Lab 1:

Display a Virtual Recipe on an LCD

Mechatronics/Intel Mach Engr, ECE 4370-001 Spring 2020

Date Submitted: January 31, 2020

Coauthors: Joey Franklin

Levi Carroll

Signatures: _____

_____

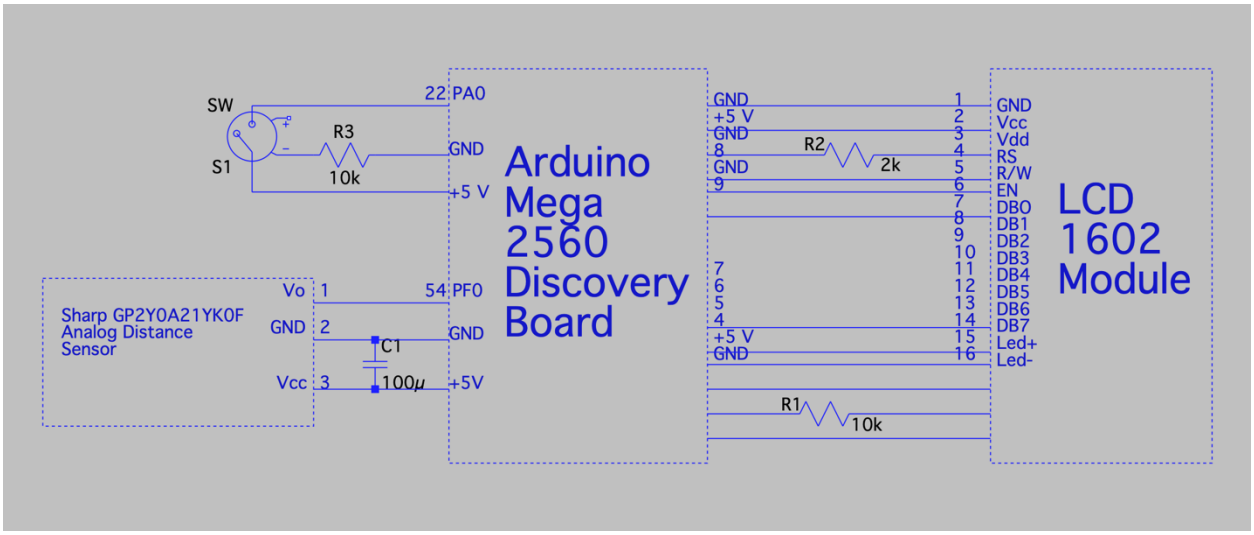
Recipient: Dr. Stephen Canfield

Executive Summary

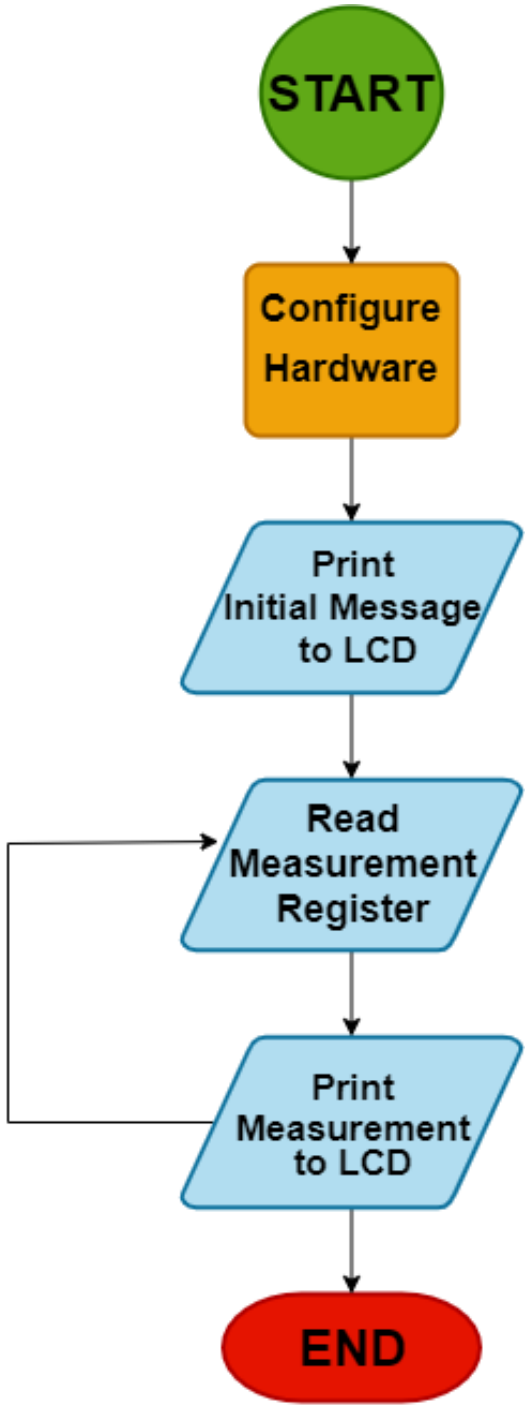
In this lab we were instructed to make a measurement device using an inferred (IR) transmitter/receiver module. The IR module blasts focused IR beam straight in from of it and measures the intensity of light that it receives back. Since light scatters in a predictable way the amount of scattered IR radiation it receives will give a reasonably actuate measurement of distance. There are however some problems with this system. Light will scatter differently when reflecting off of different colors. This can interfere with your measurements. For example, we calibrated the module using a highly reflective light blue folder, using that folder our measurements are within two tenths of a centimeter, however when we took measurements using my matte black phone case our readings were off by almost two centimeters. This is because more light was absorbed by the phone case that by the folder.

Another consideration of the IR module is that it is very sensitive to changes in it's angle while you hold it and to interference, either due to atmospheric conditions or to the presence of unexpected IR radiation. The easiest and most effective way to overcome this is to take several measurements and then sort those measurement to find the median, or the average. We chose the median as this yielded the most accurate result however the average yields a more consistent and stable measurement.

Circuit Diagram



Program Flowchart



Program Listing

```
/*****************************************************************
 *  ECE4370 - Mechatronics                                       *
 *  Dr. Stephen Canfield                                         *
 *  LAB 4: Electronic tape measure using Sharp IR sensor         *
 *         through ATD conversion                                *
 * Written by: Joey Franklin                                     *
 *        and  Levi Carroll                                      *
 *****************************************************************/
#include <LiquidCrystal.h>

// initialize the library by providing LCD pin locations
LiquidCrystal lcd(8,9,7,6,5,4);

// Declare Functions
void lcd_display(String units, int val);
float find_median(int n, float x[]);

// Variables to Hold Readings and Median of them
float ir_volt[11] ={0,0,0,0,0,0,0,0,0,0,0};
float ir_volt_median = 0;
float measurement = 0;
const int Button = 0x01; //PIN 22
bool run_measure= false;
bool lcd_backlight = false;
// Setup
void setup() {
  //Set PA0 as input
  DDRA=0b00000000;

  /////////// Set up AtoD Converter /////////
  // Set Voltage Reference to 1024 = AVREF = 2.56 --> bit 7, bit 6
  // Left Justify Register Read For Easier Calculations --> bit 5
  // Use PF0 --> bit 4, bit 3, bit 2, bit 1, bit 0
  ADMUX = 0b01100000;
```

```
  // Enable AtoD Conversion --> bit 7
  // Start AtoD Conversions --> bit 6
  // Dont Use Auto Trigger --> bit 5
  // Clear Interrupt Flag --> bit 4
  // Enable Interrupts --> bit 3
  // Set pre-scaler to 16 --> bit 2, bit 1, bit0
  ADCSRA = 0b10000100;

  // Enable AtoD Conversion
  // Start AtoD Conversions

   // Initialize the Serial
  Serial.begin(9600);
  // Wait for Serial to be ready
  while (! Serial);
  // print to the Serial port
  Serial.println("Serial is ready");
  //Set LCD Size
  lcd.begin(16,2);
}

void loop() {
if(PINA&Button){
  delay(200);
  run_measure = !run_measure;
}

while(run_measure){
  //// Select AtoD Channel (ADC0,PF0,pin97) ////
  ADMUX &= 0b11110000;
  ADMUX |= 0b00000000;

  //// Start AtoD Conversions (bit 6) ////
  ADCSRA |= 0b01000000;
```

```
  //// Wait until Conversion Complete Flag is set (bit 4) ////
  while(!(ADCSRA & 0b00010000));

  // Read High Register Data to Fill Pre-Sized Array //
  for(int num_readings = 0; num_readings <= 10; num_readings++){
    ir_volt[num_readings] = ADCH;
  }

 // Set the Value to be displayed on the LCD //
  ir_volt_median = find_median(11,ir_volt);

   // Convert Voltage to cm with curve fit from Excel 175.95e-0.026x
  measurement = (2772.8*pow(ir_volt_median/2, -1.2045))/2;


 // Print Value to the LCD //
  lcd_display ("cm", measurement);

  if(PINA&Button){
    delay(200);
  run_measure = !run_measure;
  }
}
}

/*************************************
 * Function Name: find_median         *
 * Recieves an Array to be            *
 * sorted and its size                *
 * Written By: Joey Franklin          *
 *************************************/
float find_median(int n, float x[]) {
    int temp;
    int i, j;
    // the following two loops sort the array x in ascending order
    for(i=0; i<n-1; i++) {
```

```
        for(j=i+1; j<n; j++) {
            if(x[j] < x[i]) {
                // swap elements
                temp = x[i];
                x[i] = x[j];
                x[j] = temp;
            }
        }
    }

    if(n%2==0) {
        // if there is an even number of elements, return mean of the two
elements in the middle
        return((x[n/2] + x[n/2 - 1]) / 2.0);
    } else {
        // else return the element in the middle
        return x[n/2];
    }
}



/*************************************
 * Function Name: lcd_display         *
 * Revieves a number and string to    *
 * display on the LCD                 *
 * Written By: Joey Franklin          *
 *************************************/
void lcd_display(String units, float val){
    // print to the LCD
    lcd.setCursor(4,0);
    lcd.print("Distance:");
    lcd.setCursor(6,1);
    lcd.print(val,2);
    lcd.setCursor(14,1);
    lcd.print(units);
    // delay
```

```
 delay(300);
 lcd.clear();
}
```