Ximin Lin (xlin32)

Yue Yuan (yueyuan3)

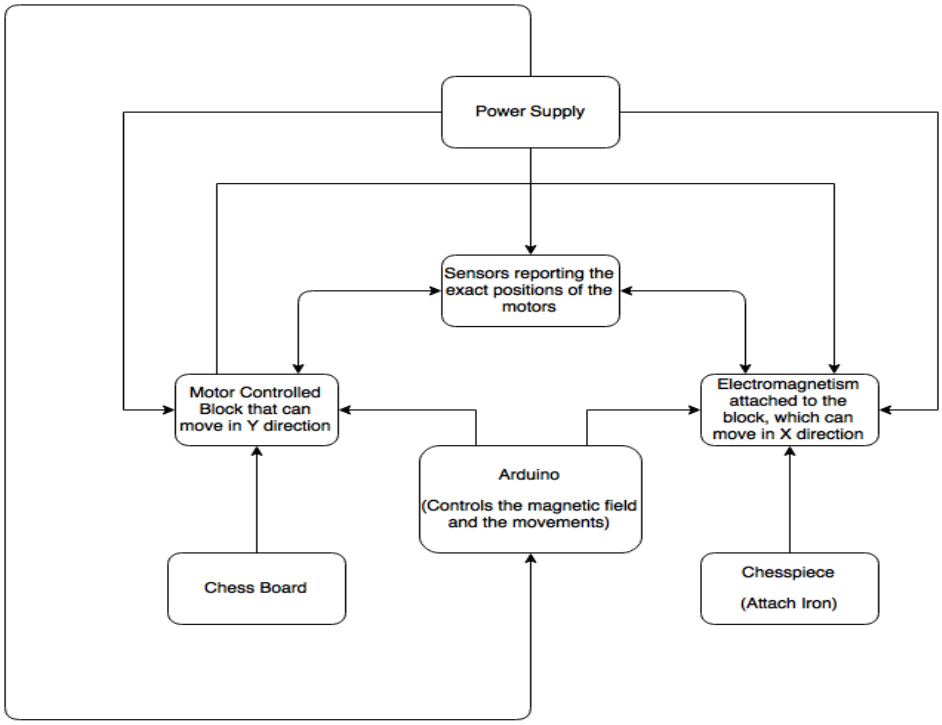
Zeran Zhu (zzhu35)

ECE 110 Magneto's Chess Board Report

Introduction

Our task is to build a computer-controlling device, which moves the chess pieces to a given position on the chessboard. To accomplish this task, we decided to use an electromagnet and a driving system beneath the chessboard to move the chess piece that has metal on its bottom. We are to attach two motors to the two ends of a bar beneath the chessboard to drive the bar in one direction. In order to move the chess pieces in another direction, we plan to use two motors to drive a block on the bar. When we give the imput to the system, it will turn on the electromagnet on the block and the motors, which will move the chess piece. However, in this semester, our group focused on the electrical part of the device. Therefore this report will illustrate the driving system including the motors, sensors and the code in the Arduino.

Design



Power supply: 9V battery

Sensors: We bind one magnet inside the each wheel and used two hall-effect sensors to count the number of the cycles that the wheels rotated in order to control the position.

Motors: We use two motors respectively represent the motors in the horizontal direction (X-axis) and vertical direction (Y-axis) We use H-bridge and inverter to make the DC motors could spin forward and backward.

Chess piece: We used weight used on the balance as a model of chess piece.

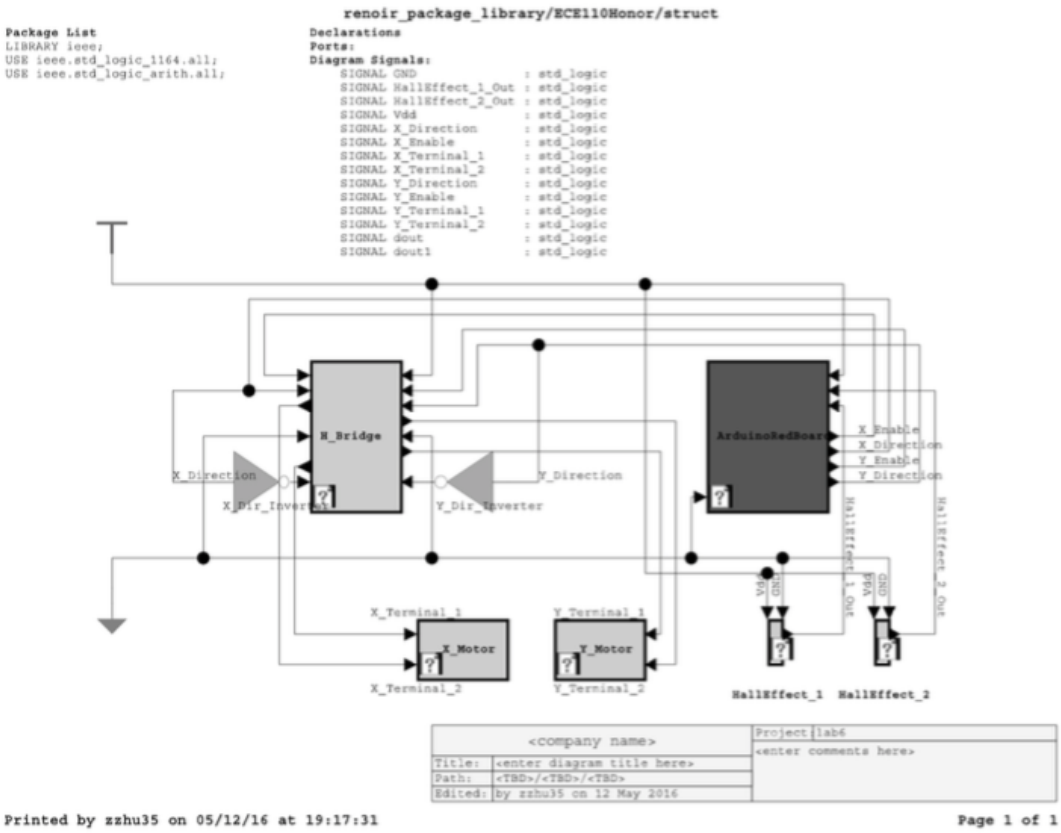
Arduino(Red Board): The Red Board will control the motors, sensors, and electromagnet by the code below:

```
int xsteps=10;        //the step x-dimension motor will turn
```

```
int ysteps=-7;        //the step y-dimension motor will turn, negative means opposite direction

boolean magon=true;

const int mag=13;  //pin number of electromagnetic in arduino

const int s=1;

int motorx=7;

int motorxd=8;

int motory=9;

int motoryd=10;

int hallcounter = 0;       //counting how many steps the wheel have turned

int hall = 12;          //pin number for hall effect sensors

int state = 0;

int laststate = 0;

void setup() {

pinMode(motorx,OUTPUT);

pinMode(motorxd,OUTPUT);

pinMode(motory,OUTPUT);

pinMode(motoryd,OUTPUT);

pinMode(mag,OUTPUT);

pinMode(s,INPUT);

pinMode(0,INPUT);

pinMode(hall, INPUT);

for (int i=0;i<14;i++){

  digitalWrite(i,LOW);   }

}

void loop() {

 go(digitalRead(s)==LOW);    //call go function to move the motors

}

void go(boolean on){

 if (on){
```

```
  if (magon) {
    digitalWrite(mag,HIGH);  //connect electromagnet
  }
  motor(motorx,xsteps);
  motor(motory,ysteps);
  digitalWrite(mag,LOW);    //disconnect electromagnet after the wheel stops
 }
}
void motor(int a,int x){
 if (x>0){
  digitalWrite(a+1,HIGH);
 }
 else{
  x=-x;
  digitalWrite(a+1,LOW);
 }
 digitalWrite(a,HIGH);
 while (hallcounter<x){
  state=digitalRead(hall);
  if ((state==LOW)&&(state!=laststate)){
    hallcounter++;
  }
 laststate=state;
 }
 digitalWrite(a,LOW);
 hallcounter=0;
}
```

Circuit Design



Result

Present Results:

We try to have x-dimension wheel move forward 5 steps, coded in computer as +5, and y-dimension wheel move forward 3 steps, coded in computer as +3. Sometimes we have jammed wheel due to its own defection in x-dimension, which need us to turn it a little bit so that it will continue turning. While the wheel is turning, the electromagnet for moving chess pieces will be connected to move the chess pieces. In testing, we use paper as symbol of chessboard. By moving electromagnet around in the paper, we get to see the chess piece move as we intend it to.

Qualitative Analysis:

We can move the chess pieces by changing codes in computer and then upload to the Red Board. We use H-Bridge in the circuit so that the car, representing the x- and y-dimension movements, can move back and forth to pick up chess pieces and move to the destinations. In determining the distance the car have moved, we use two hall effect sensor attached to the side of each wheel. Then we put a magnet inside the wheel. So when the wheel turn to a certain position, where magnet is close enough to the hall effect sensor, hall effect sensor will send low signal to pin in Arduino. By counting how many times low signals are detected, we count the distance the wheels have moved. By doing so, we also have to design chessboard in a way that each grid have the side length equal to perimeter of the wheel. We also add an LED in series with hall effect sensor so that the light is also a feedback of low signals. Despite the wheel being jammed during testing, we believe that this prototype will work.

Quantitative Analysis:

Voltage (V)	1	2	3	6	12(max)
Current (mA)	26	52	78	155	309

The I-V characteristic of the electromagnet R=40Ω

Because the electromagnet can only move the chess piece when supplied by a high voltage, which is much higher than that provided by Arduino, we might use another source to power it. This is the defect of electromagnet. We might replace it by a combination of normal magnet and servomotor, which might also accomplish our task.

Future Work

Currently, we think there are two more tasks we should finish in the future. The first one is to make the device work without using the computer to change the value of the int in our code. At present, we could only drive the motors in a particular number of cycles according to the step int in our code. To fulfill the task that makes the driving system follow the every order that people demand immediately, we need to use a remote control, which could change the value of the int, in order to drive the motor for different number of cycles. The second task is to build the mechanical part of our chess board, which is more related to Mechanical Engineering but will affect some designing parameters in our electrical part. Furthermore, we also want to use our vocal demand to control the system, which will need more knowledge about the signal processing. That will be a huge leap of our project.

Conclusion

During this semester, we learned to use the H-Bridge and inverter to make the motor spin back and forth. We also characterized the hall effect sensor and use it to collect the information we want. The driving part of our design works well. By using the H-Bridge, inverter and code, we could drive the motors forward and backward. However, our code cannot drive the motor in two axes at the same time. We could change the function in our code to fix this problem. By doing this project, we learned not only to use several new electrical components, but also the process of doing an independent project.