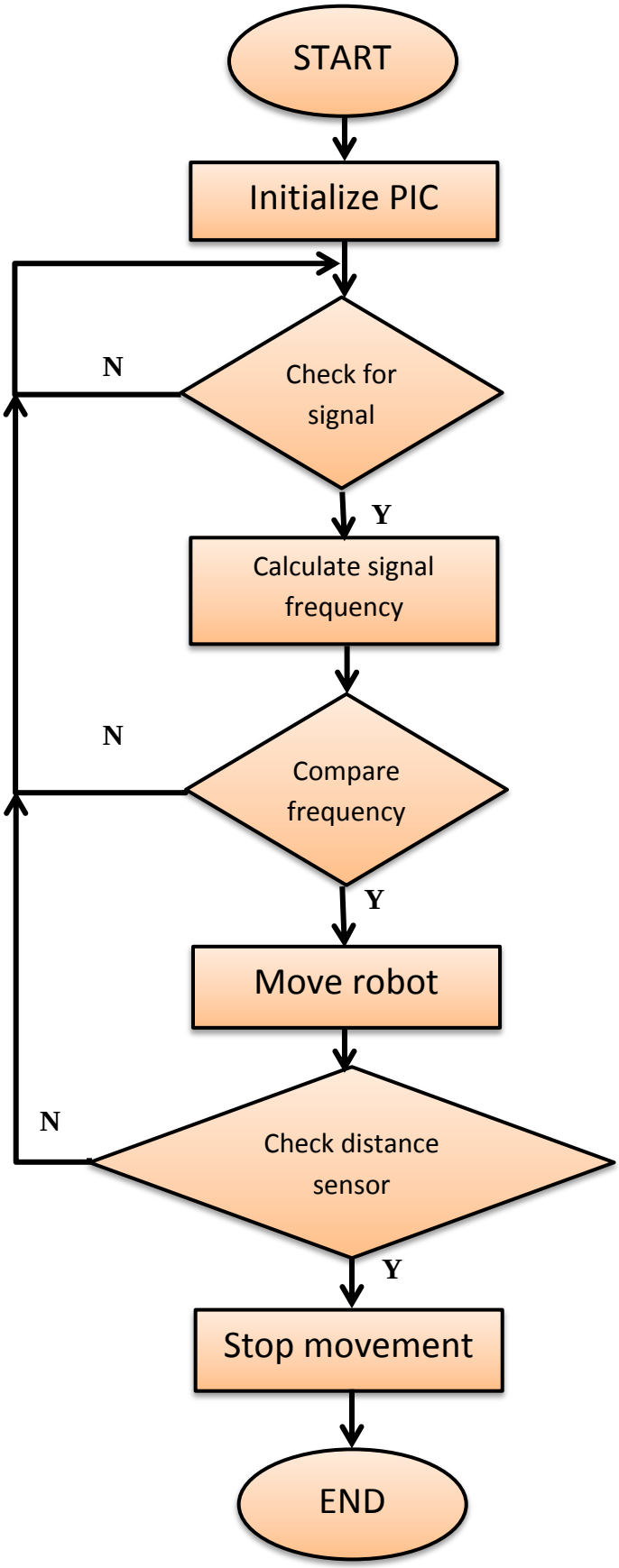

Figure 10: The program flow of receiver robot

4.7 Robot movement

The robot has 4 receivers to detect the direction of movement of its leader. The receiver is put in front of the follower robot. The four receivers is labelled as left, middle left, middle right and right sensors.

The sensors that act as the receivers of the robot will control the speed of the left and right motor as well control the movement of the robot. The table below shows the motors respond according to the receiver.

Sensors				Left Motor Speed	Right Motor Speed
Left	Middle Left	Middle Right	Right		
On	Off	Off	Off	Fast	Stop
On	On	Off	Off	Fast	Slow
Off	On	Off	Off	Fast	Normal
Off	On	On	Off	Normal	Normal
Off	Off	On	Off	Normal	Fast
Off	Off	On	On	Slow	Fast
Off	Off	Off	On	Stop	Fast
Off	Off	Off	Off	Stop	Stop

Table 4: Motor responding according to receiver

When leader of the robot is turning to the left, this will make the left receiver receive the signal. When the left sensor has detected the signal that is from its leader, the left wheel speed will be fast and the right motor will be stop from moving. This will make the robot turn to the left as its leader. When both of the middle sensor receive the signal from its leader, the follower robot will move straight because both the right and left wheel is operating at the same speed.

CHAPTER 5

CONCLUSION

5.1 Relevancy to the objectives

From this project, it proves that this platoon robot can work using on board sensor. This robot can move according to the leader by receiving the signal directly from its leader and not from another device. This make this robot is mobile and can work at any place indoor or outdoor. In addition, this robot does not need higher computing power to operate.

This robot also can differentiate its own leader from another leader or follower because this platoon robot using different frequency of signal for each of the robot. The follower robots can calculate the frequency of the signal and will follow the desired signal only.

This project can be developed and can be improve to add more function. This robot can be implemented in the transportation or as a rescue vehicle inside a building.

The problem faced while doing this platoon projects is the time constraint. This project need longer time focusing on the programming side to improve the accuracy of the robots function.

The problems can be overcomes by starting the programming of the robot during earlier during the assembly of the hardware.

5.2 Recommendations

In the future, the robot can be tested under different type of sensor such as ultrasonic. The operation can be the same as using the infrared sensors. The accuracy of these two types of sensors can be compared.

The number sensor of the receiver can be increase to make the accuracy of the robot increase.

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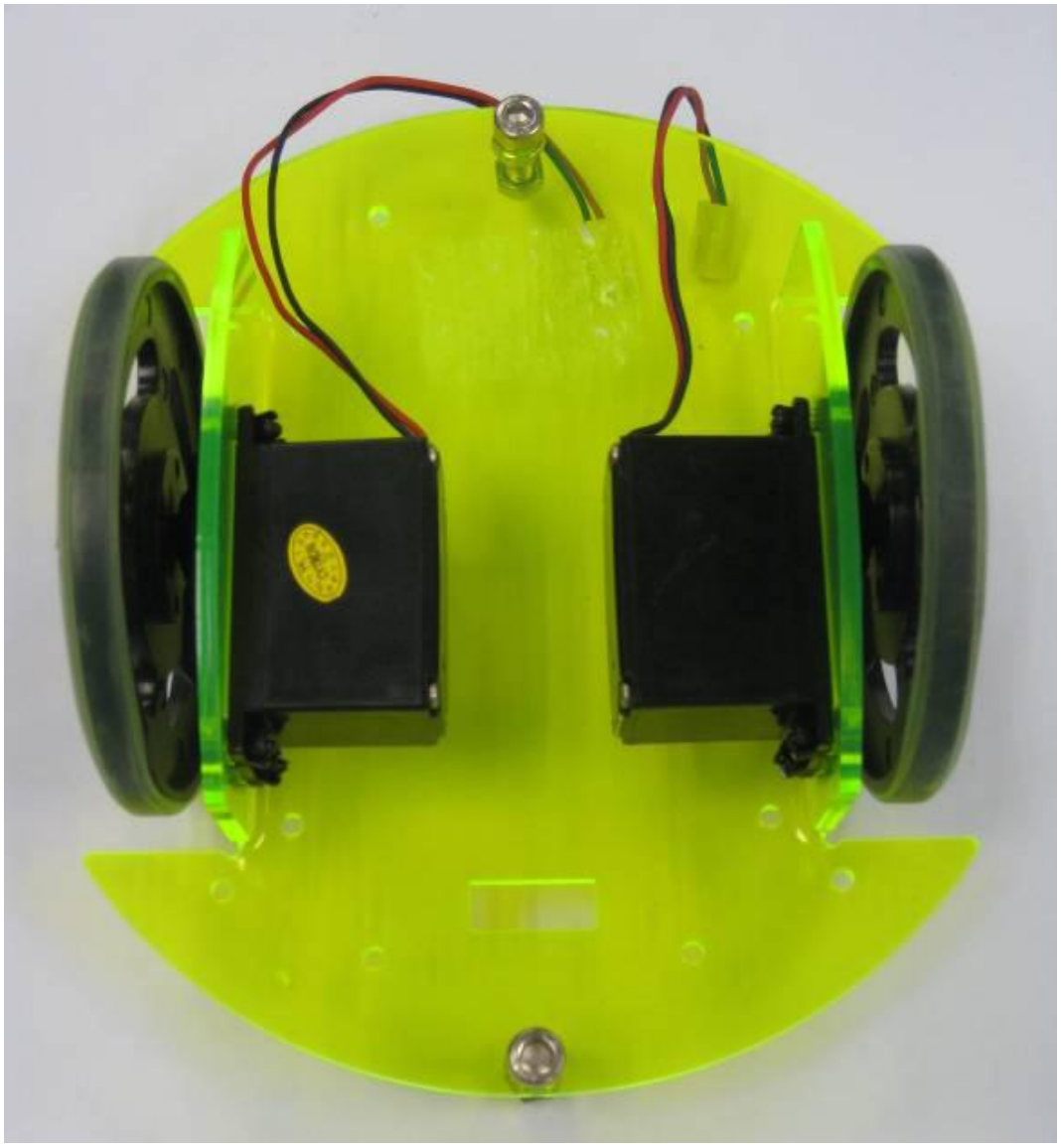
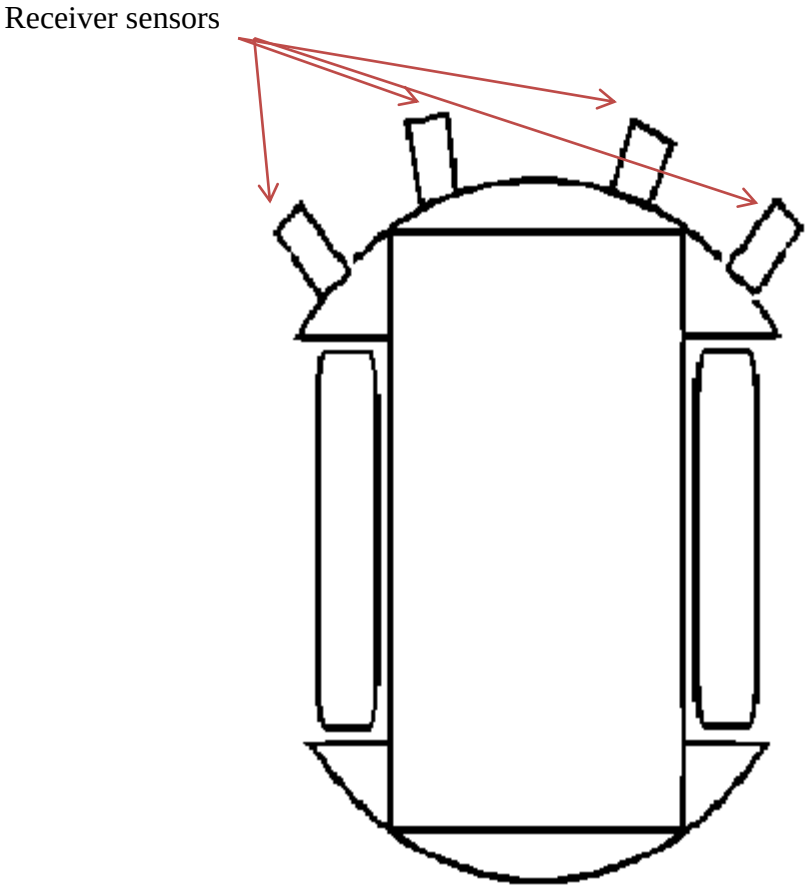
APPENDICES



Servo motor attached to the platform



The position of the receiver in front of follower robot