# Hardware Setup

The LCD shield used is the **LCD Keypad Shield v1.1 (black)**.

The following pins were used for the motor:

|  |  |
| --- | --- |
| **MOTOR PIN** | **ARDUINO PIN** |
| IN1 | D13 |
| IN2 | D12 |
| IN3 | D11 |
| IN4 | D3 |

The IR sensor is read through Analog Pin 1 on the Arduino.

The IR sensor was purchased from the website given in the beginning of the semester and the model number is GP2Y0A02YK0F.

# Code

#include <LiquidCrystal.h>

#include <avr/io.h>

#include <avr/interrupt.h>

LiquidCrystal lcd(8, 9, 4, 5, 6, 7); // Set up LCD

volatile unsigned long int milliseconds = 0;

volatile long unsigned int timer;

boolean blinking = true;

/\*\*\* IR sensor variables \*\*\*/

volatile float irHistory[5];

volatile int irValue =0;

/\*\*\* MOTOR VARIABLES \*\*\*/

int Steps;

int Direction = 0;

int StepTime = 2;

int previousStepTime = 0;

int motorSpeed = 2;

boolean startMotor = false;

int wheelSize = 20;

int stepSet = 100;

int stepCount = 0;

unsigned int stepRemaining = 0;

volatile int counterCM = 0;

/\*\*\* MODE \*\*\*/

enum Mode {

startupMODE,

debugMODE,

irMODE,

cmMODE,

pmMODE,

setMODE,

driveMODE

};

Mode currentMode;

/\*\*\* State for flickering state for menu selection \*\*\*/

enum debugState {

IR,

CM,

PM,

SET,

E

};

debugState currentDebugState = IR;

enum cmState {

starting,

exiting

};

cmState currentCMState = starting;

enum driveModeState {

idle,

CW,

CCW

};

driveModeState currentDriveState = idle;

/\*\* Button inputs \*\*/

enum Buttons {

btnNONE,

btnRIGHT,

btnUP,

btnDOWN,

btnLEFT,

btnSELECT

};

Buttons whatbuttons; // Current button pressed

Buttons buttonHistory[5] = { btnNONE, btnNONE, btnNONE, btnNONE, btnNONE };

Buttons debugSequence[5] = { btnLEFT, btnLEFT, btnUP, btnRIGHT, btnSELECT }; // to get into debug mode

volatile int counter = 0;

ISR(TIMER2\_OVF\_vect) { //Chapter 16

//Register size = 64

// CLK = 62500 Hz

//Timer pertick = 1/CLK = 0.016ms

// from 0 to 64 = 64 \* 0.016ms = 1ms

milliseconds += 1; //increment every ms

if(startMotor) { // one step every ms for drive mode

if(stepRemaining != 0) { // used for PM and drive MODE

stepperMotor(1);

stepRemaining--;

}

if(currentMode == cmMODE) { // For CM Mode only

counter++; // counter works as a delay for the different speeds

if(counter >= motorSpeed) { // if the counter is higher than motorSpeed, one step is done

stepperMotor(1);

counter = 0;

}

}

}

}

void setup() {

Serial.begin(9600);

timer\_Init();

lcd\_Init();

ADC\_Init();

stepperMotor\_Init();

currentMode = startupMODE;

}

void loop() {

switch(currentMode) {

case startupMODE:

printClock(mymillis()/60000, (mymillis() / 1000) % 60); //Convert the values to the print the clock

if(checkDebugSequence()) { // check debug sequence, if it is right, go to debug sequence

currentMode = debugMODE;

}

else if ((whatbuttons == btnSELECT) && !(checkDebugSequence())) {

currentMode = driveMODE; //goes drive mode if it doesnt equal sequence

}

break;

case debugMODE:

debugModeOperation();

break;

case irMODE:

irModeOperation();

break;

case cmMODE:

cmModeOperation();

break;

case pmMODE:

pmModeOperation();

break;

case setMODE:

setModeOperation();

break;

case driveMODE:

driveModeOperation();

break;

default:

break;

}

buttonSlidingWindow(); // for the button history

// if(whatbuttons != btnNONE) {

// Serial.println(whatbuttons);

// }

}

void timer\_Init() {

//Timer2 register A = normal operation

TCCR2A &=~(1<<WGM20);

TCCR2A &=~(1<<WGM21);

TCCR2A &=~(1<<COM2B0);

TCCR2A &=~(1<<COM2B1);

TCCR2A &=~(1<<COM2A0);

TCCR2A &=~(1<<COM2A1);

// Prescaler for 64

TCCR2B &= ~(1<<CS20);

TCCR2B &= ~(1<<CS21);

TCCR2B |= (1<<CS22);

TIMSK2 |= (1<<TOIE2); //Enable Overflow interrupt

sei(); //enable global interrupt

TIFR2 |= (1<<TOV2);

}

volatile unsigned long int mymillis() {

return milliseconds;

}

void mydelay(volatile long unsigned int delayTime) {

volatile long unsigned int count = mymillis();

while(mymillis() <= (delayTime + count)) {

}

}

void printClock(int minutes, int seconds) { // print clock for startup mode

lcd.setCursor(0,1);

lcd.print("ID:12878930");

lcd.setCursor(0,0);

if(minutes <10) {

lcd.print('0');

}

lcd.print(minutes);

lcd.print(':');

if(seconds < 10) {

lcd.print('0');

}

lcd.print(seconds);

}

void lcd\_Init() {

lcd.begin(16,2);

lcd.clear();

}

Buttons readLCDButtons() {

static int inputButton;

inputButton = myAnalogRead(0);

mydelay(145); //DEBOUNCE

// read analog 0 with registers

if(inputButton > 1000) {

return btnNONE;

}

if(inputButton < 50) {

return btnRIGHT;

}

if(inputButton < 250) {

return btnUP;

}

if(inputButton < 450) {

return btnDOWN;

}

if(inputButton < 650) {

return btnLEFT;

}

if(inputButton < 850) {

return btnSELECT;

}

return btnNONE; // when all others fail, return this

}

void buttonSlidingWindow() {

whatbuttons = readLCDButtons();

if(whatbuttons != btnNONE) {

for(int i = 0; i < 4; i++) {

buttonHistory[i] = buttonHistory[i+1];

}

buttonHistory[4] = whatbuttons;

}

}

boolean checkDebugSequence() {

for(int i = 0; i <= 4; i++) {

if(buttonHistory[i] != debugSequence[i]) {

return false;

}

}

return true;

}

void ADC\_Init() {

ADCSRA |= (1<<ADEN); // Enable ADC

ADMUX |= (1<<REFS0); // Internal Vcc 5v

}

int myAnalogRead(int Pin)

{

if(Pin == 1) {

ADMUX |= Pin; //Multiplexer for which pin to read from

}

else if(Pin == 0) {

ADMUX = 0;

ADMUX |= (1<<REFS0); // Internal Vcc 5v

}

ADCSRA |= (1<<ADSC); // start conversion

// wait for conversion to complete

while (!(ADCSRA &(1<<ADIF))); // becomes while(0) when the conversion is complete

ADCSRA |= (1<<ADIF);

return ADC;

}

void stepperMotor\_Init() {

DDRB |= (1<<DDB5); // Change data direction of pin 13 to output

DDRB |= (1<<DDB4); // Change data direction of pin 12 to output

DDRB |= (1<<DDB3); // Change data direction of pin 11 to output

DDRD |= (1<<DDD3); // Change data direction of pin 3 to output

}

void stepperMotor(int xw) {

for(int x =0; x< xw; x++)

{

switch(Steps)

{

case 0: //1000

PORTB |= (1<<PORTB5);

PORTB &= ~(1<<PORTB4);

PORTB &= ~(1<<PORTB3);

PORTD &= ~(1<<PORTD3);

break;

case 1: //1100

PORTB |= (1<<PORTB5);

PORTB |= (1<<PORTB4);

PORTB &= ~(1<<PORTB3);

PORTD &= ~(1<<PORTD3);

break;

case 2: //0100

PORTB &= ~(1<<PORTB5);

PORTB |= (1<<PORTB4);

PORTB &= ~(1<<PORTB3);

PORTD &= ~(1<<PORTD3);

break;

case 3: //0110

PORTB &= ~(1<<PORTB5);

PORTB |= (1<<PORTB4);

PORTB |= (1<<PORTB3);

PORTD &= ~(1<<PORTD3);

break;

case 4: //0010

PORTB &= ~(1<<PORTB5);

PORTB &= ~(1<<PORTB4);

PORTB |= (1<<PORTB3);

PORTD &= ~(1<<PORTD3);

break;

case 5: //0011

PORTB &= ~(1<<PORTB5);

PORTB &= ~(1<<PORTB4);

PORTB |= (1<<PORTB3);

PORTD |= (1<<PORTD3);

break;

case 6: //0001

PORTB &= ~(1<<PORTB5);

PORTB &= ~(1<<PORTB4);

PORTB &= ~(1<<PORTB3);

PORTD |= (1<<PORTD3);

break;

case 7: //1001

PORTB |= (1<<PORTB5);

PORTB &= ~(1<<PORTB4);

PORTB &= ~(1<<PORTB3);

PORTD |= (1<<PORTD3);

break;

default: //0000

PORTB &= ~(1<<PORTB5);

PORTB &= ~(1<<PORTB4);

PORTB &= ~(1<<PORTB3);

PORTD &= ~(1<<PORTD3);

break;

}

setDirection();

}

}

void setDirection() {

if(Direction ==1) { //anticlockwise

Steps++;

}

else { //clockwise

Steps--;

}

if(Steps > 7) {

Steps = 0;

}

if(Steps < 0) {

Steps = 7;

}

}

void debugModeOperation() {

lcd.setCursor(0,0);

lcd.print("DEBUG Mode");

if(blinking) {

lcd.setCursor(0,1);

lcd.print("IR CM PM SET E");

timer = mymillis();

blinking = false;

}

if(mymillis() >= (timer + 1000)) { // Blinks every second for the cursor

blinking = true;

lcd.setCursor(0,1);

switch(currentDebugState) {

case IR:

lcd.print(" CM PM SET E");

break;

case CM:

lcd.print("IR PM SET E");

break;

case PM:

lcd.print("IR CM SET E");

break;

case SET:

lcd.print("IR CM PM E");

break;

case E:

lcd.print("IR CM PM SET ");

break;

default:

break;

}

}

switch(whatbuttons) { //User inputs

case btnLEFT: // cursor going to the left

currentDebugState = currentDebugState - 1;

if(currentDebugState < 0) {

currentDebugState = 0;

}

break;

case btnRIGHT: // cursor going to the right

currentDebugState = currentDebugState +1;

if(currentDebugState > 4) {

currentDebugState = 4;

}

break;

case btnSELECT: // selecting which mode

debugModeSelection();

blinking = true;

currentDebugState = IR;

lcd.clear();

break;

}

}

void debugModeSelection() {

switch(currentDebugState) {

case IR:

currentMode = irMODE;

break;

case CM:

currentMode = cmMODE;

break;

case PM:

currentMode = pmMODE;

break;

case SET:

currentMode = setMODE;

break;

case E:

currentMode = startupMODE;

break;

default:

break;

}

}

void driveModeOperation() {

static int averaging =0; // averaging of the IR value

static volatile float sum =0;

static volatile float sensorValue =0;

static long unsigned int previousTime = 0;

static float revolutions = 0;

static boolean startupCondition = true;

if(startupCondition) {

lcd.clear();

startupCondition = false;

}

lcd.setCursor(0,0);

lcd.print("Drive Mode");

switch(currentDriveState) {

case idle: //idle means that motor isnt running

if(averaging < 5) {

if(mymillis() - previousTime >= 200) {

averaging++;

sensorValue = myAnalogRead(1);

mydelay(20);

sensorValue = 55.55/(sensorValue\*5/1023);

sum += sensorValue; // found from excel line of best fit + datasheet

previousTime = mymillis();

}

}

else if(averaging >= 5){ //Averaging after reading values

irValue = sum/averaging;

if(irValue > 150) {

irValue = 150;

}

lcd.setCursor(0,1);

lcd.print(" ");

lcd.setCursor(0,1);

lcd.print(irValue);

lcd.print(" ");

revolutions = (float) irValue/ (float) wheelSize; // revolutions = distance / circumference

lcd.print(revolutions, 1);

lcd.print(" ");

stepRemaining = revolutions \* 4096; // one revolution is 4096 steps

lcd.print(stepRemaining);

averaging =0;

sum = 0;

}

break;

case CW: //clockwise rotation

lcd.setCursor(0,1);

lcd.print(" ");

lcd.setCursor(0,1);

lcd.print(irValue);

lcd.print(" ");

lcd.print(revolutions, 1);

lcd.print(" ");

lcd.print(stepRemaining);

if(stepRemaining == 0) {

startMotor = false;

motorClear(); // clear all outputing leds of motor

currentDriveState = idle;

}

break;

case CCW: //anticlockwise rotation

lcd.setCursor(0,1);

lcd.print(" ");

lcd.setCursor(0,1);

lcd.print(irValue);

lcd.print(" ");

lcd.print(revolutions, 1);

lcd.print(" ");

lcd.print(stepRemaining);

if(stepRemaining == 0) {

startMotor = false;

currentDriveState = idle;

}

break;

}

switch(whatbuttons) {

case btnSELECT:

// clear all non initial state

currentMode = startupMODE;

Direction = 0;

currentDriveState = idle;

startupCondition = true;

startMotor = false;

stepRemaining = 0;

motorClear();

lcd.clear();

break;

case btnUP:

if(!startMotor) { // if motor is running, dont do anything

startMotor = true;

Direction =0;

currentDriveState = CW;

stepRemaining = revolutions\*4096;

}

break;

case btnDOWN:

if(!startMotor){

startMotor = true;

Direction = 1;

currentDriveState = CCW;

stepRemaining = revolutions\*4096;

}

break;

default:

break;

}

}

void irModeOperation() {

static int averaging = 0;

static volatile float sum = 0;

static volatile float sensorValue = 0;

static long unsigned int previousTime = 0;

lcd.setCursor(0,0);

lcd.print("IR Mode");

if(averaging < 5) { // averaging every 5 values found

if(mymillis() - previousTime >= 200) {

averaging++;

sensorValue = myAnalogRead(1);

mydelay(20);

sensorValue = 55.55/(sensorValue\*5/1023);

sum += sensorValue; // found from excel line of best fit + datasheet

previousTime = mymillis();

}

}

else if(averaging >= 5){

irValue = sum/averaging;

if(irValue > 150) {

irValue = 150;

}

lcd.setCursor(0,1);

lcd.print(" ");

lcd.setCursor(0,1);

lcd.print(irValue);

lcd.print(" cm");

averaging =0;

sum = 0;

}

if(whatbuttons == btnSELECT) {

lcd.clear();

averaging =0;

sum = 0;

currentMode = debugMODE;

}

}

void motorClear() { // clearing all the ports used by the motor - if not conflicts with IR

PORTB &= ~(1<<PORTB5);

PORTB &= ~(1<<PORTB4);

PORTB &= ~(1<<PORTB3);

PORTD &= ~(1<<PORTD3);

}

void setModeOperation() {

lcd.setCursor(0,0);

lcd.print("SETTINGS Mode");

lcd.setCursor(0,1);

lcd.print("Wheel: ");

lcd.setCursor(7,1);

lcd.print(wheelSize);

lcd.setCursor(10, 1);

lcd.print("cm");

switch(whatbuttons) {

case btnUP:

wheelSize += 10;

if(wheelSize > 90) { // Upper limit of the wheel is 90cm circumference

wheelSize = 90;

}

break;

case btnDOWN:

wheelSize -= 10;

if(wheelSize < 10) {

wheelSize = 10;

}

break;

case btnSELECT:

lcd.clear();

currentMode = debugMODE;

break;

}

}

void pmModeOperation() {

static boolean pmStart = false;

lcd.setCursor(0,0);

lcd.print("PM Mode");

lcd.setCursor(0,1);

lcd.print(" ");

lcd.setCursor(0,1);

lcd.print(stepSet);

lcd.print(" ");

lcd.print(stepSet);

if(!pmStart) { // when the motor isnt running yet

switch(whatbuttons) {

case btnUP:

stepSet += 100;

if(stepSet > 30000) {

stepSet = 30000;

}

break;

case btnDOWN:

stepSet -= 100;

if(stepSet < 100) {

stepSet = 100;

}

break;

case btnLEFT:

stepSet = 100;

break;

case btnRIGHT:

pmStart = true;

startMotor = true;

stepRemaining = stepSet;

break;

case btnSELECT:

lcd.clear();

currentMode = debugMODE;

}

}

else {

lcd.setCursor(0,1);

lcd.print(" ");

lcd.setCursor(0,1);

lcd.print(stepSet);

lcd.print(" ");

lcd.print(stepRemaining);

if(stepRemaining == 0) {

pmStart = false; //if no more step, goes back to idle state of pm mode

motorClear(); // clear the output LEDs motor

}

if(whatbuttons == btnSELECT) {

lcd.clear();

pmStart = false;

stepRemaining = 0;

motorClear();

currentMode = debugMODE;

}

}

}

void cmModeOperation() {

lcd.setCursor(0,0);

lcd.print("CM Mode");

if(blinking) {

lcd.setCursor(0,1);

lcd.print("Start Exit");

timer = mymillis();

blinking = false;

}

// blinking used again

if(mymillis() >= (timer + 1000) && startMotor == false) {

blinking = true;

lcd.setCursor(0,1);

switch(currentCMState) {

case starting:

lcd.print(" Exit");

break;

case exiting:

lcd.print("Start ");

break;

}

}

if(!startMotor) { // when idle

switch(whatbuttons) {

case btnLEFT:

currentCMState = starting;

break;

case btnRIGHT:

currentCMState = exiting;

break;

case btnSELECT:

if(currentCMState == exiting) {

blinking = true;

currentCMState = starting;

lcd.clear();

currentMode = debugMODE;

}

else {

startMotor = true;

blinking = false;

lcd.clear();

lcd.setCursor(0,0);

lcd.print("CM Mode");

}

break;

}

}

else { // when motor is started

lcd.setCursor(0,1);

if(Direction == 0) {

lcd.print("CW");

lcd.print(" Speed: ");

switch(motorSpeed) { // motorSpeed is how much delay

case 1:

lcd.print("fast");

break;

case 2:

lcd.print("medium");

break;

case 3:

lcd.print("slow");

break;

}

}

else {

lcd.print("CCW");

lcd.print(" Speed: ");

switch(motorSpeed) {

case 1:

lcd.print("fast");

break;

case 2:

lcd.print("medium");

break;

case 3:

lcd.print("slow");

break;

}

}

switch(whatbuttons) {

case btnLEFT: //anticlockwise

Direction = 1;

lcd.clear();

lcd.setCursor(0,0);

lcd.print("CM Mode");

break;

case btnRIGHT: // clockwise

Direction = 0;

lcd.clear();

lcd.setCursor(0,0);

lcd.print("CM Mode");

break;

case btnUP:

motorSpeed--; //decrease the delay will increase the speed

if(motorSpeed < 1) {

motorSpeed = 1;

}

lcd.clear();

lcd.setCursor(0,0);

lcd.print("CM Mode");

break;

case btnDOWN:

motorSpeed++; // increase the delay to decrease the speed

if(motorSpeed > 3) {

motorSpeed = 3;

}

lcd.clear();

lcd.setCursor(0,0);

lcd.print("CM Mode");

break;

case btnSELECT:

motorSpeed = 2; // back to initial stage

Direction = 0;

startMotor = false;

motorClear();

blinking = true;

lcd.clear();

break;

}

}

}