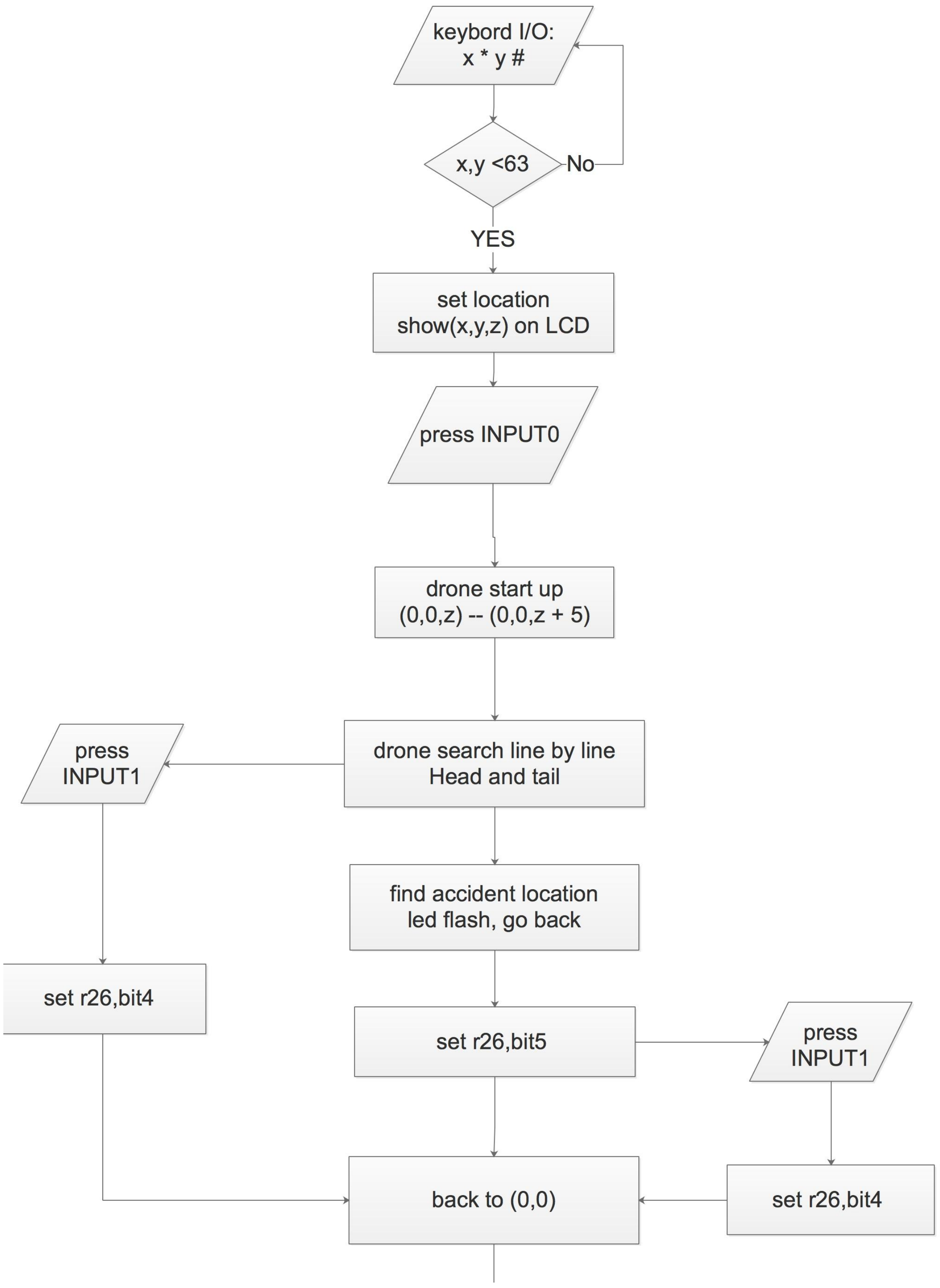
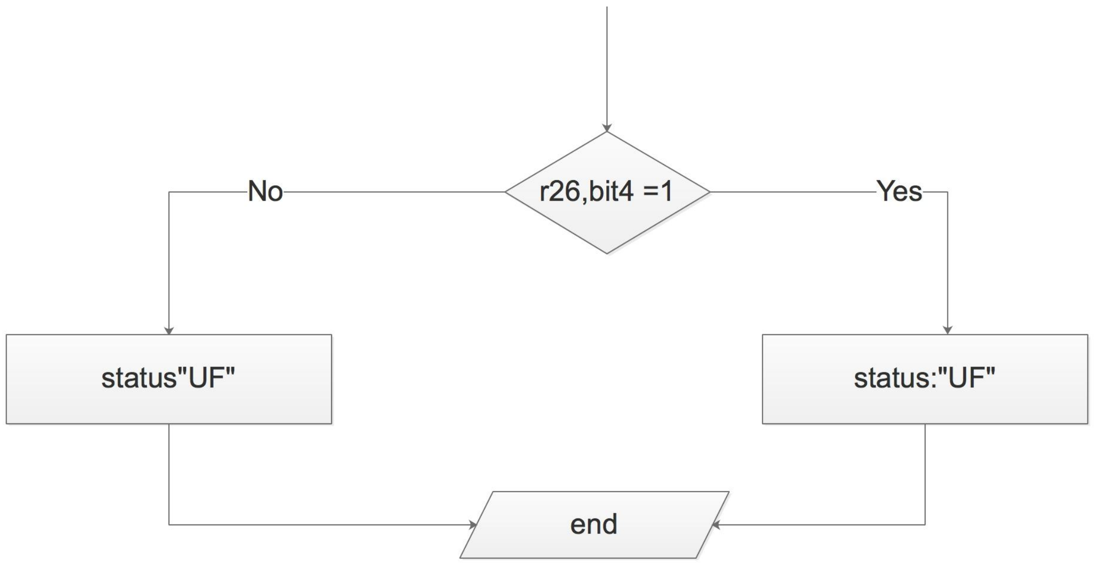
Design manual

1.flow diagram





2.Data structures and algorithms

2.1 Map:

Dixing.txt

2.2 algorithms

2.2.1 keyboard and lcd

Input x,y location,seperate by “ * ”,end by “ # ”

```
main:
        sbrc r26,0
        rjmp inbutton
        ldi cmask,INITCOLMASK //colmask from left
        clr col  //row from 0
        rjmp colloop

colloop:
        cpi col,4  //all nor pressed back
        breq main
        out PORTC,cmask  //scan column
        ldi temp1,0xFF

delay:
        dec temp1 //slow down scan colum
        brne delay

        in temp1,PINC   //read portF
        andi temp1,ROWMASK //get value from cureet colum
        cpi temp1,0xF
        breq nextcol //no 0(pressed) scan next colum

        ldi rmask,INITROWMASK //rowmask from 0001
        clr row //from 0
```

```
rowloop:
        cpi row,4 //row scan over
        breq nextcol
        mov temp2,temp1
        and temp2,rmask //get (colum,row) pressed or not
        breq continue //0 to get number
        inc row
        lsl rmask //0001 -- 0010 -- 0100 -- 1000
        jmp rowloop

nextcol:  //row scan over
        lsl cmask
        inc col // column +1
        jmp colloop
```

Check if the button is still pressed ,not get the number(keep read PINC)

```
continue:
        in temp1,PINC  //read portC
        andi temp1,ROWMASK //get value from cureet colum
        cpi temp1,0xF
        breq convert //loose button then display it
        rjmp continue

convert:
        cpi col,3 //co3 has A,B,C,D
        breq letters
        cpi row,3
        breq symbols //row3 0,*,#
        mov temp1,row // or 1-9
        lsl temp1 //row *3 + col
        add temp1,row
        add temp1,col
        subi temp1,-1
        ldi r16,'0'
        add r16,temp1
        rcall lcd_data
        rcall lcd_wait
        rjmp convert_end

letters:
        jmp wrong

symbols:
        cpi col,0
        breq star //*
        cpi col,1
        breq zero //0
        ldi r19,63
        cp r19,r27
        brlo wrong
        ldi r19,0b00000001
        or r26,r19
        rjmp playxyz

star://*
        mov r28,r27 //1st num to r28
        ldi r27,0 //r27 clear
        ldi r19,0b00000010
        //or r26,r19
        do_lcd_command 0b11000000
        do_lcd_data'Y'
        do_lcd_data':'
        rjmp main
```

```
zero:
       ldi temp1,0
       ldi r16,'0'
       add r16,temp1
       rcall lcd_data
       rcall lcd_wait
convert_end:
       ldi r16,10
       mul r27,r16
       mov r27,r0
       add r27,temp1
       ldi r19,63
       cp r19,r27
       brlo wrong
       rjmp main
```

If x/y > 63 ,show”Wrong” on lcd

```
wrong:
       do_lcd_command 0b00000001
       do_lcd_data'w'
       do_lcd_data'r'
       do_lcd_data'o'
       do_lcd_data'n'
       do_lcd_data'g'
       ldi r19,0
```

If right,Put x in r28,y in r27

Accoding to x,y read z from map(in .cseg Table)

Put point Z in first address on Table

R31:r30 + 64*y + x == adress of z (height)

Set r26,bit0 (if bit0 != 1 input0 interrupt hauence)

To get each bit of x/y,sub 10 first add count to one register till x/y no longer > 10.put count as 10s,left x/y as 1s.

Show x,y,z on lcd;save x,y on 2 register

```
playxyz:
       mov r2,r28
       mov r3,r27
       ldi ZH, high(table<<1) ; initialize Z
       ldi ZL, low(table<<1)
       ldi r19,64
       mul r27,r19
       mov r16,r0
       mov r17,r1
       add r16,r28
       ldi r19,0
       adc r17,r19
       clc
       add r30,r16
       adc r31,r19
       clc
       add r31,r17
       lpm r17, Z
       do_lcd_command 0b00000001
       do_lcd_data'('
       ldi r16,10
       ldi r18,0
       mov r19,r28
       cp r28,r16
       brsh sub10
       ldi r16,'0'
       add r16,r19
       rcall lcd_data
       rcall lcd_wait
       rjmp disy
sub10:
        sub r19,r16
        inc r18
        cp r19,r16
        brsh sub10
        ldi r16,'0'
        add r16,r18
        rcall lcd_data
        rcall lcd_wait
        ldi r16,'0'
        add r16,r19
        rcall lcd_data
        rcall lcd_wait
disy:
       do_lcd_data','
       ldi r16,10
       ldi r18,0
       mov r19,r27
       cp r27,r16
       brsh sub10_y
       ldi r16,'0'
       add r16,r19
       rcall lcd_data
       rcall lcd_wait
       rjmp dis_z
sub10_y:
        sub r19,r16
        inc r18
        cp r19,r16
        brsh sub10_y
        ldi r16,'0'
        add r16,r18
        rcall lcd_data
        rcall lcd_wait
        ldi r16,'0'
        add r16,r19
        rcall lcd_data
        rcall lcd_wait
dis_z:
       do_lcd_data','
       ldi r16,10
       ldi r18,0
       mov r19,r17
       cp r17,r16
       brsh sub10_z
       ldi r16,'0'
       add r16,r19
       rcall lcd_data
       rcall lcd_wait
       do_lcd_data')'
       ldi r19,0b10000000
       or r17,r19
       st Z,r17
       lpm r17,Z
       sbrc r17,7
       do_lcd_data' '
       rjmp showstatus
sub10_z:
        sub r19,r16
        inc r18
        cp r19,r16
        brsh sub10_z
        ldi r16,'0'
        add r16,r18
        rcall lcd_data
        rcall lcd_wait
        ldi r16,'0'
        add r16,r19
        rcall lcd_data
        rcall lcd_wait
        do_lcd_data')'
        ldi r19,0b10000000
        or r17,r19
         st Z,r17
        lpm r17,Z
```

After set x,y ,play status--unbegin

```
showstatus:
       ldi ZH, high(table<<1) ; initialize Z
       ldi ZL, low(table<<1)
       ldi r19,64
       mul r27,r19
       mov r16,r0
       mov r17,r1
       add r16,r28
       ldi r19,0
       adc r17,r19
       clc
       add r30,r16
       adc r31,r19
       clc
       add r31,r17
       lpm r17, Z
       do_lcd_command 0b11000000

       do_lcd_data's'
       do_lcd_data't'
       do_lcd_data'a'
       do_lcd_data't'
       do_lcd_data'u'
       do_lcd_data's'
       do_lcd_data':'
       do_lcd_data'U'
       do_lcd_data'B'
```

Set External interrupt: Input0 for beginning

If x,y not set,r26 bit0 == 0.,reti return from interrupt

```
.org INT0addr
       jmp Ext_int0
Ext_int0:
       sbrs r26,0
       reti
```

```
        sbrc r26,1
        reti
        push temp1 //save register
        in temp1,SREG //save SREG
        push temp1
        //out PortC,output //display pattern now
        pop temp1
        out SREG,temp1
        pop temp1
        ldi temp1,0b00001111
        sts PORTL,temp1
```

after start,let led flash for a few seconds,If press button,show status:BE

```
delay1s_1:
        rcall sleep_1ms
        rcall sleep_1ms
        rcall sleep_1ms
        ldi r18,1
        add r19,r18
        ldi r18,255
        cp r18,r19
        brne delay1s_1
        ldi temp1,0b11110000
        sts PORTL,temp1
delay1s_2:
        rcall sleep_1ms
        rcall sleep_1ms
        rcall sleep_1ms
        ldi r18,1
        add r19,r18
        ldi r18,255
        cp r18,r19
        brne delay1s_2
        ldi temp1,0b11111111
        sts PORTL,temp1
delay1s_3:
        rcall sleep_1ms
        rcall sleep_1ms
        rcall sleep_1ms
        ldi r18,1
        add r19,r18
        ldi r18,255
        cp r18,r19
        brne delay1s_3
        ldi temp1,0b00000000
        sts PORTL,temp1
        do_lcd_command 0b11000000
        do_lcd_data's'
        do_lcd_data't'
        do_lcd_data'a'
        do_lcd_data't'
        do_lcd_data'u'
        do_lcd_data's'
        do_lcd_data':'
        do_lcd_data'B'
        do_lcd_data'E'
```

set r26,bit1

```
        ldi temp1,0b00000010
        or r26,temp1
        reti
```

if not set wait till set;if set .

begin drone up till its 5 meters high than z(read z from Table)

Start motor (set(speed 0xFF))

```
 inbutton:
       sbrs r26,1
       rjmp inbutton
       ldi r17,0
       ldi r21,0
       ldi ZH, high(table<<1) ; initialize Z
       ldi ZL, low(table<<1)
       lpm r22,Z
       do_lcd_command 0b11000000
       do_lcd_data's'
       do_lcd_data't'
       do_lcd_data'a'
       do_lcd_data't'
       do_lcd_data'u'
       do_lcd_data's'
       do_lcd_data':'
       do_lcd_data'U'
       do_lcd_data'p'
```

Start motor (set(speed 0xFF))

```
       ldi r16,0xFF
       sts OCR3BL,r16
       ldi r16,10
       ldi r18,0
       mov r19,r22
startup:
       ldi r16,10
       cp r22,r16
       brsh sub10_zu
       rjmp upz
sub10_zu:
        sub r19,r16
        inc r18
        cp r19,r16
        brsh sub10_zu
        ldi r20,0
upz:
       do_lcd_command 0b10000000
       do_lcd_data'('
       do_lcd_data'0'
       do_lcd_data','
       do_lcd_data'0'
       do_lcd_data')'
       do_lcd_data' '

       inc r20
       inc r19
       ldi r16,0
       adc r18,r16
       clc
       ldi r16,'0'
       add r16,r18
       rcall lcd_data
       rcall lcd_wait
       ldi r16,'0'
       add r16,r19
```

```
        rcall lcd_data
        rcall lcd_wait
        ldi r16,0
        rcall delay1s_0
        ldi r16,5
        cp r20,r16
        brne upz
```

Set Motor

First set motor

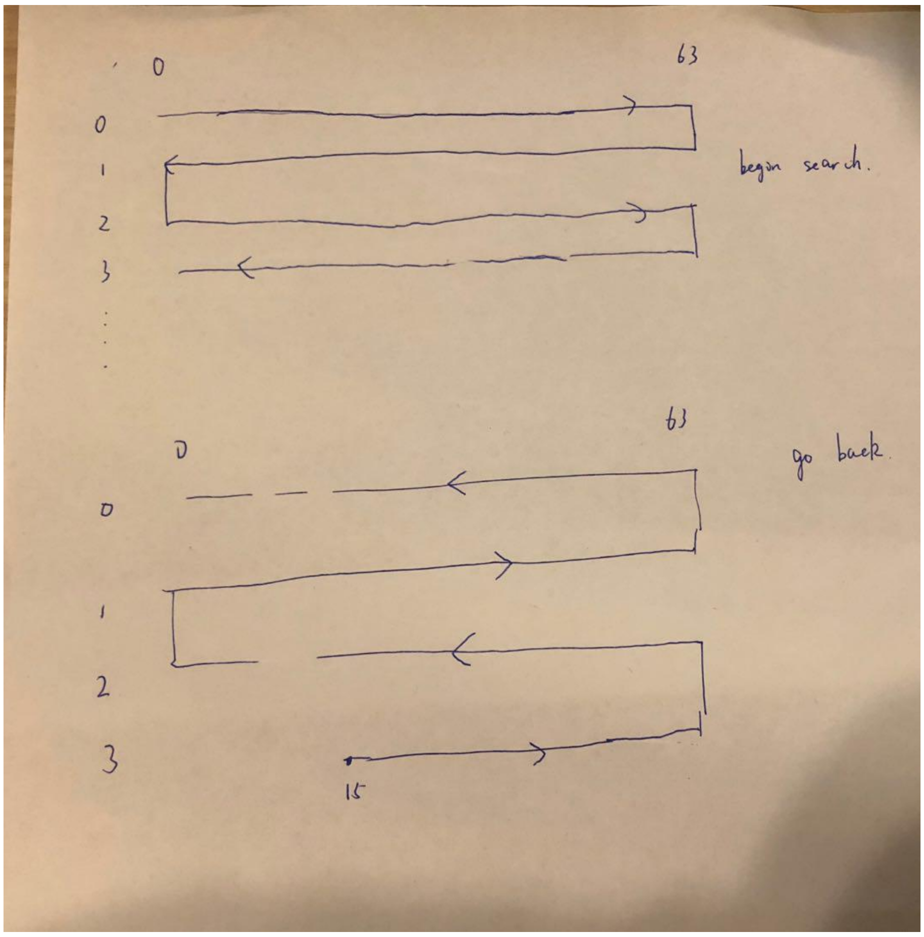
PORT E PE2 MOTOR MOT -- set one –

Set OC3A as output

Set the Timer3 operation mode as Phase Correct PWM mode

```
        in r16,DDRE
        ori r16,0b00010000
        out DDRE,r16
        clr r16
        sts OCR3BH,r16
        ldi r16,0
        sts OCR3BL,r16
        ldi r16,(1<<CS30)
        sts TCCR3B,r16
        ldi r16,(1<<WGM30)|(1<<COM3B1)
```

Search



```
If location is found set r26,bit 5
If line is even(0,2,4 ......) set r26,bit6
In searching:(r26,bit 5 == 0)
        Even line:
                If  x < 63,x + 1,r31:r30 += 1
                If x == 63,y +1;
                        R31:r30 += 64;clr r26,bit6;
                        andi r26,0b10111111
        Odd line:
                If  x < 63,x -  1,r31:r30 -= 1
                If x == 63,y +1;
                        R31:r30 += 64;set r26,bit6;
                        ori r26,0b01000000

In back(reserve)(r26,bit 5 == 1)
        odd line:
                If  x < 63,x + 1,r31:r30 += 1
                If x == 63,y -1;
                        Check if y == 0:
                                Show loction/(0,0,0) -- get status
                        If y!= 0:
                                R31:r30 -= 64;clr r26,bit6;
                                ori r26,0b01000000
        even line:
                If  x < 63,x -  1,r31:r30 -= 1
                If x == 63,y - 1;
                        R31:r30 += 64;set r26,bit6;
                        andi r26,0b10111111

If  x == r2,y == r3:
        Motor set speed 0fx1F
        Mov z into r4
        set r26,bit 5
        Show (x,y,z),led flash for a few seconds
        Motor set speed 0fx1F
         set r26,bit6 go back
```

```
startsea:
	do_lcd_command 0b11000000
	do_lcd_data's'
	do_lcd_data't'
	do_lcd_data'a'
	do_lcd_data't'
	do_lcd_data'u'
	do_lcd_data's'
	do_lcd_data':'
	do_lcd_data'S'
	do_lcd_data'E'
	ldi r16,0b01000000
	or r26,r16
	ldi r23,0
	ldi ZH, high(table<<1) ; initialize Z
	ldi ZL, low(table<<1)
	ldi r17,0
	ldi r21,0
comp:
	ldi r16,0
delay1s_5:
	rcall sleep_1ms
```

```
       ldi r19,1
       add r16,r19
       ldi r19,100
       cp r19,r16
       brne delay1s_5
       mov r19,r17
       do_lcd_command 0b10000000
       do_lcd_data'('
       mov r19,r17
       rcall getnum
       mov r17,r19
       do_lcd_data','
       mov r19,r21
       rcall getnum
       mov r21,r19
       do_lcd_data')'
       do_lcd_data' '
       lpm r22,Z
       ldi r16,5
       add r22,r16
       mov r19,r22
       rcall getnum
       do_lcd_data' '
       mov r22,r19

       sbrc r26,5
       rjmp back
       sbrc r26,4
       rjmp back
       cp r2,r17
       breq cpb
       rjmp oe
cpb:
       cp r3,r21
       breq found
       rjmp oe
found:
       ldi r27,0x1F
       sts OCR3BL,r27
       mov r4,r22
       do_lcd_command 0b11000000
       do_lcd_data's'
       do_lcd_data't'
       do_lcd_data'a'
       do_lcd_data't'
       do_lcd_data'u'
       do_lcd_data's'
       do_lcd_data':'
       do_lcd_data'F'
       do_lcd_data'O'
       ldi temp1,0b11111111
       sts PORTL,temp1
       ldi r16,0
       rcall delay1s_0
       ldi temp1,0b00000000
       sts PORTL,temp1
       ldi r16,0
       rcall delay1s_0
       ldi temp1,0b11111111
       sts PORTL,temp1
       ldi r16,0
       rcall delay1s_0
       ldi temp1,0b00000000
       sts PORTL,temp1
       rcall delay1s_0
```

```
        ldi temp1,0b11111111
        sts PORTL,temp1
        ldi r16,0
        rcall delay1s_0
        ldi temp1,0b00000000
        sts PORTL,temp1
        ldi r16,0
        rcall delay1s_0
        ldi r16,0b00100000
        or r26,r16
        ldi r27,0xFF
        sts OCR3BL,r27`
        rjmp comp

back:
        sbrc r26,6
        rjmp odd0

        ldi r16,63
        cp r17,r16
        breq set63
        inc r17
        ldi r16,1
        add r30,r16
        ldi r16,0
        adc r31,r16
        clc
        rjmp comp
set63:
        ldi r17,63
        dec r21
        ldi r16,64
        sub r30,r16
        ldi r16,0
        sbc r31,r16
        clc
        ldi r16,0b01000000
        or r26,r16
        rjmp comp

dee:
        ldi r16,0
        cp r21,r16
        breq endi
        dec r21
        ldi r16,64
        sub r30,r16
        ldi r16,0
        sbc r31,r16
        clc
        andi r26,0b10111111
        rjmp comp

endi:
        sbrs r26,5
        rjmp unfound
delay1s_8:
        //show number(x,y,z)
        rcall sleep_1ms
        ldi r19,1
        add r16,r19
        ldi r19,100
        cp r19,r16
        brne delay1s_8
        mov r19,r17
```

```
       do_lcd_command 0b10000000
       do_lcd_data'('
       mov r19,r2
       rcall getnum
       do_lcd_data','
       mov r19,r3
       rcall getnum
       do_lcd_data','
       mov r19,r4
       ldi r16,5
       sub r19,r16
       rcall getnum
       do_lcd_data')'
       do_lcd_data' '

eddd:
       ldi temp1,0x00
       sts OCR3BL,temp1`
       rjmp eddd
odd0:
       ldi r16,0
       cp r17,r16
       breq dee
       dec r17
       ldi r16,1
       sub r30,r16
       ldi r16,0
       sbc r31,r16
       clc
       rjmp comp

oe:
       sbrc r26,6
       rjmp odd
       ldi r16,0
       cp r17,r16
       breq pl11
       dec r17
       ldi r16,1
       sub r30,r16
       ldi r16,0
       sbc r31,r16
       clc
       rjmp comp

pl11:
       ldi r17,0
       inc r21
       ldi r16,64
       add r30,r16
       ldi r16,0
       adc r31,r16
       clc
       ldi r23,0
       ldi r16,0b01000000
       or r26,r16
       do_lcd_data' '
       rjmp comp
odd:
       ldi r16,63
       cp r17,r16
       breq mul64
       inc r17
       ldi r16,1
       add r30,r16
       ldi r16,0
       adc r31,r16
       clc
       do_lcd_data' '
       rjmp comp

mul64:

       ldi r16,64
       add r30,r16
       ldi r16,0
       adc r31,r16
       clc
       inc r21
       andi r26,0b10111111
       do_lcd_data' '
       rjmp comp

getnum:
       ldi r18,0
       ldi r16,10
       cp r19,r16
       brsh sub10_num
       ldi r16,'0'
       add r16,r19
       rcall lcd_data
       rcall lcd_wait
       ret
sub10_num:
        sub r19,r16
        inc r18
        cp r19,r16
        brsh sub10_num
        ldi r16,'0'
        add r16,r18
        rcall lcd_data
        rcall lcd_wait
        ldi r16,'0'
        add r16,r19
        rcall lcd_data
        rcall lcd_wait
        ldi r16,10
       mul r18,r16
       mov r18,r0
       add r19,r18
        ret


end:
       ldi temp1,0x00
       sts OCR3BL,temp1`
       rjmp end
```

External interrupt:INPUT1 -- abort button

Set r26,bit4 go back

If bit0/ 1 is clr(not set x,y /not begin),go back ,external interrupt doesn’t work

```
.org INT1addr
       jmp EXT_INT1
EXT_INT1:
       sbrs r26,0
       reti
       sbrs r26,1
```

```
        reti
        push temp1 //save register
        in temp1,SREG //save SREG
        push temp1
        //out PortC,output //display pattern now
        pop temp1
        out SREG,temp1
        pop temp1
        do_lcd_command 0b11000000
        sbrs r26,5
        do_lcd_command 0b000000010
        do_lcd_data'S'
        do_lcd_data'T'
        do_lcd_data' '
        do_lcd_data' '
        do_lcd_data' '
        do_lcd_data' '
        do_lcd_data' '
        do_lcd_data' '
        do_lcd_data' '
        do_lcd_data' '
        sbrs r26,5
        do_lcd_data'N'
        do_lcd_data'F'
        ldi r16,0b00010000
        or r26,r16
        rjmp comp
```

External interrupt:INPUT1 -- abort button

Set r26,bit4 go back

If bit0/ 1 is clr(not set x,y /not begin),go back ,external interrupt doesn’t work

After go back to (0,0)

```
    Check if r26,bit4 set
    Set(interrupt INPUT1):
        If set r26,bit 5(FOund):
            Show(x,y,z) and “ST        F”(stop found)
        If clr r26,bit 5(unfound):
            (0,0,0) and(“AB  NF”)abort,not found
    Clr( no interrupt INPUT1):
        Show(x,y,z) and “FO”(found)
```

Set motor speed 0x00

```
unfound:
        do_lcd_command 0b11000000
        do_lcd_data's'
        do_lcd_data't'
        do_lcd_data'a'
        do_lcd_data't'
        do_lcd_data'u'
        do_lcd_data's'
        do_lcd_data':'
        do_lcd_data'U'
        do_lcd_data'F'
        do_lcd_command 0b10000000
        do_lcd_data'('
        do_lcd_data'0'
        do_lcd_data','
        do_lcd_data'0'
        do_lcd_data','
        do_lcd_data'0'
        do_lcd_data')'
        do_lcd_data'A'
        do_lcd_data'b'
        do_lcd_data' '
        rjmp end
```

```
......
```

Save map:

```
table:.db
10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,10,
10,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,20,10,10,10,10,10,10,10,10,10,10,10,10,10,10,
10,10,10,15,15,15,15,15,15,15,15,15,15,15,15,15,15,10,10,10,10,10,10,10,10,10,10,10,10,10,10,
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