MECH – 207

End of Quarter Project

The Penny Arcade – Pinball Machine

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Date: 12/11/2019

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INTRODUCTION:

The idea to create a pinball machine arose as its game play involves the player to constantly pay attention while the ball is in action and that the player is always informed of their points during the game. So we decided to combine the ideas to make a small-scale pinball machine that would meet the project requirements which is stated.

Here we used two servo motors for two separate paddles and one servo motor for the gate. User input via a push button activates the paddles to strike the pinball, which then travels around the playing base. If the pinball enters the score region, it will be detected by infrared (IR) sensors and the machine will update the score by lighting up one LED. The user can get a maximum of 3 points which means 3 LED is lighted. The game is started by inserting a penny in the penny slot. Game is over when the pinball escapes three times. The goal is to enter the score region as many times as possible.

HARDWARE INTERFACE:

As shown in the hardware diagram in **Figure 1**, the main electrical components for this project are the servo motors, pushbuttons, IR sensors, and LED's for points. The mechanical aspects of this project consisted of the playing base, the paddles, and how they are mounted together with the electrical components. We used two servo motors, rated at 6V, to swing the paddles to 60 degrees. The motors were mounted on the bottom of the playing base, and as the pinball fell, the push buttons could activate the

motors. Two IR sensors were installed around the center of the playing base. When the pinball travelled through the gap, points are counted and LED is lit up accordingly.

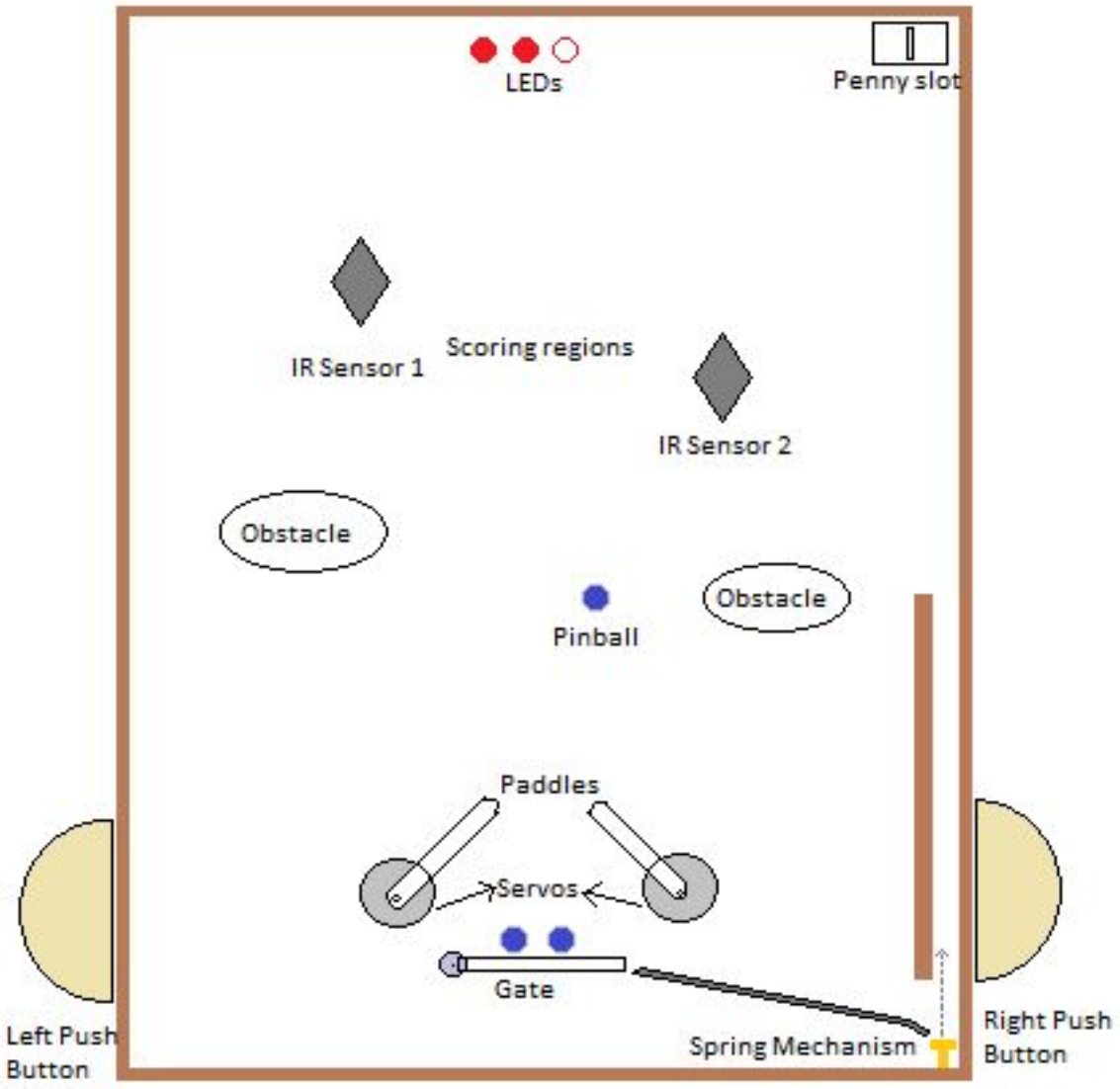


Figure 1

The picture in **Figure 2** shows our implementation of the conceptual design in Figure 1. We used cardboard materials for the playing base and some thick plastic materials for the paddles. We also used cardboard material to make the edges and obstacles on the playing base.

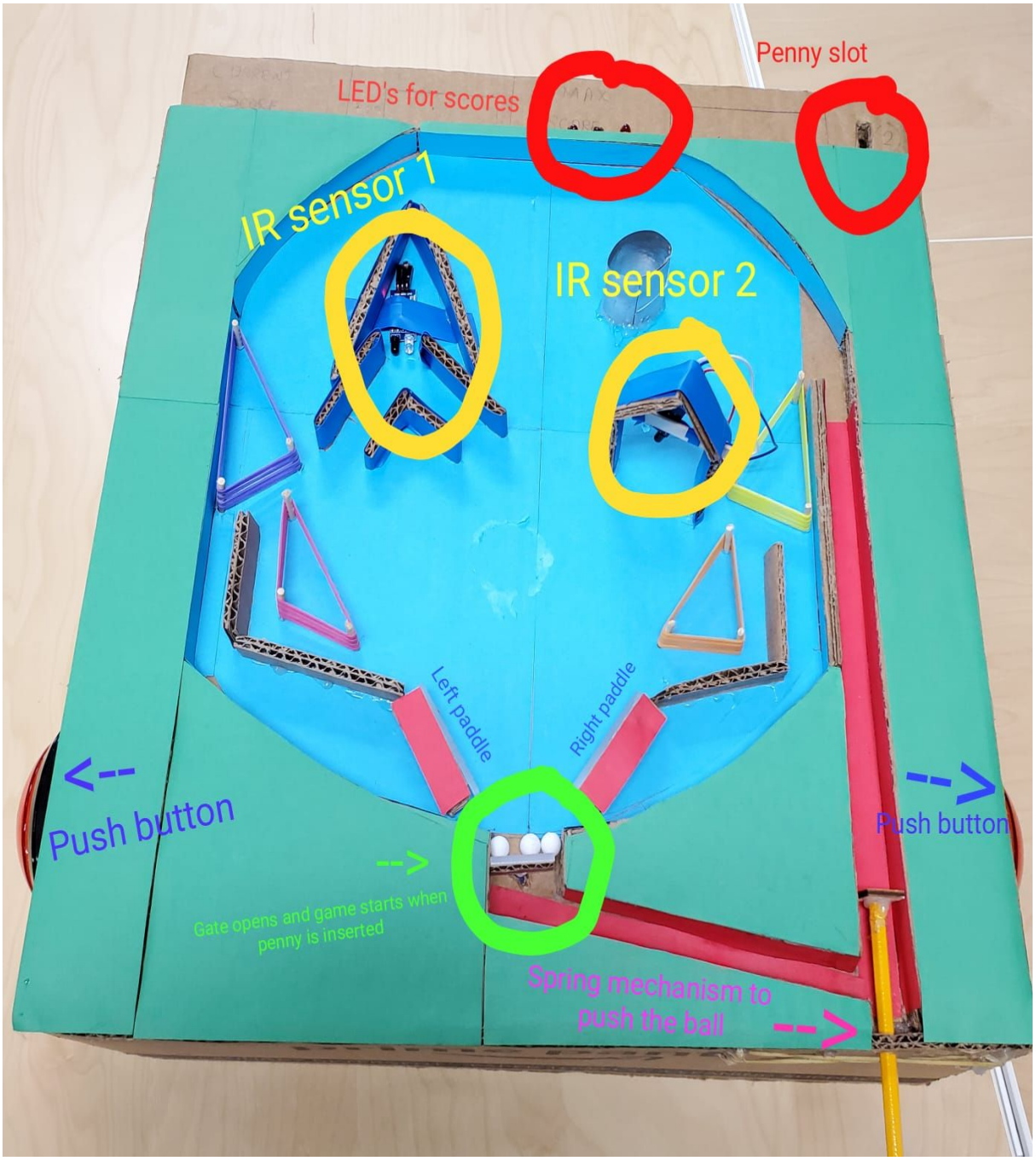


Figure 2

SOFTWARE INTERFACE:

Here we used two separate Arduino boards. One for paddle control and the other for main system.

```
#include <Servo.h>

Servo servoleft;
Servo servoright;

int left_switch = A0;
int right_switch = A2;

int left_reading = 0;
int right_reading = 0;

int leftpin = 11;
int rightpin = 10;

int down_theta = -70;
int up_theta = 50;

void setup() {
  pinMode(leftpin, OUTPUT);
  pinMode(rightpin, OUTPUT);

  servoleft.attach(leftpin);
  servoright.attach(rightpin);
}

void loop() {
  left_reading = analogRead(left_switch);
  right_reading = analogRead(right_switch);

  if (left_reading >= 511)
    {
    servoleft.write(93 + up_theta);
    }
  else
    {
    servoleft.write(93 + down_theta);
    }

  if(right_reading >=511)
    {
    servoright.write(85 - up_theta);
    }
  else
    {
    servoright.write(85 - down_theta);
    }
}
```

This is the code for the paddle control.

```
#include <Servo.h>

Servo servogate;

int gate_pin = 10;

byte digit = 0;
int score = 0;

int get_one_point = A2;
int one_point_reading = HIGH;

int get_three_point = A4;
int three_point_reading = HIGH;

int candy_light_one = 7;
int candy_light_one_up = 0;

int candy_light_two = 8;
int candy_light_two_up = 0;

int candy_light_three = 12;
int candy_light_three_up = 0;

int coin_insert = A0;
int coin_reading = 0;

byte seven_seg_digits[10] = { B11111100,  // = 0
                              B01100000,  // = 1
                              B11011010,  // = 2
                              B11110010,  // = 3
                              B01100110,  // = 4
                              B10110110,  // = 5
                              B10111110,  // = 6
                              B11100000,  // = 7
                              B11111110,  // = 8
                              B11100110   // = 9
                             };

int latchPin = 3;

int clockPin = 4;

int dataPin = 2;

```

```
46 void setup()
47 {
48   // Set latchPin, clockPin, dataPin as output
49   pinMode(latchPin, OUTPUT);
50   pinMode(clockPin, OUTPUT);
51   pinMode(dataPin, OUTPUT);
52   pinMode(get_three_point,INPUT);
53
54   servogate.attach(gate_pin);
55 }
56
57 // display a number on the digital segment display
58 void sevenSegWrite(byte digit) {
59   // set the latchPin to low potential, before sending data
60   digitalWrite(latchPin, LOW);
61
62   // the original data (bit pattern)
63   shiftOut(dataPin, clockPin, LSBFIRST, seven_seg_digits[digit]);
64
65   // set the latchPin to high potential, after sending data
66   digitalWrite(latchPin, HIGH);
67 }
68
69 void loop()
70 {
71   sevenSegWrite(digit);
72   one_point_reading = digitalRead(get_one_point);
73   three_point_reading = digitalRead(get_three_point);
74   coin_reading = analogRead(coin_insert);
75   servogate.write(180);
76
77   if(one_point_reading  == LOW)
78   {
79   digit = ++score % 10;
80   delay(100);
81     if(score / 10 == 1)
82     {
83     candy_light_one_up = 255;
84     analogWrite(candy_light_one,candy_light_one_up);
85     }
86
87     else if (score / 10 == 2)
88     {
89     candy_light_one_up = 255;
90     analogWrite(candy_light_one,candy_light_one_up);
91     candy_light_two_up = 255;
92     analogWrite(candy_light_two,candy_light_two_up);
93     }
94
95     else if (score / 10 == 3)
96     {
97     candy_light_one_up = 255;
98     analogWrite(candy_light_one,candy_light_one_up);
99     candy_light_two_up = 255;
100    analogWrite(candy_light_two,candy_light_two_up);
101    candy_light_three_up = 255;
102    analogWrite(candy_light_three,candy_light_three_up);
103    }
104  }
```

```
106   else if(three_point_reading == LOW)
107   {
108   digit = ++score % 10;
109   digit = ++score % 10;
110   digit = ++score % 10;
111   delay(1000);
112     if(score / 10 == 1)
113     {
114     candy_light_one_up = 255;
115     analogWrite(candy_light_one,candy_light_one_up);
116     }
117
118     else if (score / 10 == 2)
119     {
120     candy_light_one_up = 255;
121     analogWrite(candy_light_one,candy_light_one_up);
122     candy_light_two_up = 255;
123     analogWrite(candy_light_two,candy_light_two_up);
124     }
125
126     else if (score / 10 == 3)
127     {
128     candy_light_one_up = 255;
129     analogWrite(candy_light_one,candy_light_one_up);
130     candy_light_two_up = 255;
131     analogWrite(candy_light_two,candy_light_two_up);
132     candy_light_three_up = 255;
133     analogWrite(candy_light_three,candy_light_three_up);
134     }
135   }
136
137   else if(coin_reading > 511)
138   {
139   score = 0;
140   digit = 0;
141   candy_light_one_up = 0;
142   analogWrite(candy_light_one,candy_light_one_up);
143   candy_light_two_up = 0;
144   analogWrite(candy_light_two,candy_light_two_up);
145   candy_light_three_up = 0;
146   analogWrite(candy_light_three,candy_light_three_up);
147   servogate.write(45);
148   delay(3000);
149   servogate.write(180);
150   }
151
152 }
```

This is the code for the main system.

CIRCUIT DIAGRAM:

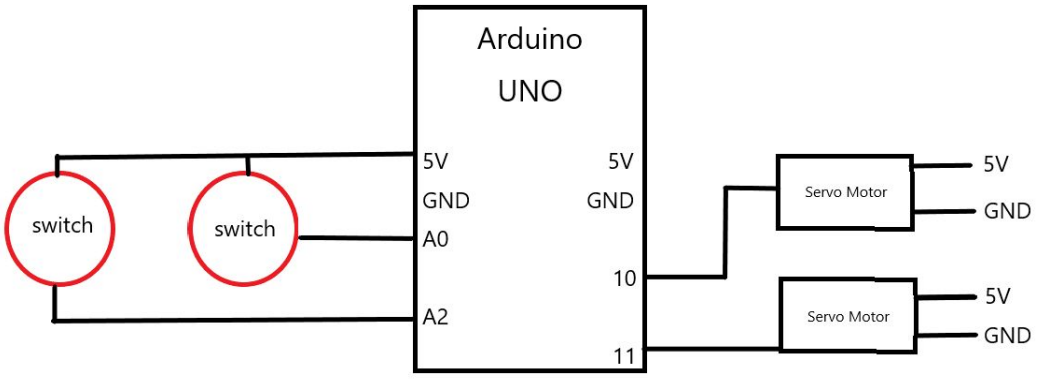


Figure 3: Circuit Diagram for Paddle Control

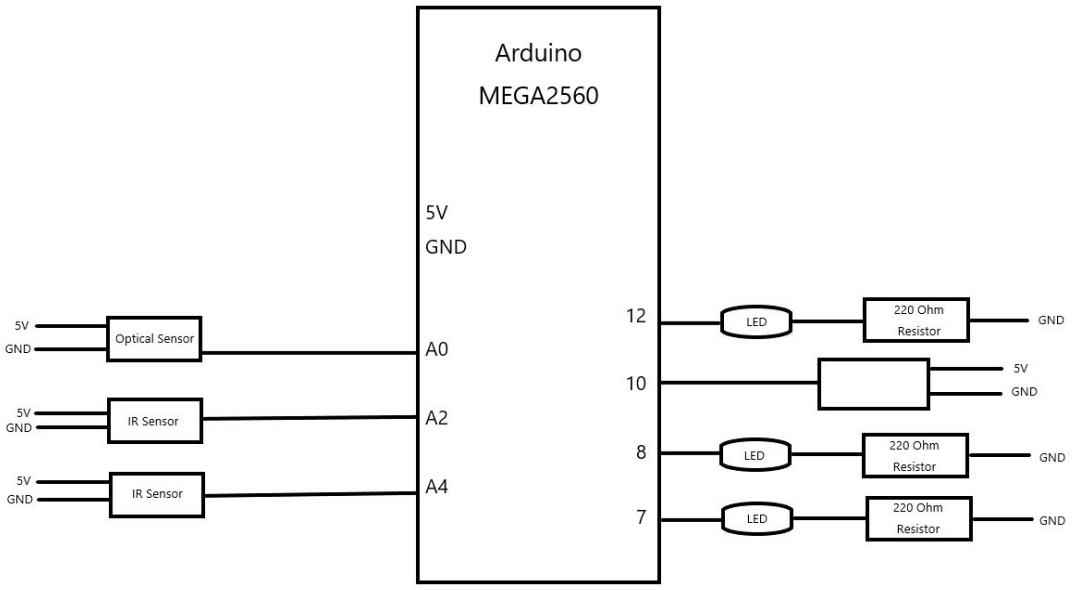
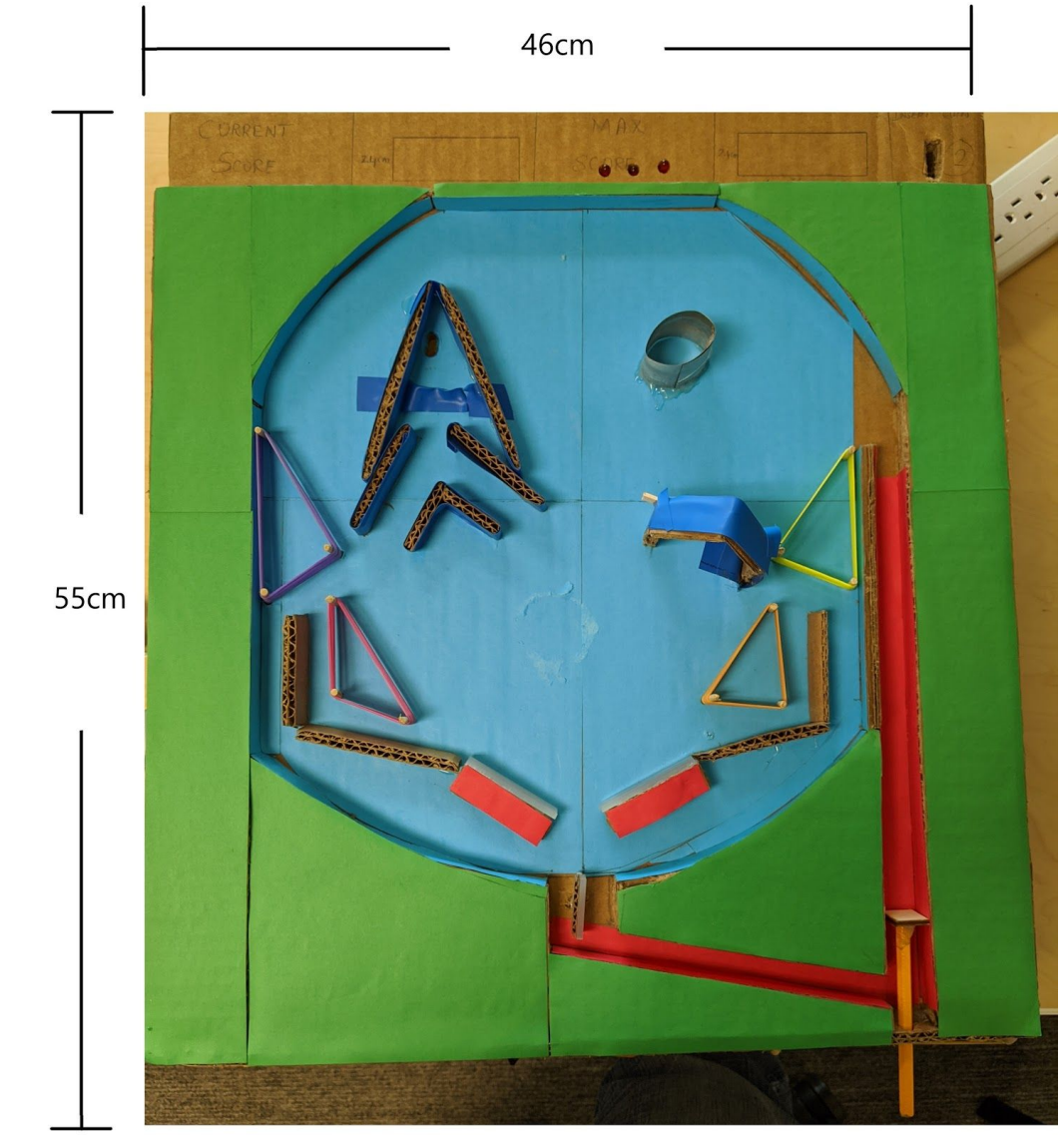
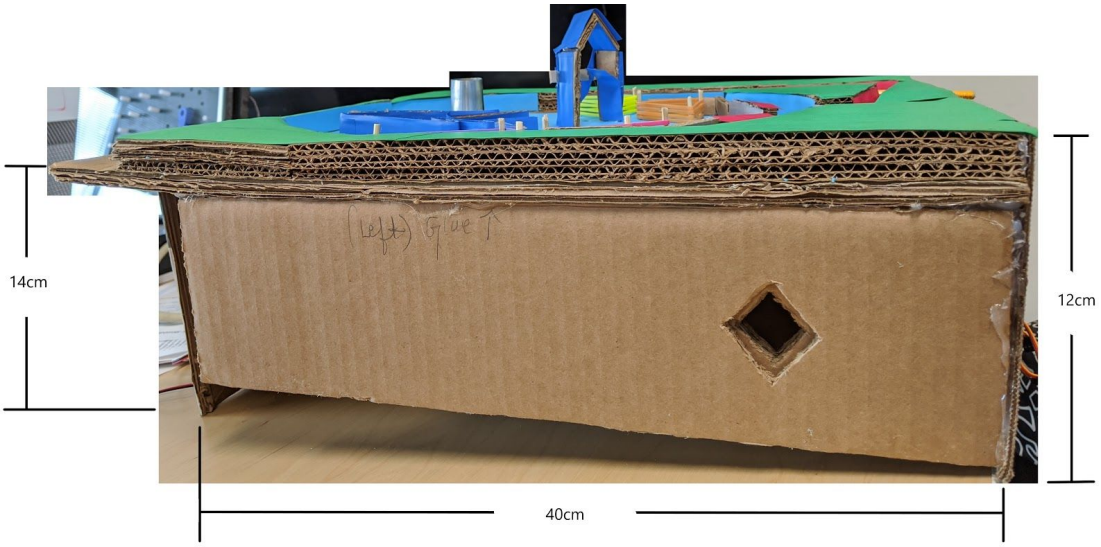


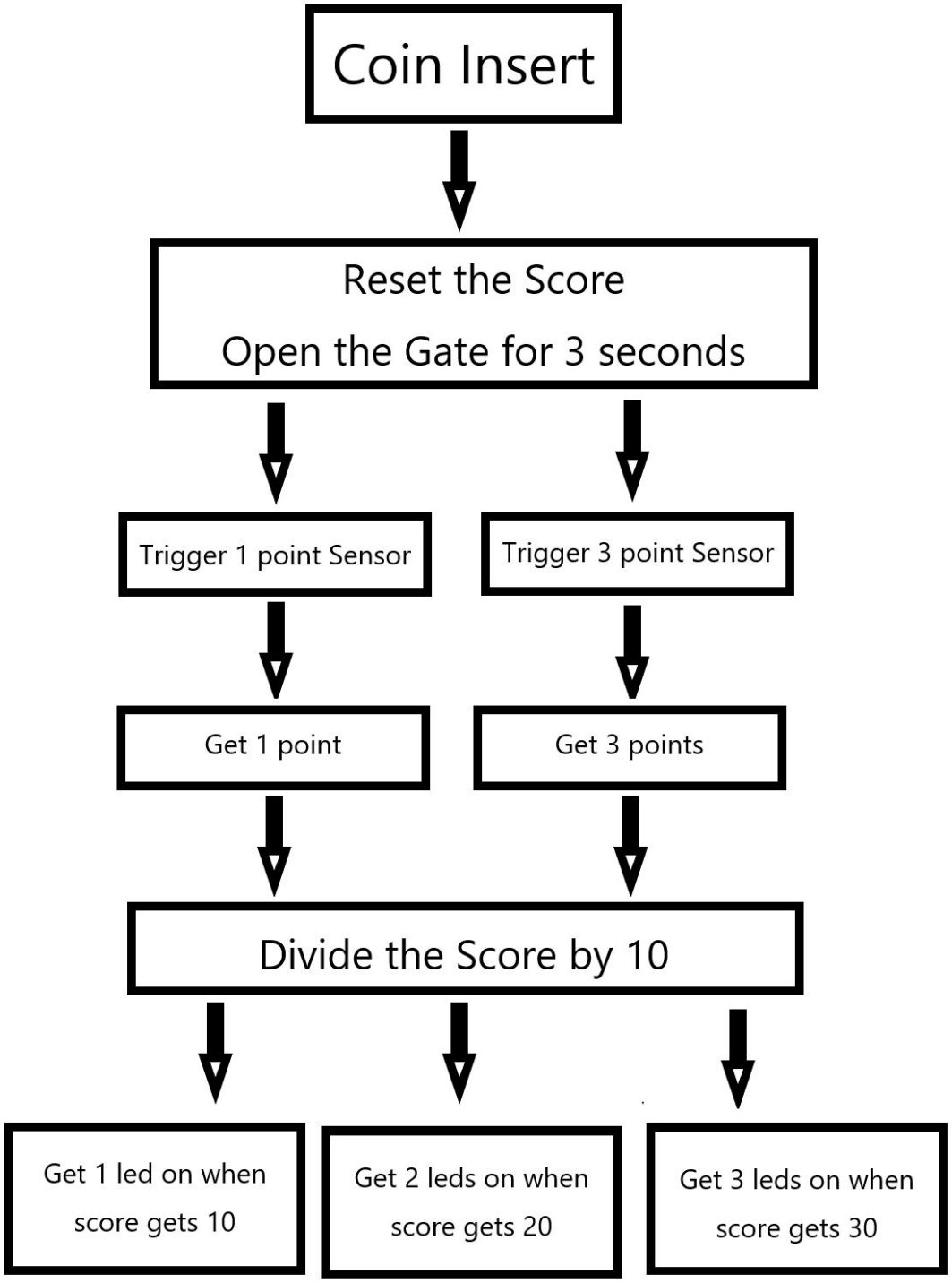
Figure 4: Circuit Diagram for the System

SCHEMATICS:





FLOWCHART:


Coin Insert
Reset the Score
Open the Gate for 3 seconds
Trigger 1 point Sensor
Trigger 3 point Sensor
Get 1 point
Get 3 points
Divide the Score by 10
Get 1 led on when score gets 10
Get 2 leds on when score gets 20
Get 3 leds on when score gets 30

CONCLUSION:

Given the scope of the project specifications from the beginning, which proposed a simplified version of a pinball game, this project was successful. The IR sensor system was successful in detecting the presence of the ball and appropriately adjusting the score. Use of servo motors allowed the position of the paddles to be controlled with every button press, which eliminated positioning errors that may have been introduced by other motors.

While designing this project we faced **one primary challenge** that consumed a great deal of time. This challenge dealt with the servo motor which we used for two paddles. It has low torque and speed which was not sufficient enough to hit the ball up to the top of the board. We also tried using gear for this, but we were not able to mount it correctly within the given time. We also tried using different pinball materials but nothing worked as we expected. So, we ended up using the same servo motor. Even though the ball didn't go till the top of the board, it was travelling well below that region and we were able to count points.

We were pleased with the successful implementation of our design. We learned a great deal about the microcontroller and how well it can be used to make great designs and we were also able to expand our knowledge about using the various electronic components which we have used for this project.

Thank You!