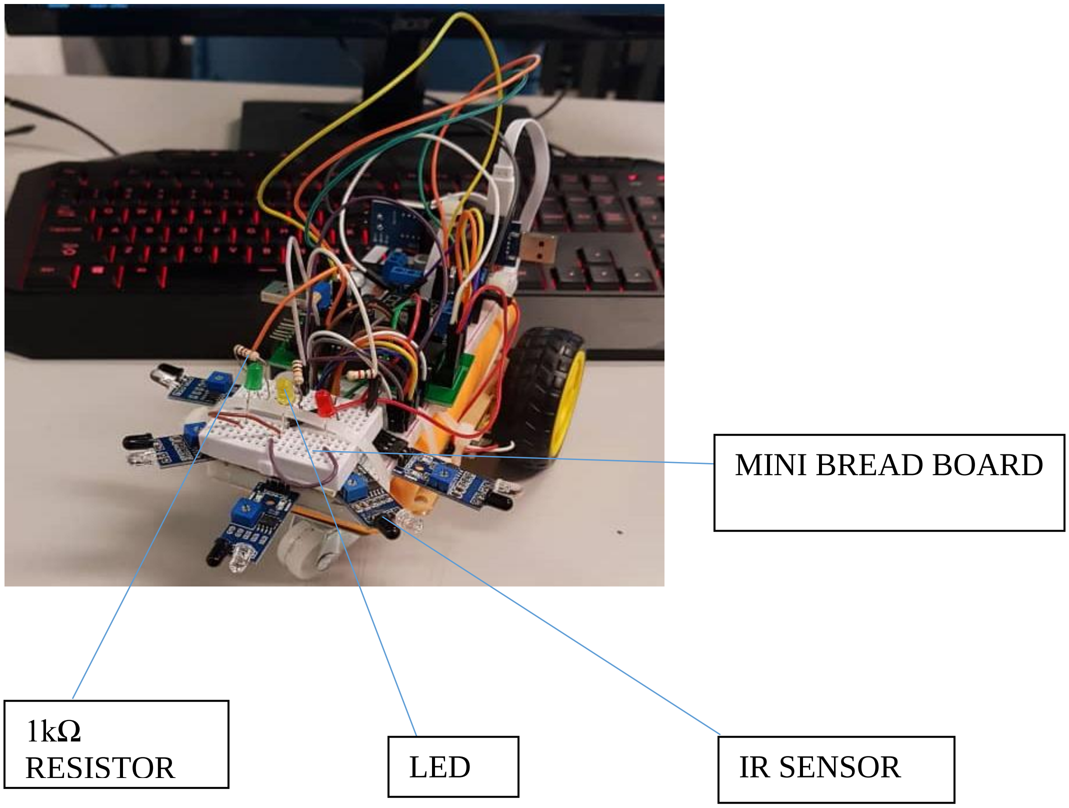
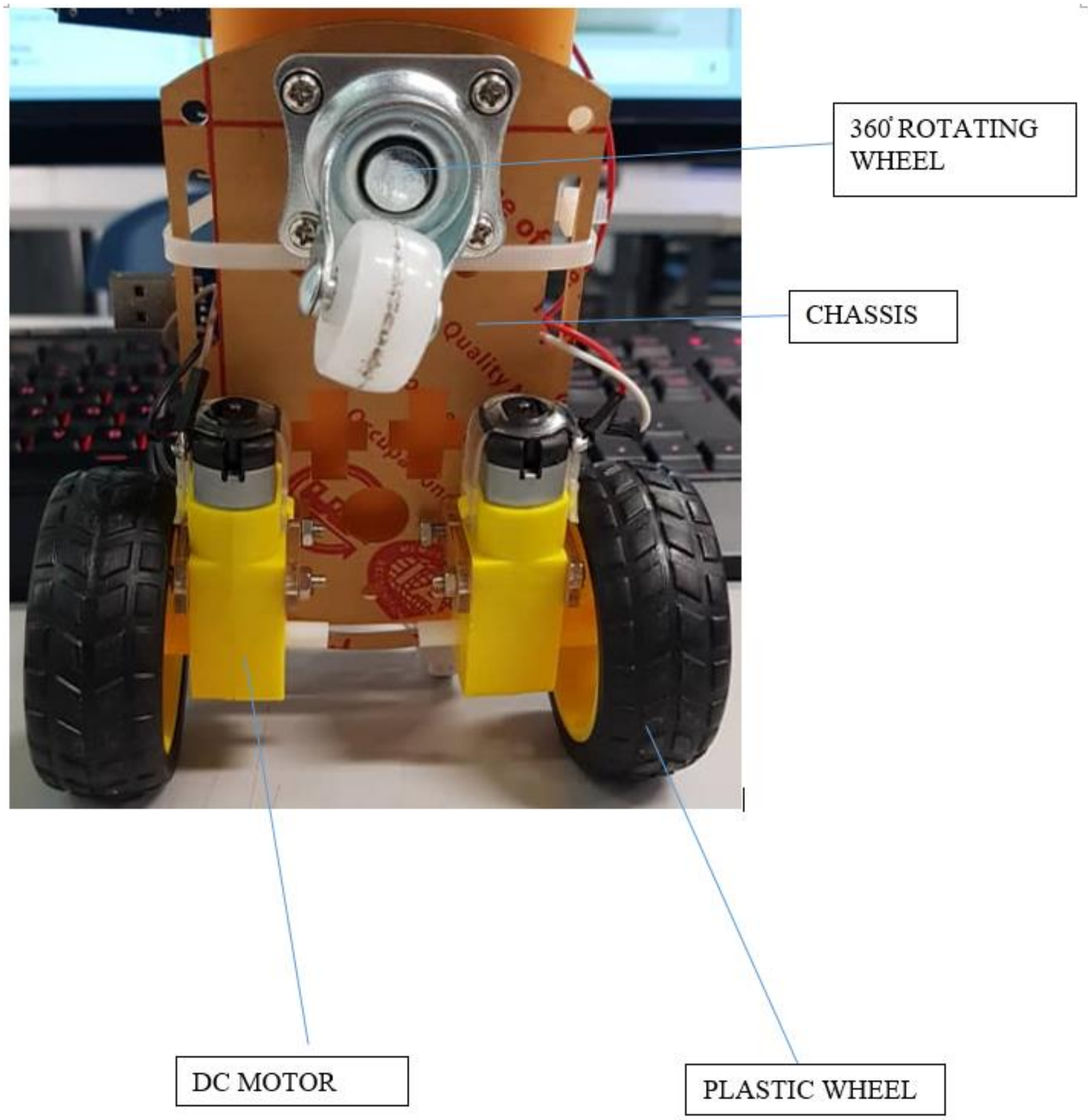
Circuit Design

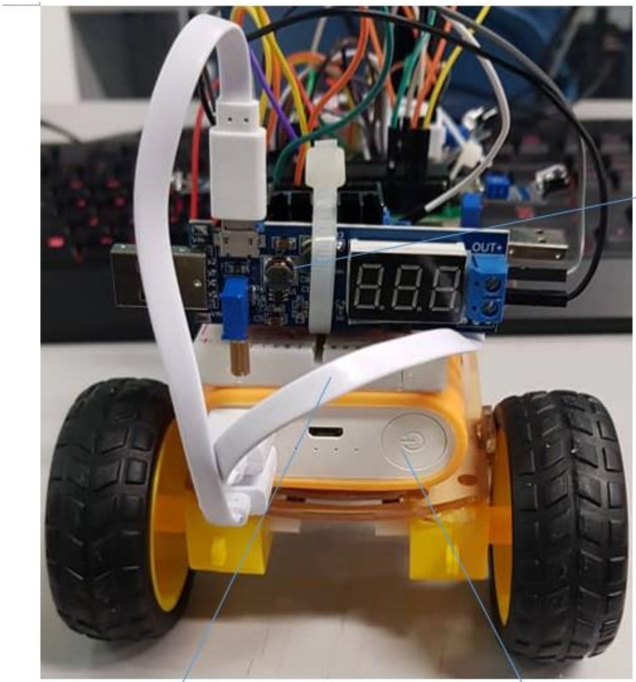
List of components used:

1. Breadboard X1
2. Mini breadboard X1
3. USB-A to micro USB wires X2
4. L298N motor driver X1
5. DC motor X2
6. Robot Car chassis X1
7. Plastic wheels X2
8. 360˚ rotating wheel X1
9. IR Sensors X5
10. Adjustable voltage regulators X2
11. LED X3
12. 1kΩ resistors X3
13. PIC 18F4520 X1
14. PIC 18F4520 PCB module X1
15. Power bank with 2 outlets X1

LABELLED DIAGRAMS:



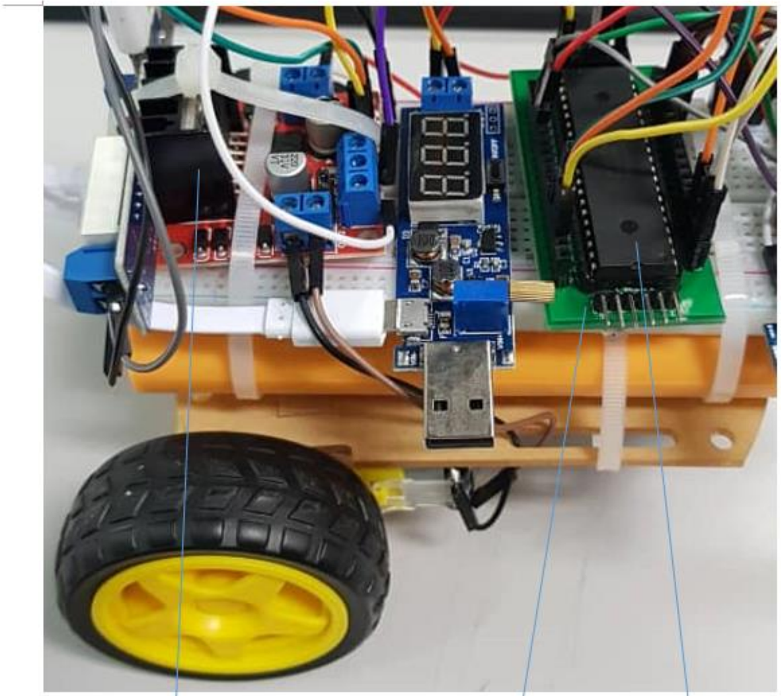

360° ROTATING WHEEL
CHASSIS
DC MOTOR
PLASTIC WHEEL



ADJUSTABLE VOLTAGE REGULATOR

USB-A to micro USB WIRE

POWER BANK

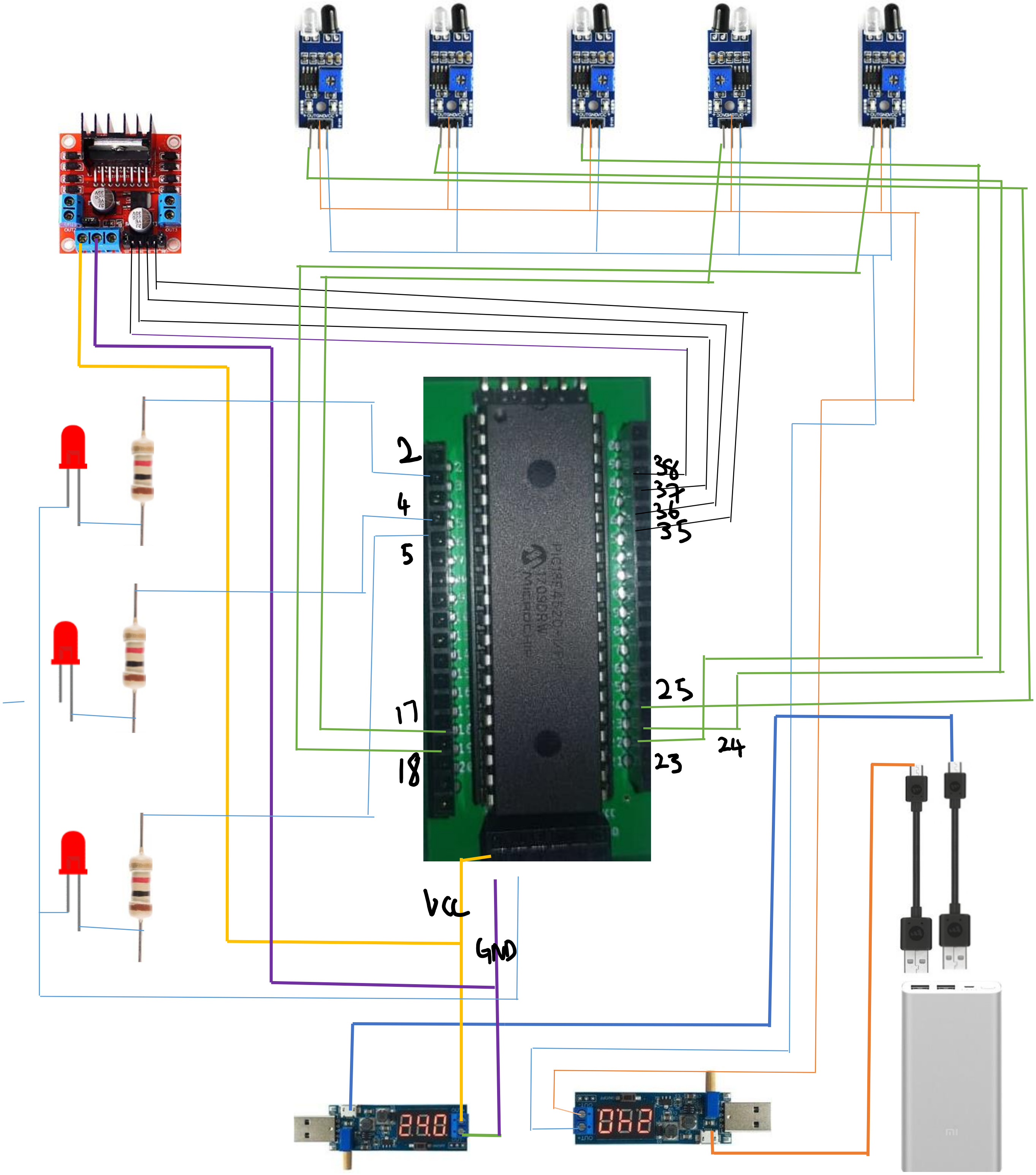


L298N MOTOR DRIVER

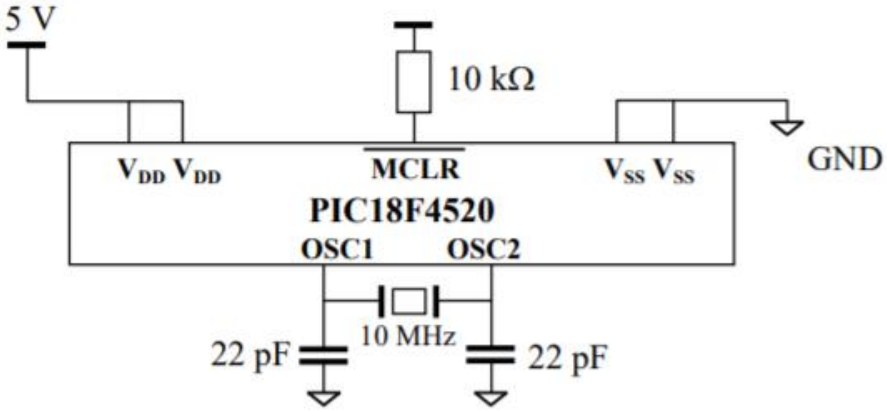
PIC 18F4520

PIC 18F4520 MODULE

CIRCUIT DIAGRAM 1:

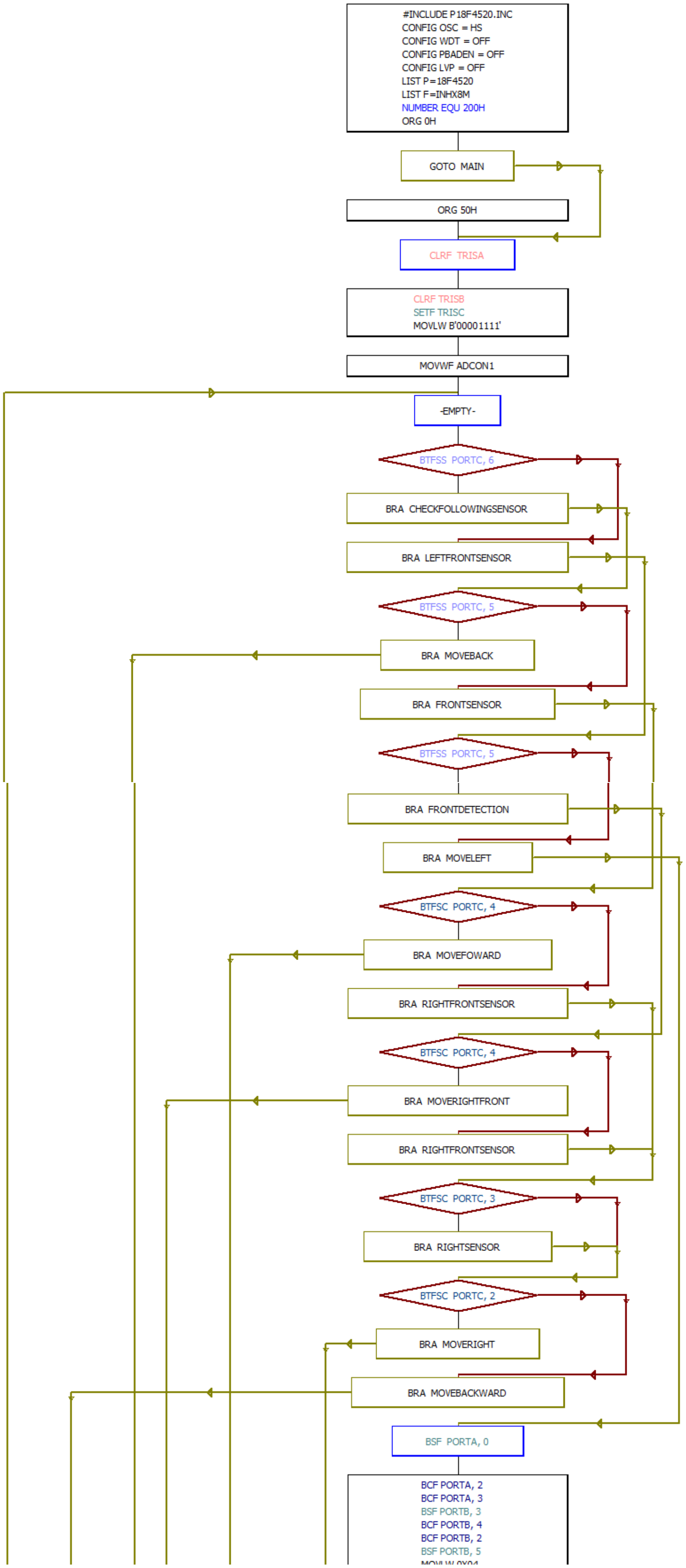


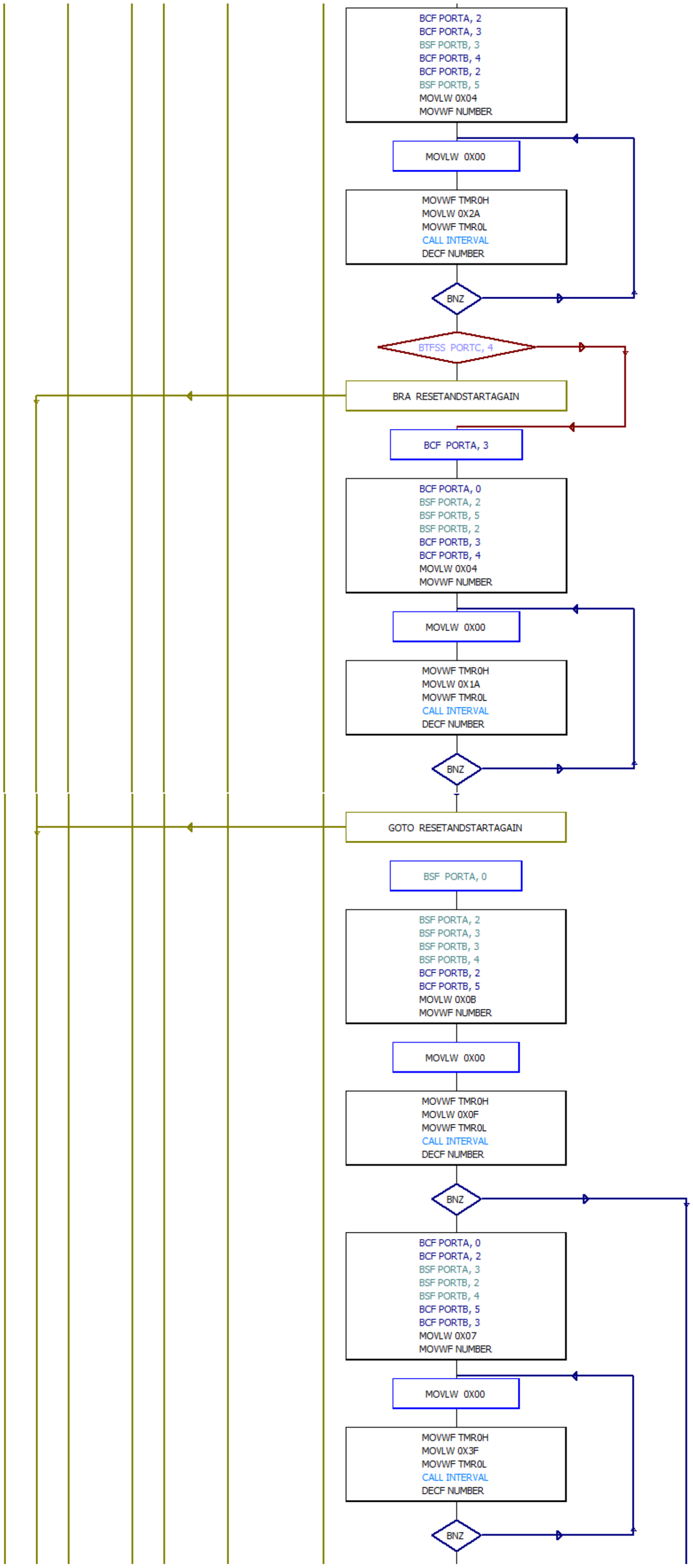
CIRCUIT DIAGRAM 2:



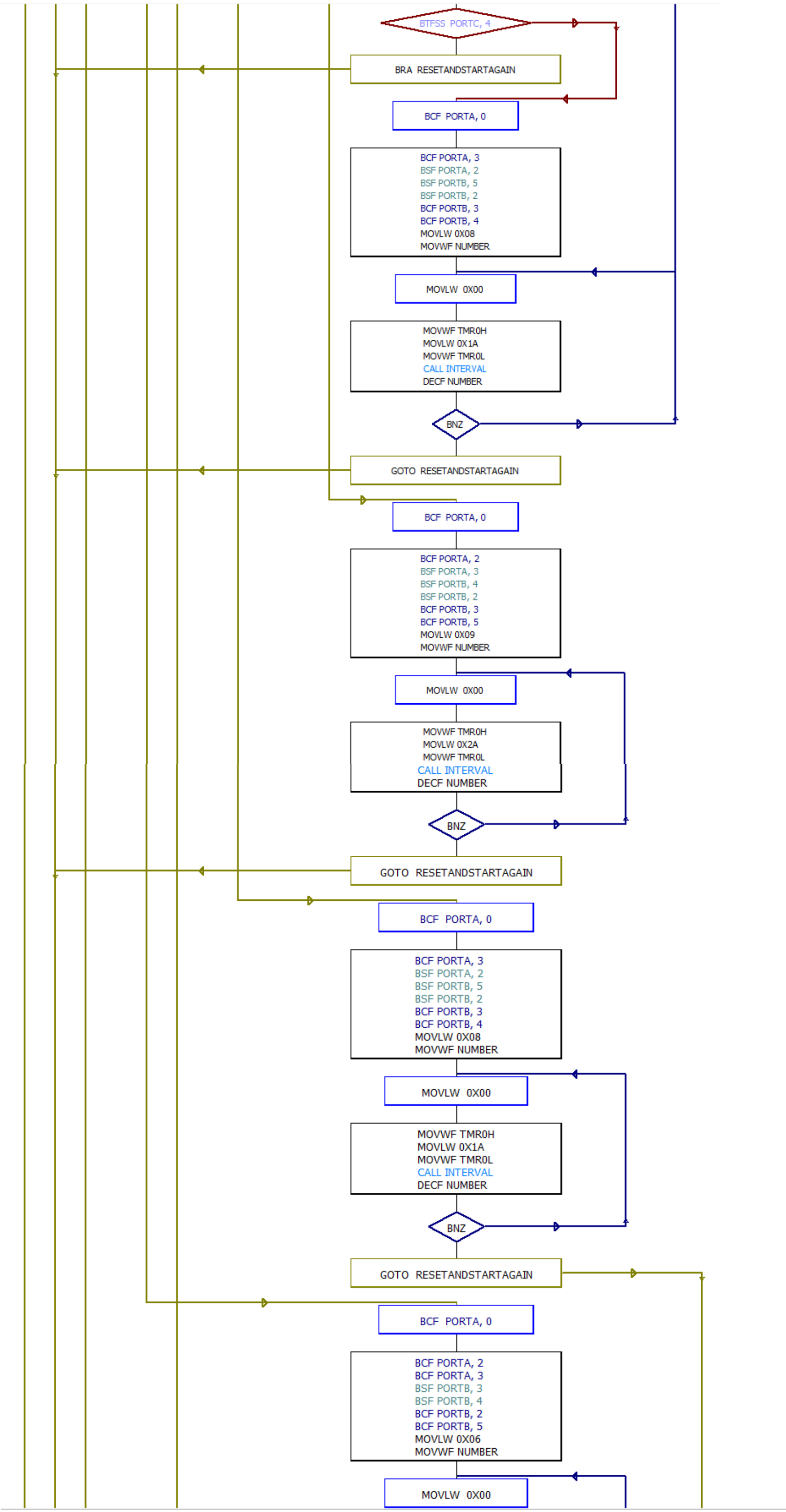
Take not that the PIC18F4520 module above has already pre-wired the set up as shown in the diagram above.

Flowchart Of Our Program

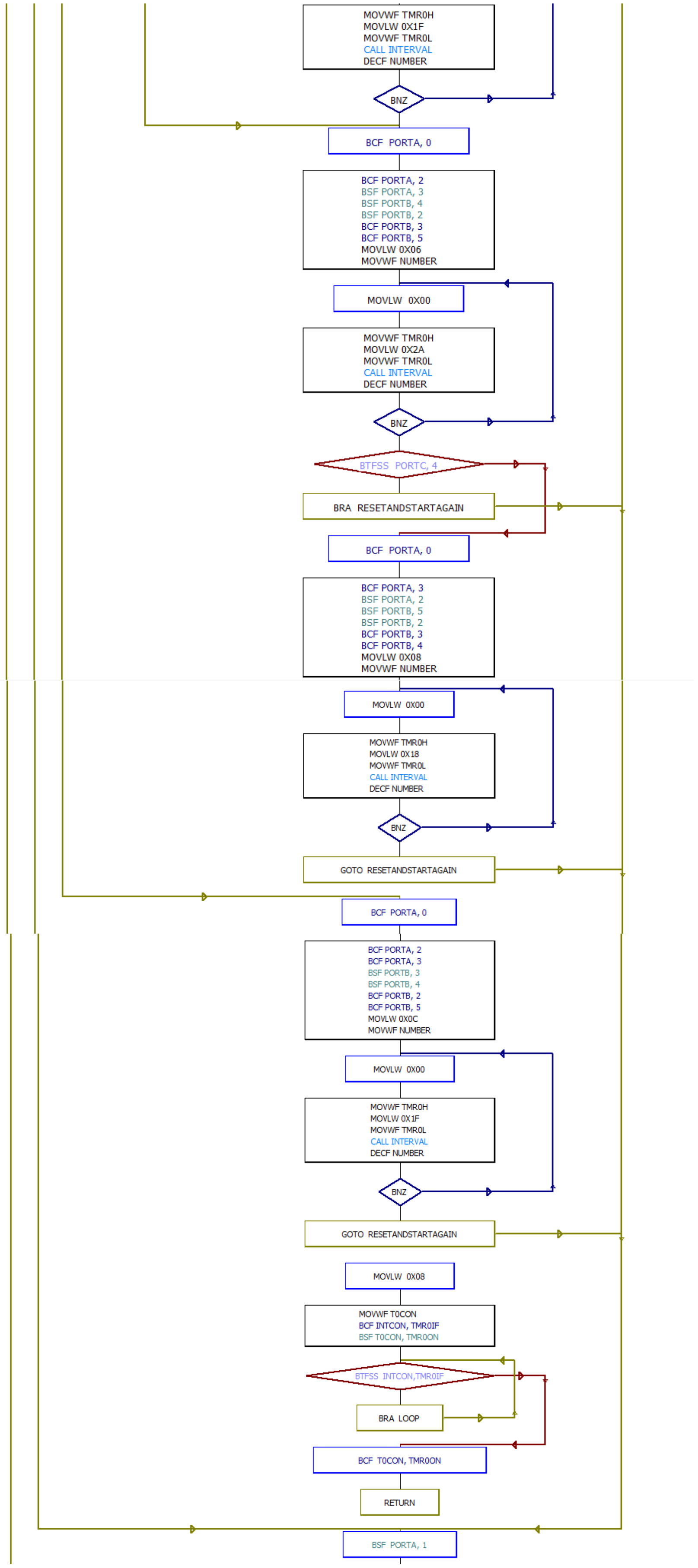




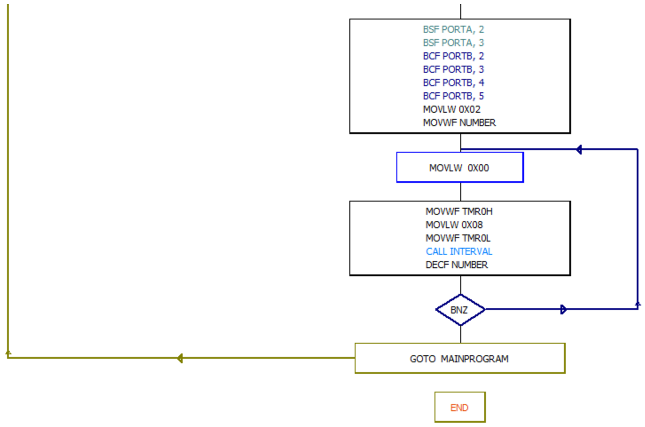
```
BCF PORTA, 2
BCF PORTA, 3
BSF PORTB, 3
BCF PORTB, 4
BCF PORTB, 2
BSF PORTB, 5
MOVLW 0X04
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X2A
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

BTFSS  PORTC, 4

BRA  RESETANDSTARTAGAIN

BCF  PORTA, 3

BCF PORTA, 0
BSF PORTA, 2
BSF PORTB, 5
BSF PORTB, 2
BCF PORTB, 3
BCF PORTB, 4
MOVLW 0X04
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X1A
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

GOTO  RESETANDSTARTAGAIN

BSF  PORTA, 0

BSF PORTA, 2
BSF PORTA, 3
BSF PORTB, 3
BSF PORTB, 4
BCF PORTB, 2
BCF PORTB, 5
MOVLW 0X0B
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X0F
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

BCF PORTA, 0
BCF PORTA, 2
BSF PORTA, 3
BSF PORTB, 2
BSF PORTB, 4
BCF PORTB, 5
BCF PORTB, 3
MOVLW 0X07
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X3F
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ
```



```
BTFSS PORTC, 4
BRA RESETANDSTARTAGAIN
BCF PORTA, 0
BCF PORTA, 3
BSF PORTA, 2
BSF PORTB, 5
BSF PORTB, 2
BCF PORTB, 3
BCF PORTB, 4
MOVLW 0X08
MOVWF NUMBER
MOVLW 0X00
MOVWF TMR0H
MOVLW 0X1A
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER
BNZ
GOTO RESETANDSTARTAGAIN
BCF PORTA, 0
BCF PORTA, 2
BSF PORTA, 3
BSF PORTB, 4
BSF PORTB, 2
BCF PORTB, 3
BCF PORTB, 5
MOVLW 0X09
MOVWF NUMBER
MOVLW 0X00
MOVWF TMR0H
MOVLW 0X2A
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER
BNZ
GOTO RESETANDSTARTAGAIN
BCF PORTA, 0
BCF PORTA, 3
BSF PORTA, 2
BSF PORTB, 5
BSF PORTB, 2
BCF PORTB, 3
BCF PORTB, 4
MOVLW 0X08
MOVWF NUMBER
MOVLW 0X00
MOVWF TMR0H
MOVLW 0X1A
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER
BNZ
GOTO RESETANDSTARTAGAIN
BCF PORTA, 0
BCF PORTA, 2
BCF PORTA, 3
BSF PORTB, 3
BSF PORTB, 4
BCF PORTB, 2
BCF PORTB, 5
MOVLW 0X06
MOVWF NUMBER
MOVLW 0X00
```

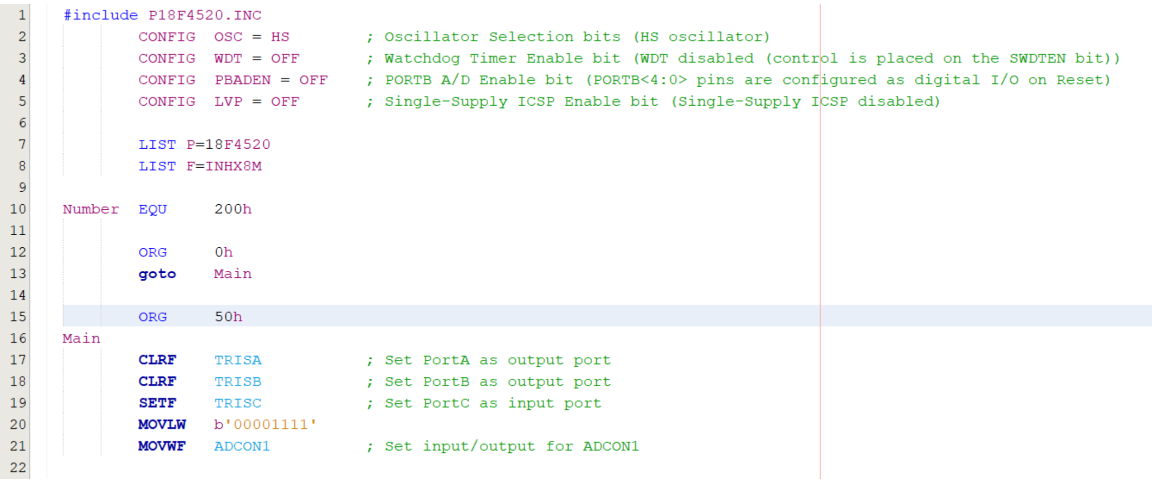


```
MOVWF TMR0H
MOVLW 0X1F
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

BCF  PORTA, 0

BCF PORTA, 2
BSF PORTA, 3
BSF PORTB, 4
BSF PORTB, 2
BCF PORTB, 3
BCF PORTB, 5
MOVLW 0X06
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X2A
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

BTFSS  PORTC, 4

BRA  RESETANDSTARTAGAIN

BCF  PORTA, 0

BCF PORTA, 3
BSF PORTA, 2
BSF PORTB, 5
BSF PORTB, 2
BCF PORTB, 3
BCF PORTB, 4
MOVLW 0X08
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X18
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

GOTO  RESETANDSTARTAGAIN

BCF  PORTA, 0

BCF PORTA, 2
BCF PORTA, 3
BSF PORTB, 3
BSF PORTB, 4
BCF PORTB, 2
BCF PORTB, 5
MOVLW 0X0C
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X1F
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

GOTO  RESETANDSTARTAGAIN

MOVLW  0X08

MOVWF T0CON
BCF INTCON, TMR0IF
BSF T0CON, TMR0ON

BTFSS  INTCON,TMR0IF

BRA  LOOP

BCF  T0CON, TMR0ON

RETURN

BSF  PORTA, 1
```



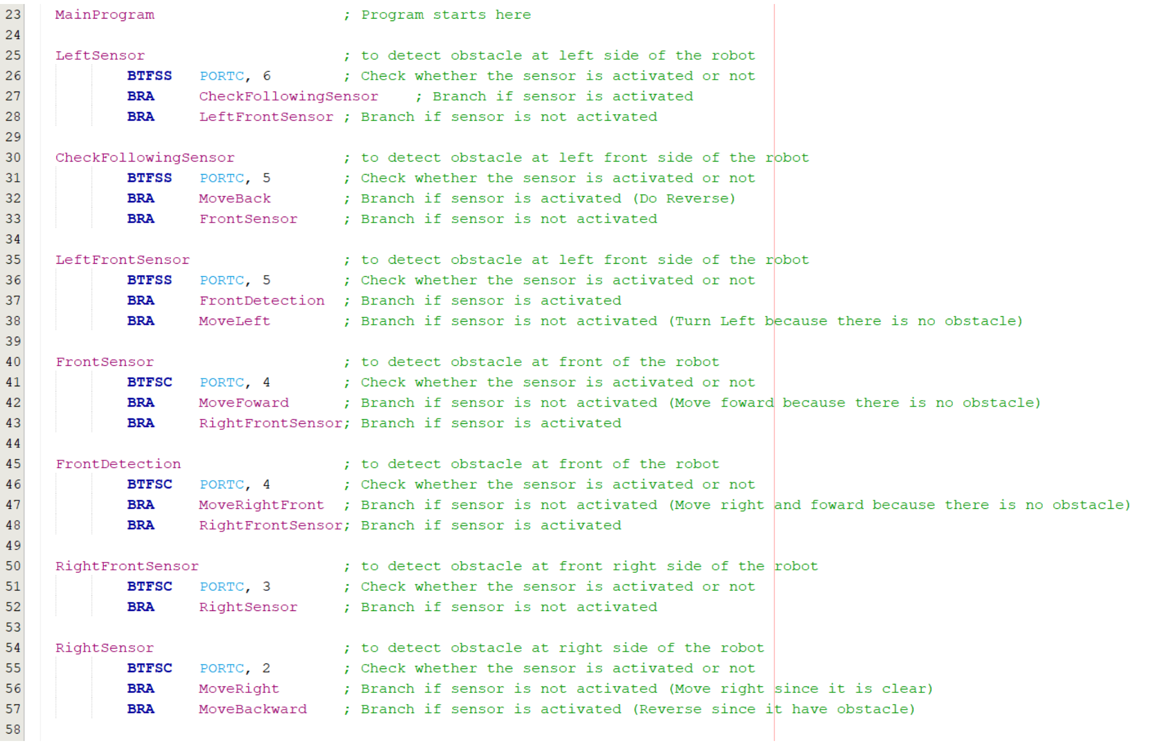
```
BSF PORTA, 2
BSF PORTA, 3
BCF PORTB, 2
BCF PORTB, 3
BCF PORTB, 4
BCF PORTB, 5
MOVLW 0X02
MOVWF NUMBER

MOVLW  0X00

MOVWF TMR0H
MOVLW 0X08
MOVWF TMR0L
CALL INTERVAL
DECF NUMBER

BNZ

GOTO  MAINPROGRAM

END
```

Explanation Of The Robot Assembly Code



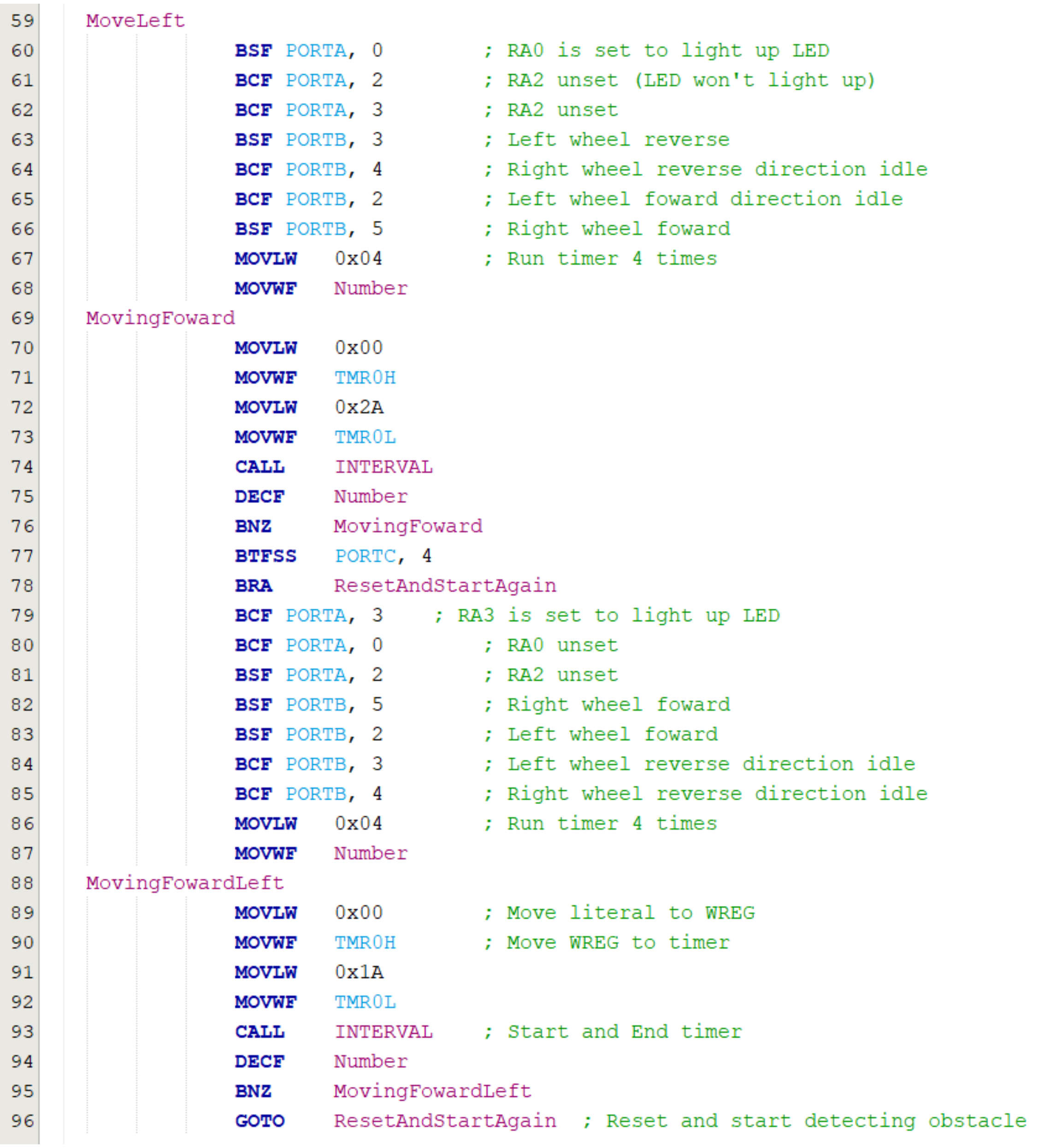
```
 1  #include P18F4520.INC
 2          CONFIG  OSC = HS        ; Oscillator Selection bits (HS oscillator)
 3          CONFIG  WDT = OFF       ; Watchdog Timer Enable bit (WDT disabled (control is placed on the SWDTEN bit))
 4          CONFIG  PBADEN = OFF    ; PORTB A/D Enable bit (PORTB<4:0> pins are configured as digital I/O on Reset)
 5          CONFIG  LVP = OFF       ; Single-Supply ICSP Enable bit (Single-Supply ICSP disabled)
 6
 7          LIST P=18F4520
 8          LIST F=INHX8M
 9
10  Number  EQU     200h
11
12          ORG     0h
13          goto    Main
14
15          ORG     50h
16  Main
17          CLRF    TRISA           ; Set PortA as output port
18          CLRF    TRISB           ; Set PortB as output port
19          SETF    TRISC           ; Set PortC as input port
20          MOVLW   b'00001111'
21          MOVWF   ADCON1          ; Set input/output for ADCON1
22
```

Line 1 to 8 is the code for PIC setting. Line 10 is to declare Number equals to 200 hex, which we will use it later. Line 12 to 15 is just to set the memory address location. The function Main is to declare input/output pin for various ports.



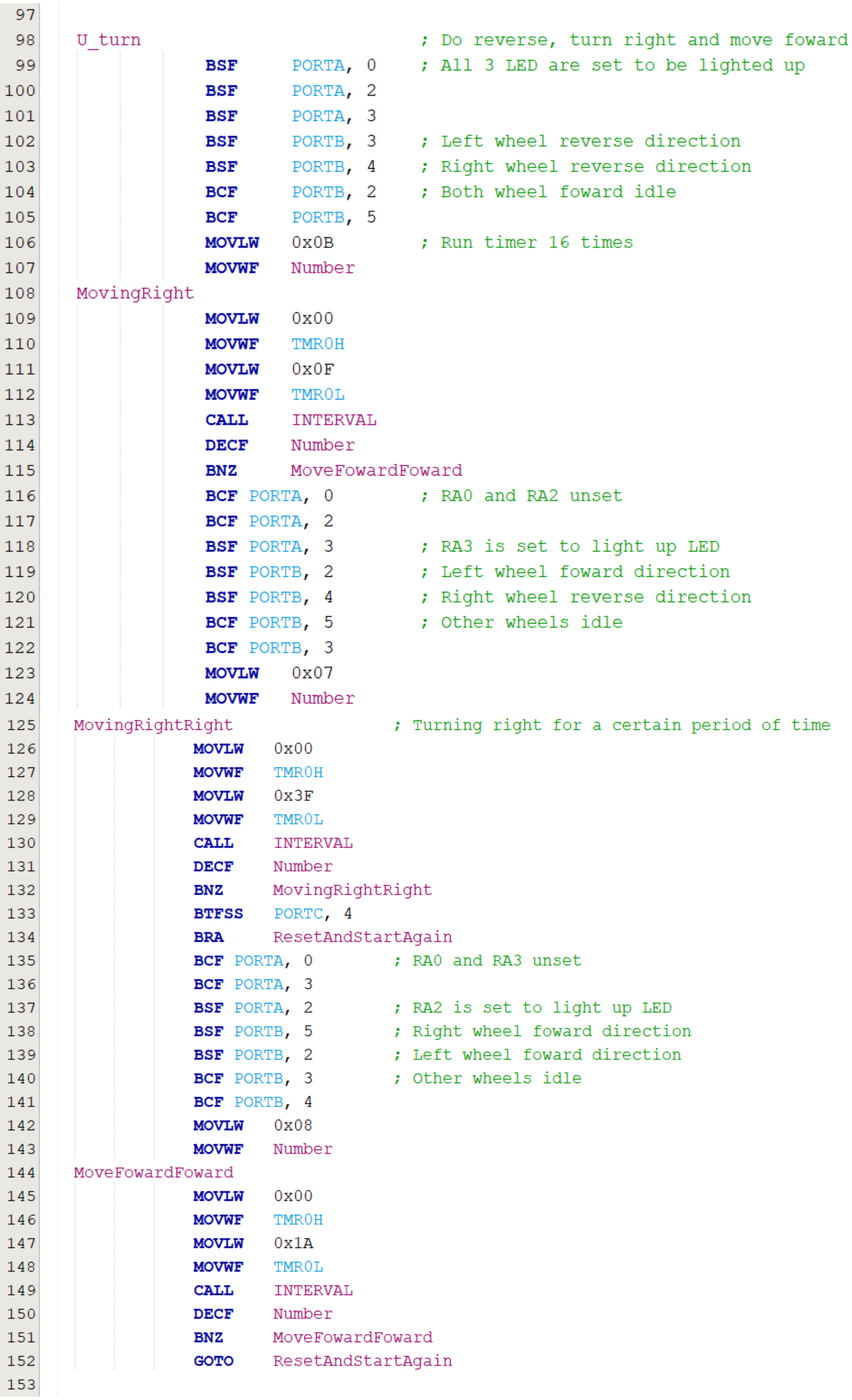
```
23  MainProgram                     ; Program starts here
24
25  LeftSensor                      ; to detect obstacle at left side of the robot
26          BTFSS   PORTC, 6        ; Check whether the sensor is activated or not
27          BRA     CheckFollowingSensor    ; Branch if sensor is activated
28          BRA     LeftFrontSensor ; Branch if sensor is not activated
29
30  CheckFollowingSensor            ; to detect obstacle at left front side of the robot
31          BTFSS   PORTC, 5        ; Check whether the sensor is activated or not
32          BRA     MoveBack        ; Branch if sensor is activated (Do Reverse)
33          BRA     FrontSensor     ; Branch if sensor is not activated
34
35  LeftFrontSensor                 ; to detect obstacle at left front side of the robot
36          BTFSS   PORTC, 5        ; Check whether the sensor is activated or not
37          BRA     FrontDetection  ; Branch if sensor is activated
38          BRA     MoveLeft        ; Branch if sensor is not activated (Turn Left because there is no obstacle)
39
40  FrontSensor                     ; to detect obstacle at front of the robot
41          BTFSC   PORTC, 4        ; Check whether the sensor is activated or not
42          BRA     MoveFoward      ; Branch if sensor is not activated (Move foward because there is no obstacle)
43          BRA     RightFrontSensor; Branch if sensor is activated
44
45  FrontDetection                  ; to detect obstacle at front of the robot
46          BTFSC   PORTC, 4        ; Check whether the sensor is activated or not
47          BRA     MoveRightFront  ; Branch if sensor is not activated (Move right and foward because there is no obstacle)
48          BRA     RightFrontSensor; Branch if sensor is activated
49
50  RightFrontSensor                ; to detect obstacle at front right side of the robot
51          BTFSC   PORTC, 3        ; Check whether the sensor is activated or not
52          BRA     RightSensor     ; Branch if sensor is not activated
53
54  RightSensor                     ; to detect obstacle at right side of the robot
55          BTFSC   PORTC, 2        ; Check whether the sensor is activated or not
56          BRA     MoveRight       ; Branch if sensor is not activated (Move right since it is clear)
57          BRA     MoveBackward    ; Branch if sensor is activated (Reverse since it have obstacle)
58
```

Starting from line 23 is where our robot programmed to run in the maze. Various sensor and how the robot should react is explained in the comment section of the code.



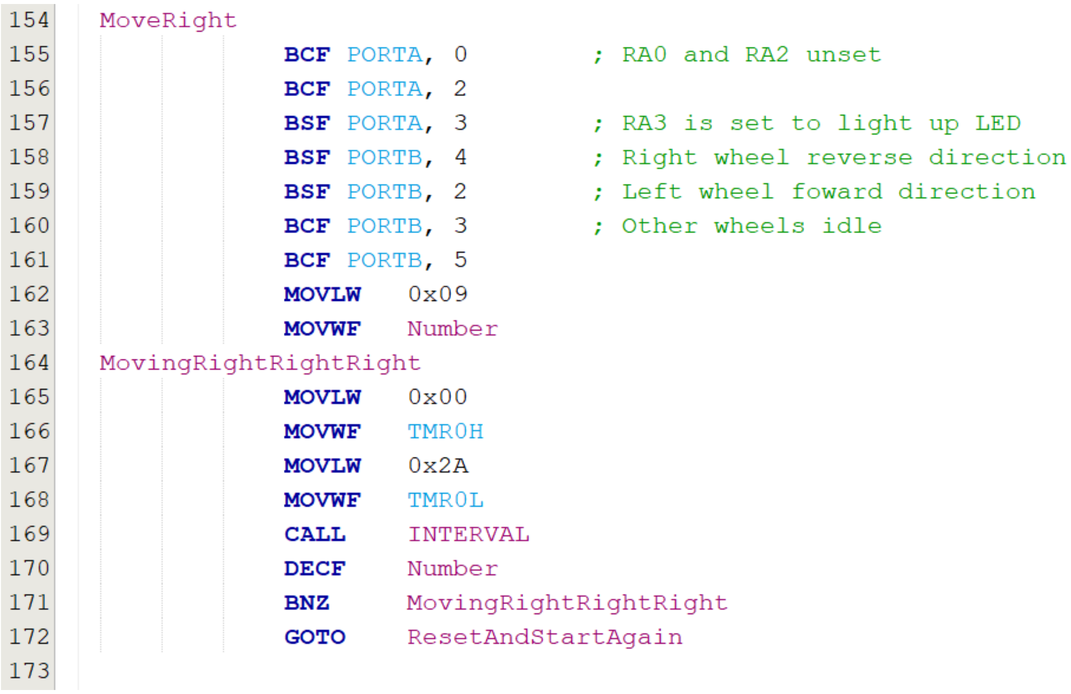
```
59  MoveLeft
60              BSF PORTA, 0        ; RA0 is set to light up LED
61              BCF PORTA, 2        ; RA2 unset (LED won't light up)
62              BCF PORTA, 3        ; RA2 unset
63              BSF PORTB, 3        ; Left wheel reverse
64              BCF PORTB, 4        ; Right wheel reverse direction idle
65              BCF PORTB, 2        ; Left wheel foward direction idle
66              BSF PORTB, 5        ; Right wheel foward
67              MOVLW   0x04        ; Run timer 4 times
68              MOVWF   Number
69  MovingFoward
70              MOVLW   0x00
71              MOVWF   TMR0H
72              MOVLW   0x2A
73              MOVWF   TMR0L
74              CALL    INTERVAL
75              DECF    Number
76              BNZ     MovingFoward
77              BTFSS   PORTC, 4
78              BRA     ResetAndStartAgain
79              BCF PORTA, 3    ; RA3 is set to light up LED
80              BCF PORTA, 0        ; RA0 unset
81              BSF PORTA, 2        ; RA2 unset
82              BSF PORTB, 5        ; Right wheel foward
83              BSF PORTB, 2        ; Left wheel foward
84              BCF PORTB, 3        ; Left wheel reverse direction idle
85              BCF PORTB, 4        ; Right wheel reverse direction idle
86              MOVLW   0x04        ; Run timer 4 times
87              MOVWF   Number
88  MovingFowardLeft
89              MOVLW   0x00        ; Move literal to WREG
90              MOVWF   TMR0H       ; Move WREG to timer
91              MOVLW   0x1A
92              MOVWF   TMR0L
93              CALL    INTERVAL    ; Start and End timer
94              DECF    Number
95              BNZ     MovingFowardLeft
96              GOTO    ResetAndStartAgain  ; Reset and start detecting obstacle
```

MoveLeft function at line 59 is to make the robot turn left when there is no obstacle at the left of the robot as called by LeftFrontSensor in line 35. After turning left, the function MovingFoward is to make the robot go forward. MovingFowardLeft function is just to delay the robot. After executing this whole branch, the robot will goto ResetAndStartAgain where it will go back to the MainProgram to sense obstacle again.



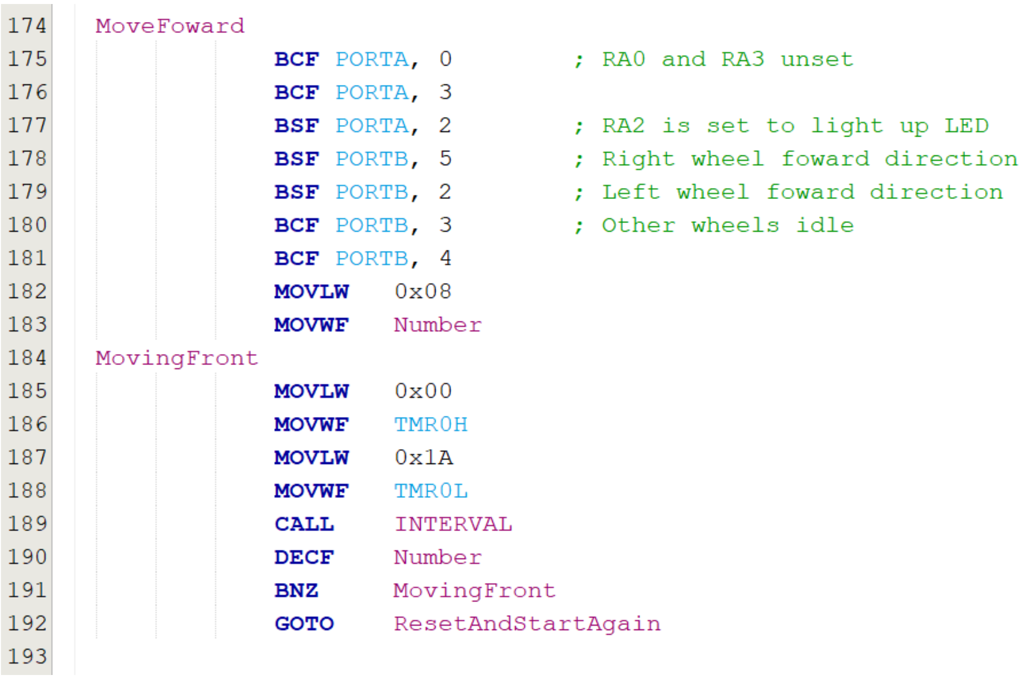
```
U_turn                          ; Do reverse, turn right and move foward
            BSF     PORTA, 0    ; All 3 LED are set to be lighted up
            BSF     PORTA, 2
            BSF     PORTA, 3
            BSF     PORTB, 3    ; Left wheel reverse direction
            BSF     PORTB, 4    ; Right wheel reverse direction
            BCF     PORTB, 2    ; Both wheel foward idle
            BCF     PORTB, 5
            MOVLW   0x0B        ; Run timer 16 times
            MOVWF   Number
MovingRight
            MOVLW   0x00
            MOVWF   TMR0H
            MOVLW   0x0F
            MOVWF   TMR0L
            CALL    INTERVAL
            DECF    Number
            BNZ     MoveFowardFoward
            BCF PORTA, 0        ; RA0 and RA2 unset
            BCF PORTA, 2
            BSF PORTA, 3        ; RA3 is set to light up LED
            BSF PORTB, 2        ; Left wheel foward direction
            BSF PORTB, 4        ; Right wheel reverse direction
            BCF PORTB, 5        ; Other wheels idle
            BCF PORTB, 3
            MOVLW   0x07
            MOVWF   Number
MovingRightRight                ; Turning right for a certain period of time
            MOVLW   0x00
            MOVWF   TMR0H
            MOVLW   0x3F
            MOVWF   TMR0L
            CALL    INTERVAL
            DECF    Number
            BNZ     MovingRightRight
            BTFSS   PORTC, 4
            BRA     ResetAndStartAgain
            BCF PORTA, 0        ; RA0 and RA3 unset
            BCF PORTA, 3
            BSF PORTA, 2        ; RA2 is set to light up LED
            BSF PORTB, 5        ; Right wheel foward direction
            BSF PORTB, 2        ; Left wheel foward direction
            BCF PORTB, 3        ; Other wheels idle
            BCF PORTB, 4
            MOVLW   0x08
            MOVWF   Number
MoveFowardFoward
            MOVLW   0x00
            MOVWF   TMR0H
            MOVLW   0x1A
            MOVWF   TMR0L
            CALL    INTERVAL
            DECF    Number
            BNZ     MoveFowardFoward
            GOTO    ResetAndStartAgain
```

The function U_Turn is executed when there is obstacle in all direction. The sequence of steps that will be performed are reverse, turn right, straight foward, then delay. Upon completion of steps, the program will goto ResetAndStartAgain where the robot will begin sensing and taking nessasary action again.



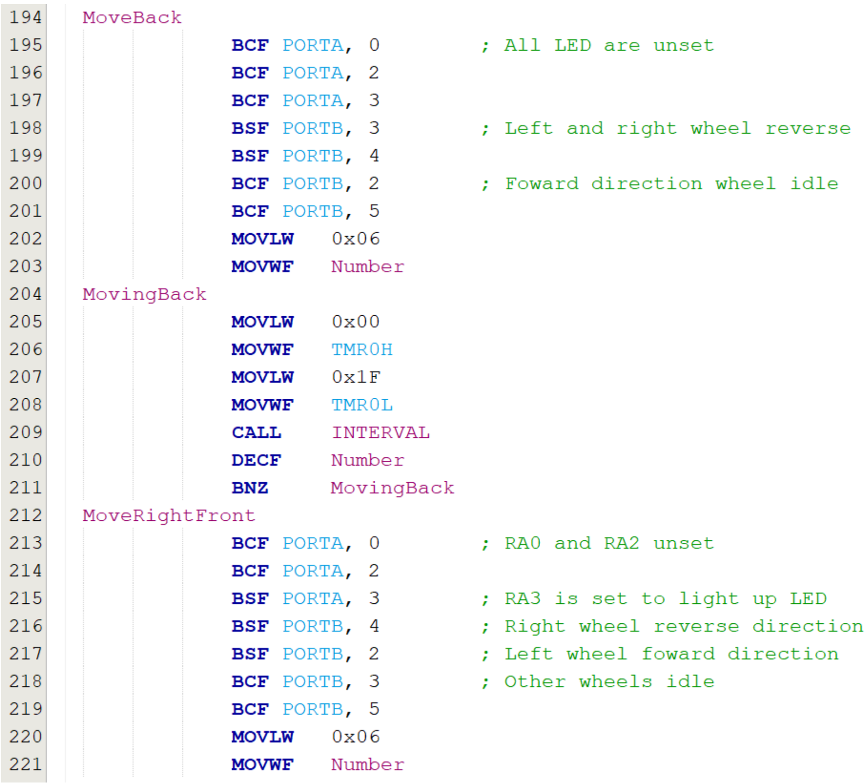
```
154 MoveRight
155             BCF PORTA, 0        ; RA0 and RA2 unset
156             BCF PORTA, 2
157             BSF PORTA, 3        ; RA3 is set to light up LED
158             BSF PORTB, 4        ; Right wheel reverse direction
159             BSF PORTB, 2        ; Left wheel foward direction
160             BCF PORTB, 3        ; Other wheels idle
161             BCF PORTB, 5
162             MOVLW   0x09
163             MOVWF   Number
164 MovingRightRightRight
165             MOVLW   0x00
166             MOVWF   TMR0H
167             MOVLW   0x2A
168             MOVWF   TMR0L
169             CALL    INTERVAL
170             DECF    Number
171             BNZ     MovingRightRightRight
172             GOTO    ResetAndStartAgain
173
```

The function MoveRight will be carried out upon branching from RightSensor at line 54. This function will only be executed when there is no obstacle at the right side of the robot. It performs right turn and then delay. Next, it will go to ResetAndStartAgain, same as previous function describe above.

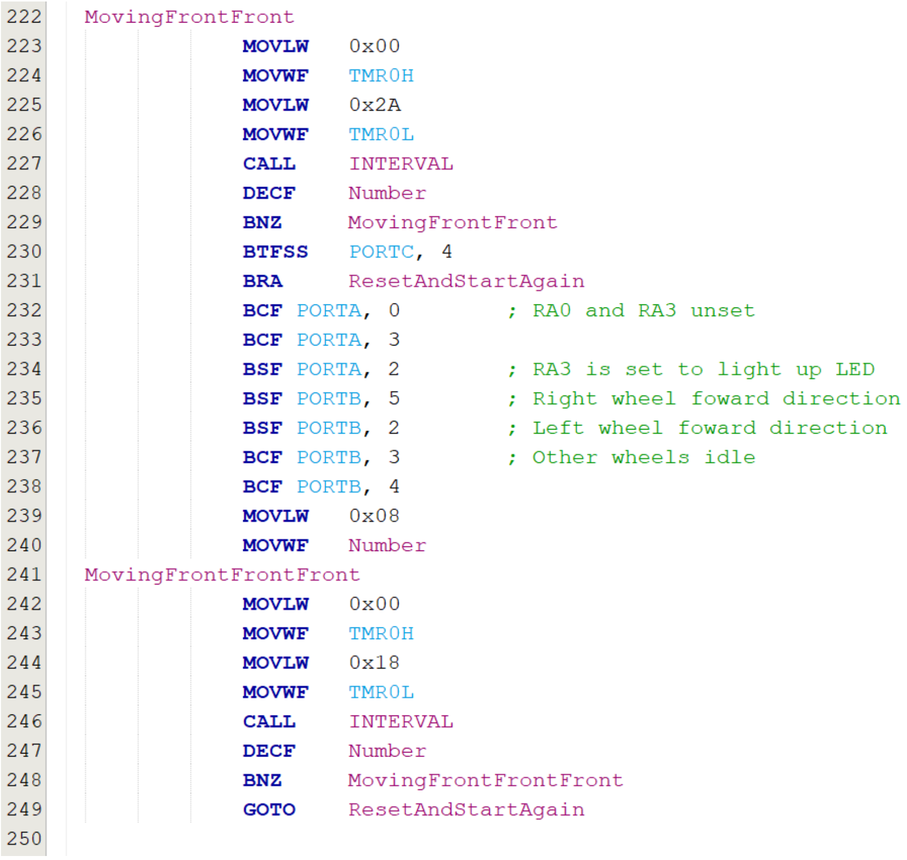


```
174 MoveFoward
175             BCF PORTA, 0        ; RA0 and RA3 unset
176             BCF PORTA, 3
177             BSF PORTA, 2        ; RA2 is set to light up LED
178             BSF PORTB, 5        ; Right wheel foward direction
179             BSF PORTB, 2        ; Left wheel foward direction
180             BCF PORTB, 3        ; Other wheels idle
181             BCF PORTB, 4
182             MOVLW   0x08
183             MOVWF   Number
184 MovingFront
185             MOVLW   0x00
186             MOVWF   TMR0H
187             MOVLW   0x1A
188             MOVWF   TMR0L
189             CALL    INTERVAL
190             DECF    Number
191             BNZ     MovingFront
192             GOTO    ResetAndStartAgain
193
```

This function MoveFoward is pretty straight forward. It just goes forward when there is nothing obstructing in its way as indicated in FrontSensor at line 40. After moving forward, it will delay for a while and then go to ResetAndStartAgain.

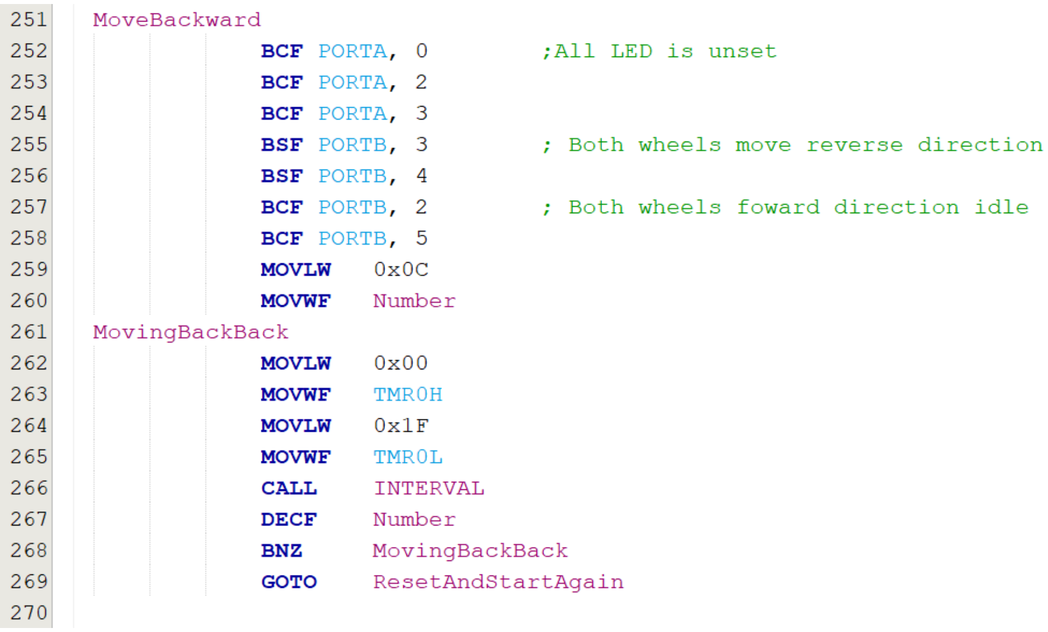


```
194  MoveBack
195              BCF PORTA, 0        ; All LED are unset
196              BCF PORTA, 2
197              BCF PORTA, 3
198              BSF PORTB, 3        ; Left and right wheel reverse
199              BSF PORTB, 4
200              BCF PORTB, 2        ; Foward direction wheel idle
201              BCF PORTB, 5
202              MOVLW   0x06
203              MOVWF   Number
204  MovingBack
205              MOVLW   0x00
206              MOVWF   TMR0H
207              MOVLW   0x1F
208              MOVWF   TMR0L
209              CALL    INTERVAL
210              DECF    Number
211              BNZ     MovingBack
212  MoveRightFront
213              BCF PORTA, 0        ; RA0 and RA2 unset
214              BCF PORTA, 2
215              BSF PORTA, 3        ; RA3 is set to light up LED
216              BSF PORTB, 4        ; Right wheel reverse direction
217              BSF PORTB, 2        ; Left wheel foward direction
218              BCF PORTB, 3        ; Other wheels idle
219              BCF PORTB, 5
220              MOVLW   0x06
221              MOVWF   Number
```



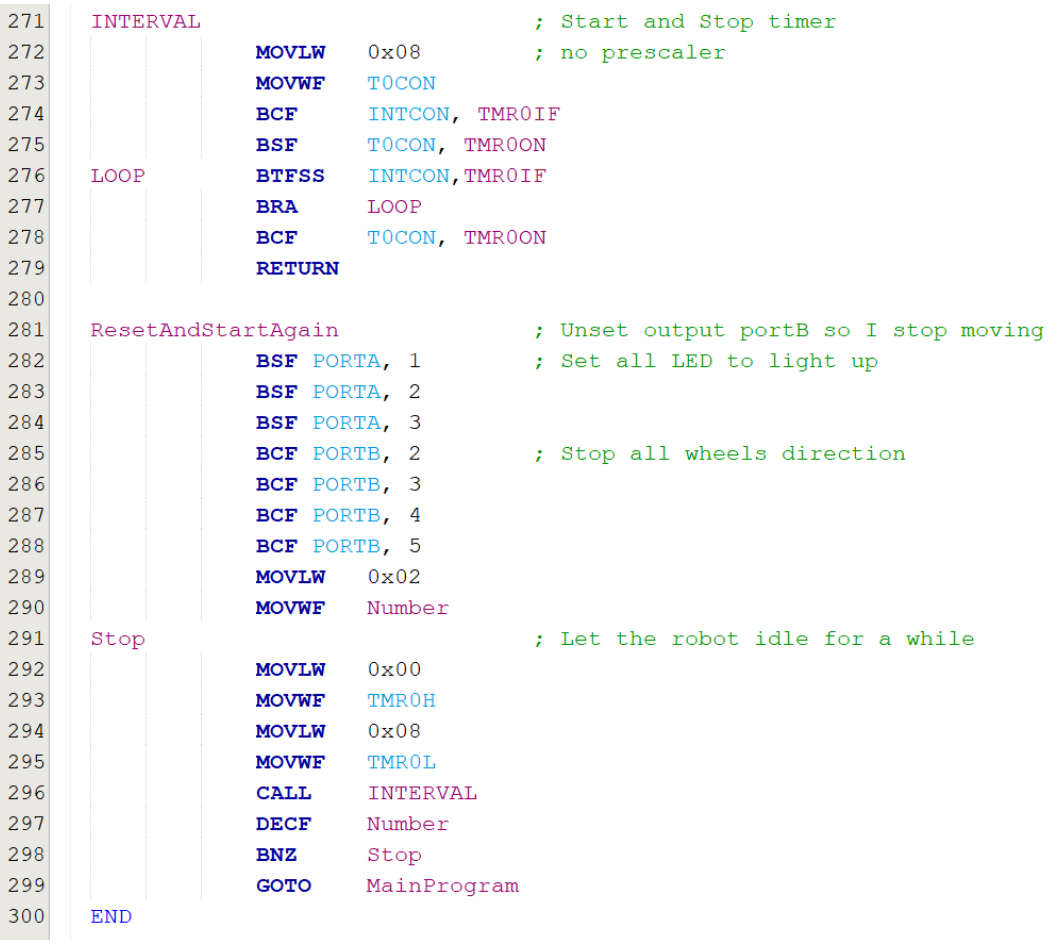
```
222  MovingFrontFront
223              MOVLW   0x00
224              MOVWF   TMR0H
225              MOVLW   0x2A
226              MOVWF   TMR0L
227              CALL    INTERVAL
228              DECF    Number
229              BNZ     MovingFrontFront
230              BTFSS   PORTC, 4
231              BRA     ResetAndStartAgain
232              BCF PORTA, 0        ; RA0 and RA3 unset
233              BCF PORTA, 3
234              BSF PORTA, 2        ; RA3 is set to light up LED
235              BSF PORTB, 5        ; Right wheel foward direction
236              BSF PORTB, 2        ; Left wheel foward direction
237              BCF PORTB, 3        ; Other wheels idle
238              BCF PORTB, 4
239              MOVLW   0x08
240              MOVWF   Number
241  MovingFrontFrontFront
242              MOVLW   0x00
243              MOVWF   TMR0H
244              MOVLW   0x18
245              MOVWF   TMR0L
246              CALL    INTERVAL
247              DECF    Number
248              BNZ     MovingFrontFrontFront
249              GOTO    ResetAndStartAgain
250
```

Line 194 to 249 is for function MoveBack. It does reversing, stop, turn right, turn left, and stop, sequentially. After that, the program will go to ResetAndStartAgain.



```
MoveBackward
                BCF PORTA, 0          ;All LED is unset
                BCF PORTA, 2
                BCF PORTA, 3
                BSF PORTB, 3          ; Both wheels move reverse direction
                BSF PORTB, 4
                BCF PORTB, 2          ; Both wheels foward direction idle
                BCF PORTB, 5
                MOVLW   0x0C
                MOVWF   Number
MovingBackBack
                MOVLW   0x00
                MOVWF   TMR0H
                MOVLW   0x1F
                MOVWF   TMR0L
                CALL    INTERVAL
                DECF    Number
                BNZ     MovingBackBack
                GOTO    ResetAndStartAgain

```

The MoveBackward function is same as above MoveBack except that it only does reverse only, followed by delay and ResetAndStartAgain.



```
INTERVAL                              ; Start and Stop timer
                MOVLW   0x08          ; no prescaler
                MOVWF   T0CON
                BCF     INTCON, TMR0IF
                BSF     T0CON, TMR0ON
LOOP            BTFSS   INTCON,TMR0IF
                BRA     LOOP
                BCF     T0CON, TMR0ON
                RETURN

ResetAndStartAgain                    ; Unset output portB so I stop moving
                BSF PORTA, 1          ; Set all LED to light up
                BSF PORTA, 2
                BSF PORTA, 3
                BCF PORTB, 2          ; Stop all wheels direction
                BCF PORTB, 3
                BCF PORTB, 4
                BCF PORTB, 5
                MOVLW   0x02
                MOVWF   Number
Stop                                  ; Let the robot idle for a while
                MOVLW   0x00
                MOVWF   TMR0H
                MOVLW   0x08
                MOVWF   TMR0L
                CALL    INTERVAL
                DECF    Number
                BNZ     Stop
                GOTO    MainProgram
END
```

Appeared in many times in the function previously described, INTERVAL is to delay the robot program execution time so it doesn’t take action too fast and hitting the maze. ResetAndStartAgain is to reset and stop the robot’s wheel direction, and go back to the MainProgram where it does sensing and react again.

Complete Assembly Code With Comment

```
#include P18F4520.INC
        CONFIG  OSC = HS      ; Oscillator Selection bits (HS oscillator)
        CONFIG  WDT = OFF ; Watchdog Timer Enable bit (WDT disabled (control is placed on
the SWDTEN bit))
        CONFIG  PBADEN = OFF        ;  PORTB  A/D  Enable  bit  (PORTB<4:0>  pins  are
configured as digital I/O on Reset)
        CONFIG  LVP = OFF   ; Single-Supply ICSP Enable bit (Single-Supply ICSP disabled)

        LIST P=18F4520
        LIST F=INHX8M

NumberEQU     200h

        ORG     0h
        goto    Main

        ORG     50h
Main
        CLRF    TRISA               ; Set PortA as output port
        CLRF    TRISB               ; Set PortB as output port
        SETF    TRISC               ; Set PortC as input port
        MOVLW           b'00001111'
        MOVWF           ADCON1                  ; Set input/output for ADCON1

MainProgram                         ; Program starts here

LeftSensor                          ; to detect obstacle at left side of the robot
     BTFSS   PORTC, 6 ; Check whether the sensor is activated or not
     BRA     CheckFollowingSensor        ; Branch if sensor is activated
     BRA     LeftFrontSensor       ; Branch if sensor is not activated

CheckFollowingSensor                ; to detect obstacle at left front side of the robot
     BTFSS   PORTC, 5              ; Check whether the sensor is activated or not
     BRA     MoveBack  ; Branch if sensor is activated (Do Reverse)
     BRA     FrontSensor           ; Branch if sensor is not activated

LeftFrontSensor                     ; to detect obstacle at left front side of the robot
     BTFSS        PORTC, 5         ; Check whether the sensor is activated or not
     BRA     FrontDetection        ; Branch if sensor is activated
     BRA     MoveLeft    ; Branch if sensor is not activated (Turn Left because there is no obstacle)

FrontSensor                         ; to detect obstacle at front of the robot
     BTFSC        PORTC, 4         ; Check whether the sensor is activated or not
     BRA     MoveFoward            ; Branch if sensor is not activated (Move foward because there is
no obstacle)
     BRA     RightFrontSensor; Branch if sensor is activated

FrontDetection                      ; to detect obstacle at front of the robot
     BTFSC        PORTC, 4         ; Check whether the sensor is activated or not
     BRA     MoveRightFront        ; Branch if sensor is not activated (Move right and foward because
there is no obstacle)
     BRA     RightFrontSensor; Branch if sensor is activated

RightFrontSensor                    ; to detect obstacle at front right side of the robot
     BTFSC        PORTC, 3         ; Check whether the sensor is activated or not
```

```
    BRA     RightSensor           ; Branch if sensor is not activated

RightSensor                       ; to detect obstacle at right side of the robot
    BTFSC      PORTC, 2           ; Check whether the sensor is activated or not
    BRA     MoveRight ; Branch if sensor is not activated (Move right since it is clear)
    BRA     MoveBackward          ; Branch if sensor is activated (Reverse since it have obstacle)

MoveLeft
        BSF PORTA, 0   ; RA0 is set to light up LED
        BCF       PORTA, 2        ; RA2 unset (LED won't light up)
        BCF       PORTA, 3        ; RA2 unset
        BSF       PORTB, 3        ; Left wheel reverse
        BCF       PORTB, 4        ; Right wheel reverse direction idle
        BCF       PORTB, 2        ; Left wheel foward direction idle
        BSF       PORTB, 5        ; Right wheel foward
        MOVLW   0x04  ; Run timer 4 times
        MOVWF   Number
MovingFoward
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x2A
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ          MovingFoward
        BTFSS   PORTC, 4
            BRA       ResetAndStartAgain
            BCF PORTA, 3    ; RA3 is set to light up LED
        BCF       PORTA, 0        ; RA0 unset
        BSF       PORTA, 2        ; RA2 unset
        BSF       PORTB, 5        ; Right wheel foward
        BSF       PORTB, 2        ; Left wheel foward
        BCF       PORTB, 3        ; Left wheel reverse direction idle
        BCF       PORTB, 4        ; Right wheel reverse direction idle
        MOVLW   0x04  ; Run timer 4 times
        MOVWF   Number
MovingFowardLeft
        MOVLW   0x00  ; Move literal to WREG
        MOVWF   TMR0H             ; Move WREG to timer
        MOVLW   0x1A
        MOVWF   TMR0L
        CALL    INTERVAL          ; Start and End timer
        DECF    Number
        BNZ          MovingFowardLeft
        GOTO    ResetAndStartAgain      ; Reset and start detecting obstacle

U_turn                            ; Do reverse, turn right and move foward
        BSF     PORTA, 0    ; All 3 LED are set to be lighted up
        BSF     PORTA, 2
        BSF     PORTA, 3
        BSF     PORTB, 3    ; Left wheel reverse direction
        BSF     PORTB, 4    ; Right wheel reverse direction
        BCF      PORTB, 2         ; Both wheel foward idle
        BCF          PORTB, 5
        MOVLW   0x0B        ; Run timer 16 times
        MOVWF   Number
```

```
MovingRight
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x0F
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MoveFowardFoward
        BCF PORTA, 0  ; RA0 and RA2 unset
        BCF     PORTA, 2
        BSF     PORTA, 3        ; RA3 is set to light up LED
        BSF     PORTB, 2        ; Left wheel foward direction
        BSF     PORTB, 4        ; Right wheel reverse direction
        BCF     PORTB, 5        ; Other wheels idle
        BCF     PORTB, 3
        MOVLW   0x07
        MOVWF   Number
MovingRightRight                ; Turning right for a certain period of time
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x3F
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MovingRightRight
        BTFSS   PORTC, 4
           BRA      ResetAndStartAgain
           BCF PORTA, 0         ; RA0 and RA3 unset
        BCF     PORTA, 3
        BSF     PORTA, 2        ; RA2 is set to light up LED
        BSF     PORTB, 5        ; Right wheel foward direction
        BSF     PORTB, 2        ; Left wheel foward direction
        BCF     PORTB, 3        ; Other wheels idle
        BCF     PORTB, 4
        MOVLW   0x08
        MOVWF   Number
MoveFowardFoward
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x1A
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MoveFowardFoward
        GOTO    ResetAndStartAgain

MoveRight
        BCF PORTA, 0  ; RA0 and RA2 unset
        BCF     PORTA, 2
        BSF     PORTA, 3        ; RA3 is set to light up LED
        BSF     PORTB, 4        ; Right wheel reverse direction
        BSF     PORTB, 2        ; Left wheel foward direction
        BCF     PORTB, 3        ; Other wheels idle
           BCF  PORTB, 5
        MOVLW   0x09
        MOVWF   Number
```

```
MovingRightRightRight
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x2A
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MovingRightRightRight
        GOTO    ResetAndStartAgain

MoveFoward
        BCF PORTA, 0  ; RA0 and RA3 unset
        BCF      PORTA, 3
        BSF      PORTA, 2        ; RA2 is set to light up LED
        BSF      PORTB, 5        ; Right wheel foward direction
        BSF      PORTB, 2        ; Left wheel foward direction
        BCF      PORTB, 3        ; Other wheels idle
        BCF      PORTB, 4
        MOVLW   0x08
        MOVWF   Number
MovingFront
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x1A
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MovingFront
        GOTO    ResetAndStartAgain

MoveBack
        BCF      PORTA, 0        ; All LED are unset
        BCF      PORTA, 2
        BCF      PORTA, 3
        BSF      PORTB, 3        ; Left and right wheel reverse
        BSF      PORTB, 4
        BCF      PORTB, 2        ; Foward direction wheel idle
        BCF      PORTB, 5
        MOVLW   0x06
        MOVWF   Number
MovingBack
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x1F
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MovingBack
MoveRightFront
        BCF PORTA, 0  ; RA0 and RA2 unset
        BCF      PORTA, 2
        BSF      PORTA, 3        ; RA3 is set to light up LED
        BSF      PORTB, 4        ; Right wheel reverse direction
        BSF      PORTB, 2        ; Left wheel foward direction
        BCF      PORTB, 3        ; Other wheels idle
           BCF   PORTB, 5
        MOVLW   0x06
        MOVWF   Number
MovingFrontFront
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x2A
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MovingFrontFront
        BTFSS   PORTC, 4
           BRA      ResetAndStartAgain
           BCF PORTA, 0          ; RA0 and RA3 unset
        BCF      PORTA, 3
        BSF      PORTA, 2        ; RA3 is set to light up LED
        BSF      PORTB, 5        ; Right wheel foward direction
        BSF      PORTB, 2        ; Left wheel foward direction
        BCF      PORTB, 3        ; Other wheels idle
        BCF      PORTB, 4
        MOVLW   0x08
        MOVWF   Number
MovingFrontFrontFront
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x18
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MovingFrontFrontFront
        GOTO    ResetAndStartAgain

MoveBackward
        BCF      PORTA, 0        ;All LED is unset
        BCF      PORTA, 2
        BCF      PORTA, 3
        BSF      PORTB, 3        ; Both wheels move reverse direction
        BSF      PORTB, 4
        BCF      PORTB, 2        ; Both wheels foward direction idle
        BCF      PORTB, 5
        MOVLW   0x0C
        MOVWF   Number
MovingBackBack
        MOVLW   0x00
        MOVWF   TMR0H
        MOVLW   0x1F
        MOVWF   TMR0L
        CALL    INTERVAL
        DECF    Number
        BNZ         MovingBackBack
        GOTO    ResetAndStartAgain

INTERVAL                         ; Start and Stop timer
        MOVLW   0x08  ; no prescaler
        MOVWF   T0CON
        BCF         INTCON, TMR0IF
        BSF         T0CON, TMR0ON
```

```
LOOP        BTFSS   INTCON,TMR0IF
            BRA          LOOP
            BCF          T0CON, TMR0ON
            RETURN

ResetAndStartAgain                  ; Unset output portB so I stop moving
            BSF       PORTA, 1          ; Set all LED to light up
            BSF       PORTA, 2
            BSF       PORTA, 3
            BCF       PORTB, 2          ; Stop all wheels direction
            BCF       PORTB, 3
            BCF       PORTB, 4
            BCF       PORTB, 5
            MOVLW   0x02
            MOVWF   Number
Stop                                    ; Let the robot idle for a while
            MOVLW   0x00
            MOVWF   TMR0H
            MOVLW   0x08
            MOVWF   TMR0L
            CALL    INTERVAL
            DECF    Number
            BNZ          Stop
            GOTO    MainProgram
END
```