

ECE 376 - Homework #5

Keypads in C, Stepper Motors in C, NeoPixels in C.

Design an embedded system which uses the keypad, stepper motor, and NeoPixel.

Stepper Motors: Combination Lock

1) Requirements:

Inputs:

- Keypad

Outputs:

- Stepper Motor

Relationship

- Input a four digit number on the keypad
- Press *
- If the number is 1234, then
 - Rotate the motor 200 steps at a rate of 10ms/step
 - Pause 1 second
 - Rotate back 200 steps at a rate of 10ms/step
 - Then wait for a new input
- If the number is not 1234, then do nothing.

2) C code, flow chart, and resulting number of lines of assembler

```

:
:
:
void main(void)
{
    unsigned int i, j;
    int X, TEMP;
    unsigned char STEP;

    TRISA = 0;
    TRISB = 0xFF;
    TRISC = 0xF8;
    TRISD = 0;
    TRISE = 0;
    TRISA = 0;
    ADCON1 = 15;

    LCD_Init();

    LCD_Move(0,0);
    for (i=0; i<20; i++) LCD_Write(MSG0[i]);

    X = 0;
    STEP = 0;

    LCD_Move(1,0);  LCD_Write('X');

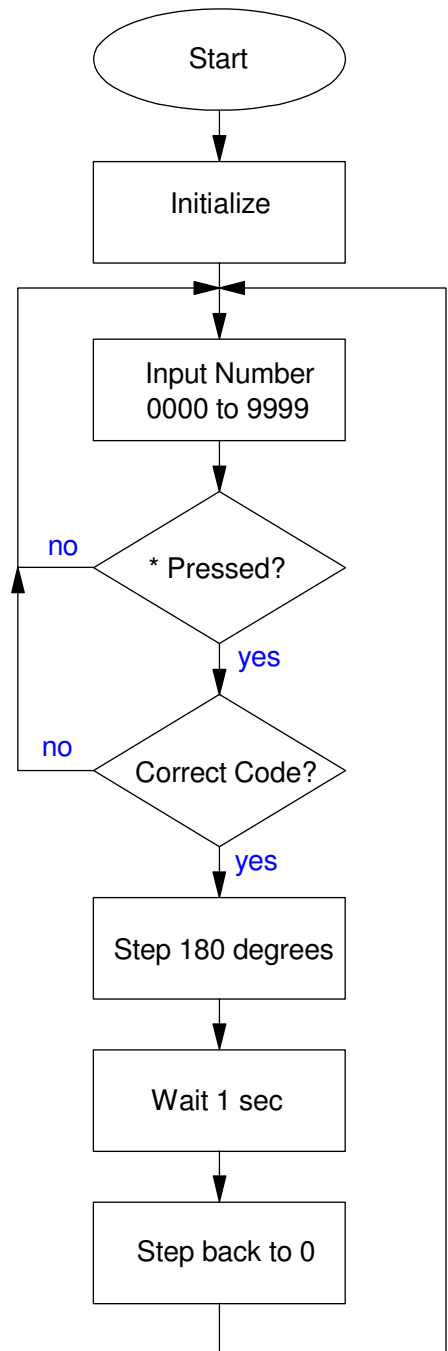
    while(1) {
        TEMP = ReadKey();

        if (TEMP < 10) X = (X*10) + TEMP;

        if (TEMP == 10) {
            if(X == 1234) {
                for(i=0; i<100; i++) {
                    PORTA = TABLE[STEP++ % 4];
                    Wait_ms(10);
                }
                Wait_ms(1000);
                for(i=0; i<100; i++) {
                    PORTA = TABLE[STEP-- % 4];
                    Wait_ms(10);
                }
                PORTA = 0;
            }
            Wait_ms(1000);
            X = 0;
        }
        if (TEMP == 11) {
            X = X / 10;
        }

        LCD_Move(1,5);  LCD_Out(X, 5, 0);
    }
}

```



Memory Summary:

Program space	used	EF6h (3830)	of 10000h bytes	(5.8%)
Data space	used	2Eh (46)	of F80h bytes	(1.2%)
EEPROM space	used	0h (0)	of 400h bytes	(0.0%)
ID Location space	used	0h (0)	of 8h nibbles	(0.0%)
Configuration bits	used	0h (0)	of 7h words	(0.0%)

3) Validation: Collect data in lab to verify you met the requirements.

- In theory, check all possible combinations.
- In practice, to a random sample

Verify that the requirements are met

Input numbers from 0000 to 9999

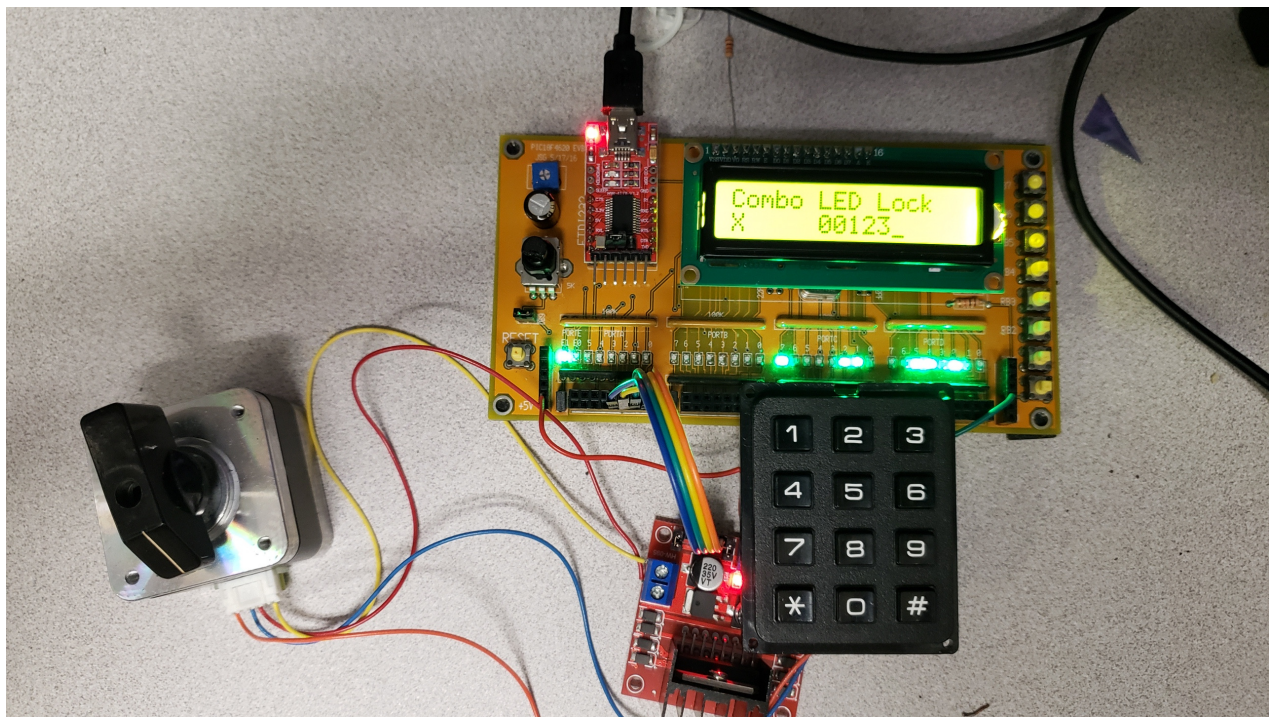
- *1234 accepted*
- *5678 accepted*
- *1932 accepted*
- *9999 accepted*

*Press *. If the code is incorrect, nothing happens*

- *7341 * resulted in no action (incorrect code)*
- *8312 * resulted in no action (incorrect code)*
- *2222 * resulted in no action (incorrect code)*

If the code is correct, step 200 times at 10ms per step, wait 1 second, return

- *1234 * is input*
- *Motor steps 200 times at 10ms per step*
 - *Motor turned 360 degrees*
 - *Time for 200 steps was 2 seconds (ish)*
- *Pauses 1.0 second*
 - *Measured time was 1 second (ish)*
- *Motor returns to original spot at 10ms per step*
 - *Motor returns to original position (check)*
 - *Time for 200 steps was 2 seconds (ish)*



4) Demo. Video or in person.

NeoPixel: Combination Lock

5) Requirement: Add to the previous requirements

Relationship

- Display the angle of the stepper motor on the NeoPixel display as a bar graph
 - 0 .. 16 red LED's as it rotates

6) C-Code, Flow Chart

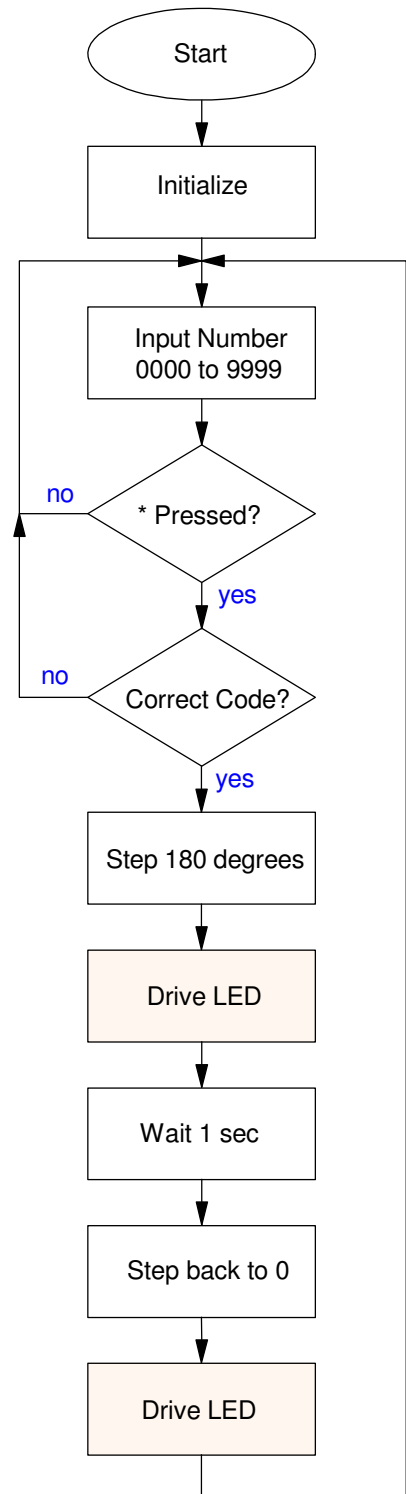
```
// **** Keypad Routines ****
:
//**** NeoPixel Routines ****
:

void BarGraph(unsigned int N)
{
    unsigned int i;
    unsigned char RED[16];
    for(i=0; i<N; i++) NeoPixel_Display(200,0,0);
    for(i=N; i<16; i++) NeoPixel_Display(0,0,0);
}

void main(void)
:
    while(1) {
        TEMP = ReadKey();

        if (TEMP < 10) X = (X*10) + TEMP;

        if (TEMP == 10) {
            if(X == 1234) {
                for(i=0; i<200; i++) {
                    PORTA = TABLE[STEP++ % 4];
                    BarGraph(i/12);
                    Wait_ms(10);
                }
                Wait_ms(1000);
                for(i=200; i>0; i--) {
                    PORTA = TABLE[STEP-- % 4];
                    BarGraph(i/12);
                    Wait_ms(10);
                }
                PORTA = 0;
            }
            Wait_ms(1000);
            X = 0;
        }
        if (TEMP == 11) {
            X = X / 10;
        }
        LCD_Move(1,5);  LCD_Out(X, 5, 0);
    }
}
```



Memory Summary:

Program space	used	1126h (4390)	of 10000h bytes	(6.7%)
Data space	used	2Fh (47)	of F80h bytes	(1.2%)
EEPROM space	used	0h (0)	of 400h bytes	(0.0%)
ID Location space	used	0h (0)	of 8h nibbles	(0.0%)
Configuration bits	used	0h (0)	of 7h words	(0.0%)

7) Validation

- Code 1122*
 - nothing happens
- Code 1234*
 - Stepper motor turns 360 degrees
 - As it turns, the NeoPixel lights up
 - Waits 1 second
 - Stepper motor turns back to 0 degrees
 - As it turns, the NeoPixel turns off

