Dancing Robot

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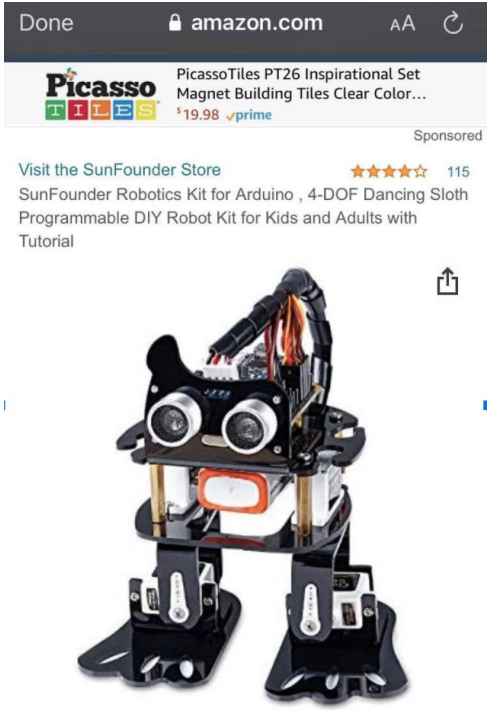
ECE 196, Fall 2020



A screenshot taken from amazon.com

Introduction

Goal: build and program a dancing robot using Arduino

The robot will be able to:

1. Dance (code designed by SunFounder, not us)
2. Move forwards, and move backwards when it senses an obstacle within 5 cm (code designed by us)

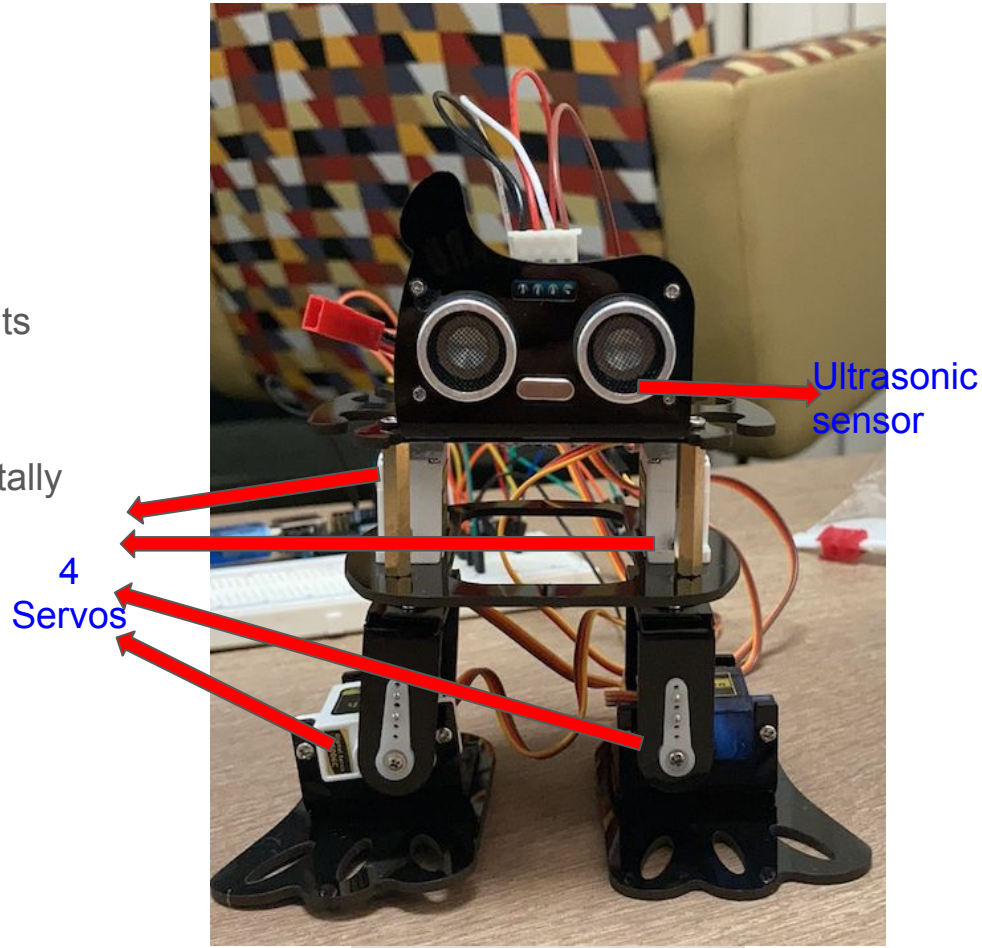
Problem Solving Approach

- Understand the robot’s structure
  - Two legs and feet and a pair of eyes
- Test each component
  - Four servos and an ultrasonic sensor
- Build the robot
  - Calibrate the internal angle of each servo
- Design and connect the circuit
  - All components connected in series
- Program the robot
  - Implement the dancing code.
  - Design the code for moving forward and turning right.
- Upload and make it dance/move!

The robot’s structure

- Two legs and feet: controlled by four servos
  - Capability of performing various movements
  - Servo’s range: 0° to 180°
  - Two servos on the feet rotate vertically
  - Two servos on the body/leg rotate horizontally

- Eyes: an ultrasonic distance sensor
  - sense distance from obstacle

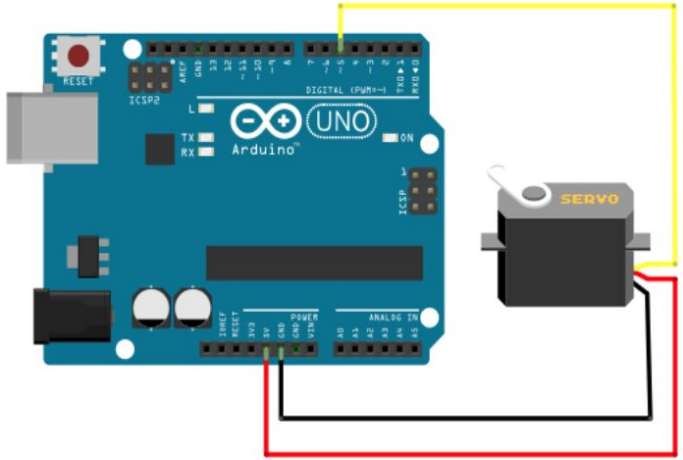


Our Finished Product

Test servo:

```
#include <Servo.h>

int servo_pin = 5;

Servo servoMain; // Create object

void setup() {
  servoMain.attach( servo_pin );
}

void loop() {
  servoMain.write( 180 );  // Highest angle delay(1000);
  delay(1000);
  servoMain.write( 0 ); // Lowest angle delay(1000);
  delay(1000);
}
```

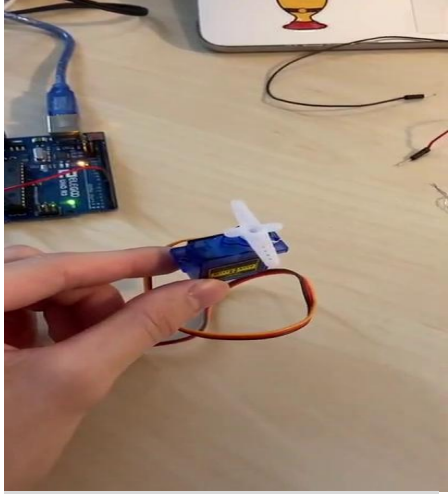
The code we used for testing the servo



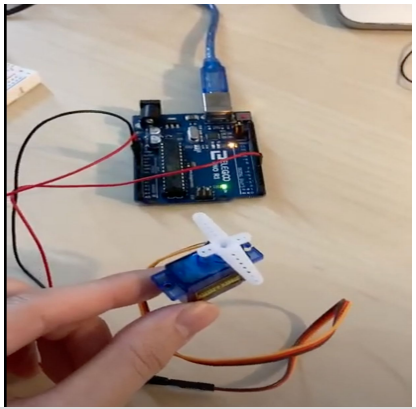
Circuit referenced from “Introduction to Arduino” by PIB

- **Remark**:

  one mistake: didn’t test the case when all four servos are powered by a single 9V battery



A short clip of testing a servo



A screenshot in case the video doesn’t work

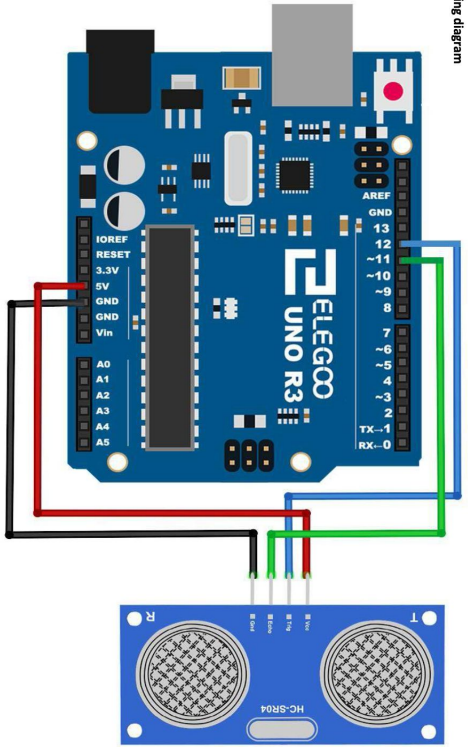
Test ultrasonic sensor:

SR04_Example | SR04.cpp | SR04.h

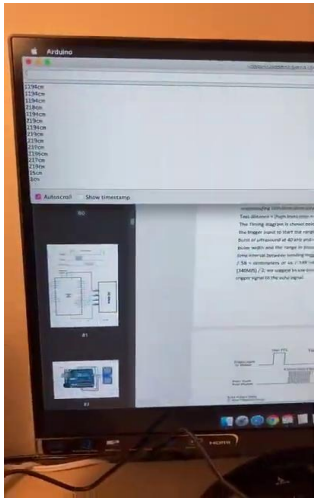
```
//www.elegoo.com
//2016.12.08
#include "SR04.h"
#define TRIG_PIN 12
#define ECHO_PIN 11
SR04 sr04 = SR04(ECHO_PIN,TRIG_PIN);
long a;

void setup() {
   Serial.begin(9600);
   delay(1000);
}

void loop() {
   a=sr04.Distance();
   Serial.print(a);
   Serial.println("cm");
   delay(1000);
}
```

Code referenced from www.elegoo.com

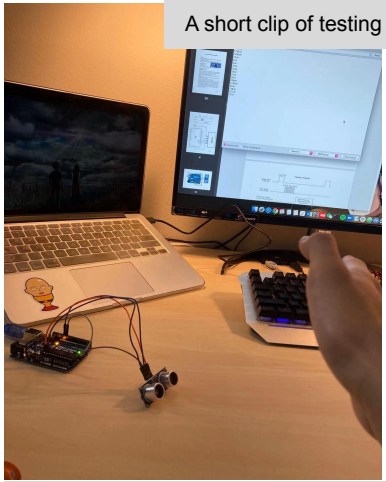
Wiring diagram



Circuit referenced from “THE MOST COMPLETE STARTER KIT TUTORIAL FOR UNO” by Elegoo

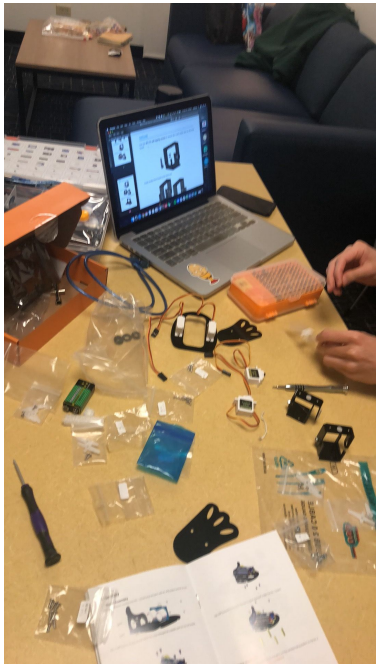


A short clip of testing the sensor



A picture in case the video doesn’t work

Build the robot

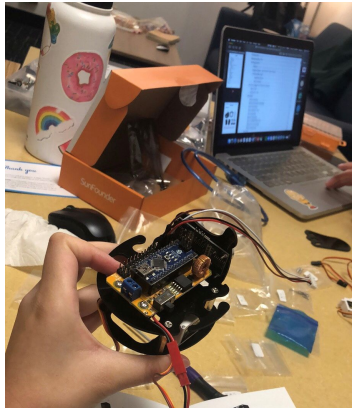


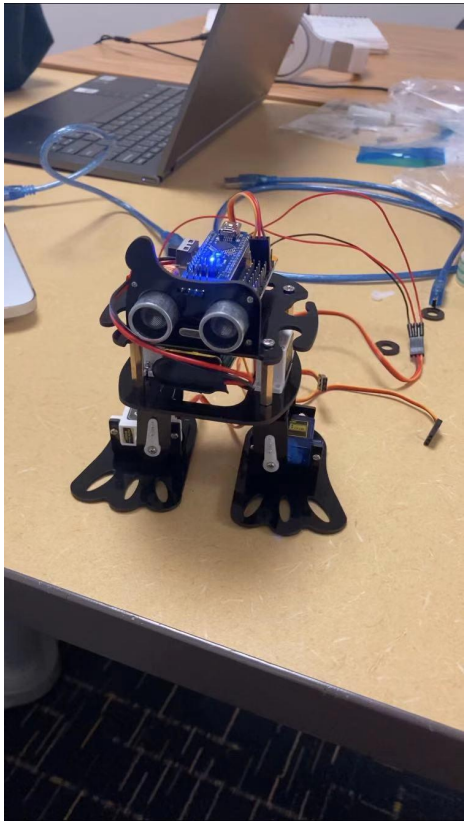
Us building the robot

- **Remark**:

  One mistake: didn't calibrate the internal angle of the servos before installing

- Goal: internal angle = 90° when:
  - Feet: perpendicular to the table
  - Leg: toes towards the front



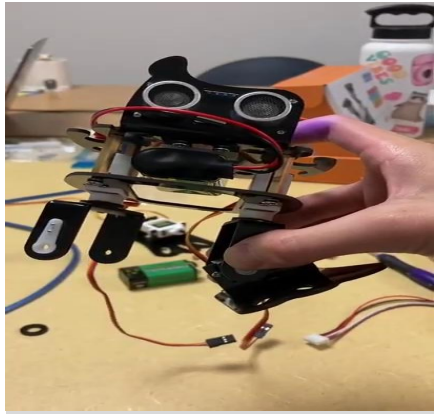


The first version of our robot

Calibrate the internal angle of each servo

1. Code: look for internal 90°
2. 4 rotations in each iteration (90°,0°,150°,0°)
3. Find the 90°
4. Reinstall it with the right direction
5. Done!

```
void loop(){
    myservo1.write(90);

    delay(1000);
    myservo1.write(0);

    delay(1000);
    myservo1.write(150);

    delay(1000);
    myservo1.write(0);

    delay(1000);
```



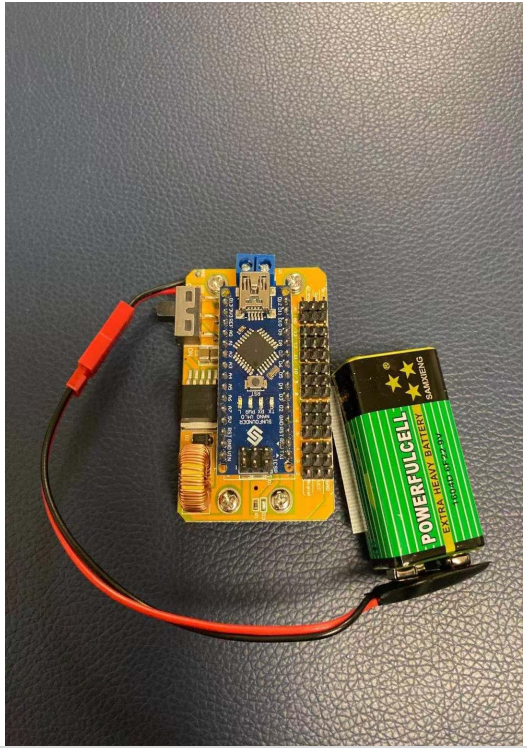
before calibrating the **left** foot

- Before calibrating the **left** foot
- After calibrating the **right** foot

after calibrating the **right** foot

A problem met when connecting the circuit: NOT ENOUGH POWER :<

- **Initially**: Arduino Nano board + a 9V battery
- 9V battery: not enough power!
- One servo (✅)
- Four servos (❌)
- **Solution**: Nano board → Uno board.

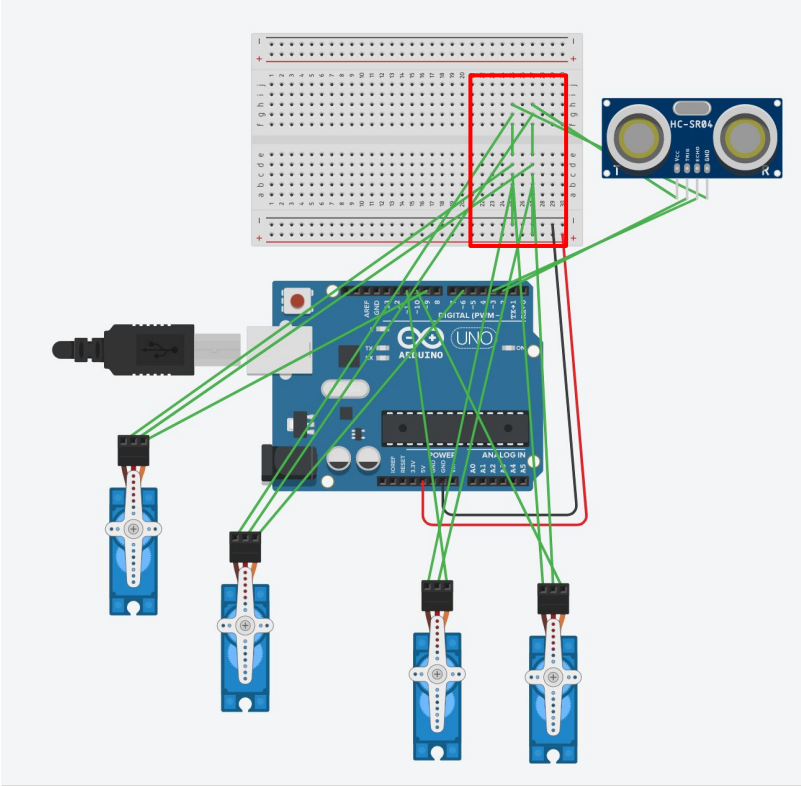


The Nano board provided and a 9V battery

Design the circuit

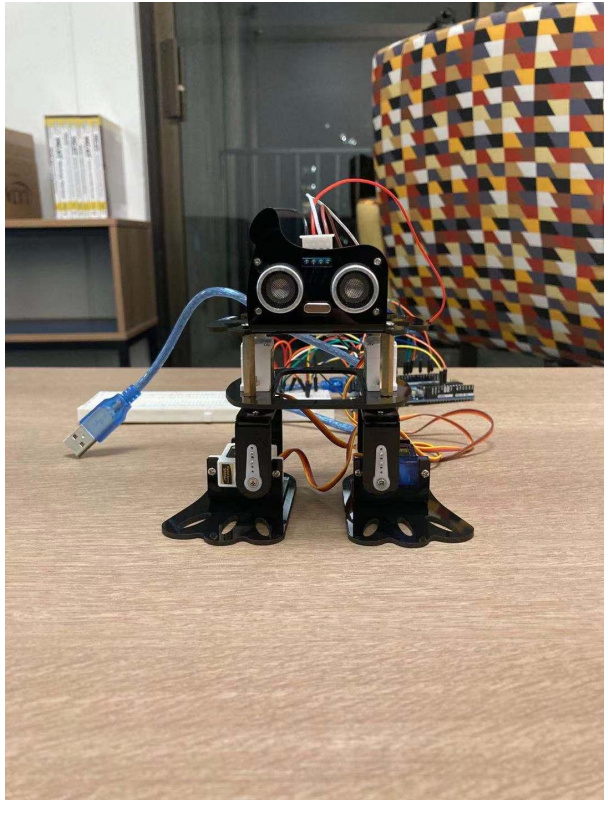
- Need help from a breadboard.

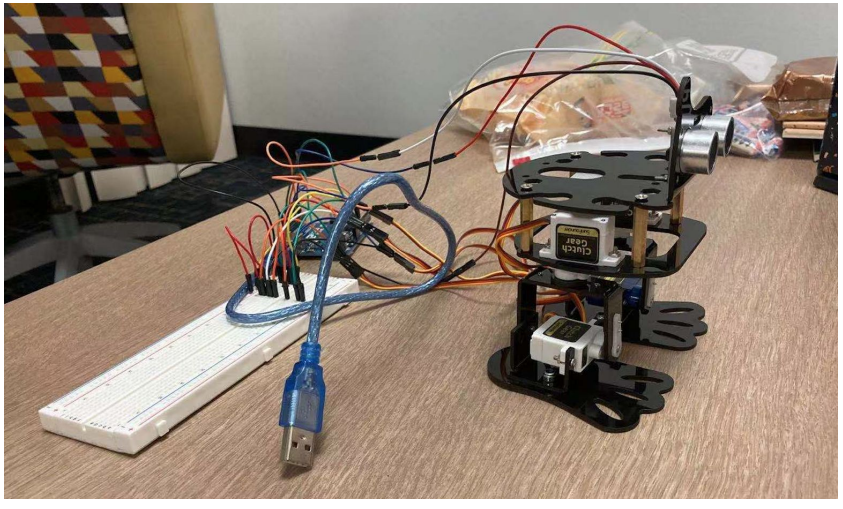
- The use of the breadboard (Physics concept):
  - Four servos and the ultrasonic sensor connected in **parallel** !!

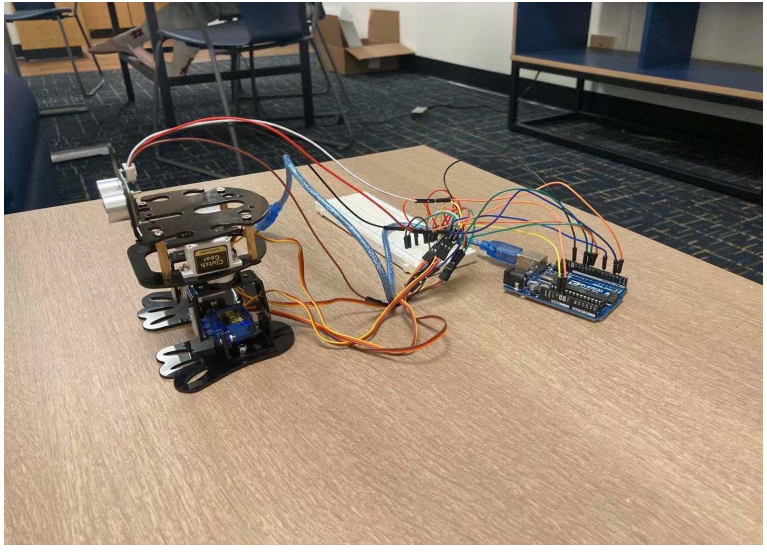


The circuit we designed by ourselves using TinkerCad

Final product:







Program the robot: Dancing

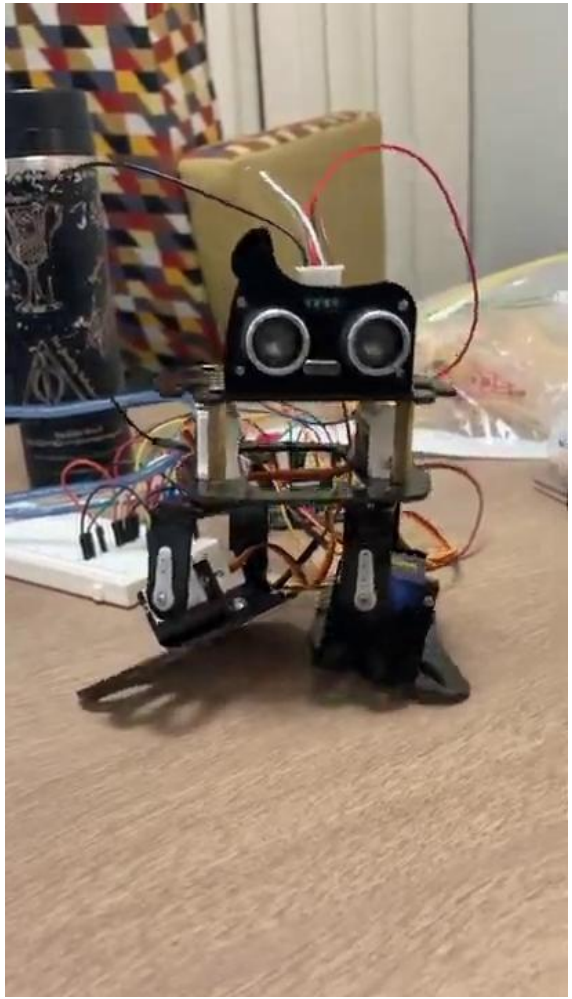
- Code referenced from https://www.sunfounder.com/.

- We believe Stella will be able to design a more beautiful dancing because she is a professional hip-hop dancer in UCSD!

```
void Dancing3(int Times = 1, int Vel = 40, int Delay = 250, int low = 0, int high = 0)
{
    for(int time3 = 0; time3 < Times; time3++) {
        for(int z=0; z<6; z++) {
            if ( time3 > 1 && time3 < 4) {
            vel_Dance3 = Vel;
            delay_Dance3 = Delay;
            }
            else {
            vel_Dance3 = 40;
            delay_Dance3 = 200;
            }

            RU.slowmove (array_cal[0] + array_dance3[z][0] , vel_Dance3);
            RL.slowmove (array_cal[1] + array_dance3[z][1] , vel_Dance3);
            LU.slowmove (array_cal[2] + array_dance3[z][2] , vel_Dance3);
            LL.slowmove (array_cal[3] + array_dance3[z][3] , vel_Dance3);
            delay(delay_Dance3);
        }
    }
    for(int z=6; z<8; z++) {
            RU.slowmove (array_cal[0] + array_dance3[z][0] , vel_Dance3);
            RL.slowmove (array_cal[1] + array_dance3[z][1] , vel_Dance3);
            LU.slowmove (array_cal[2] + array_dance3[z][2] , vel_Dance3);
            LL.slowmove (array_cal[3] + array_dance3[z][3] , vel_Dance3);
            delay(delay_Dance3);
        }
```

A screenshot of the dancing code

Dancing video



Program the robot: move forward and backward

- Set up

```
#include <Servo.h>
#include "SR04.h"
Servo myservo1;
Servo myservo2;
Servo myservo3;
Servo myservo4;

#define TRIG_PIN 2
#define ECHO_PIN 3
SR04 sr04 = SR04(ECHO_PIN,TRIG_PIN);
long a;
int i;

void setup(){
  Serial.begin(9600);
  myservo1.attach(6);    // LL
  myservo2.attach(9);    // RL
  myservo3.attach(10);     // LU
  myservo4.attach(11);     // RU
```

Initialize and attach the four servos

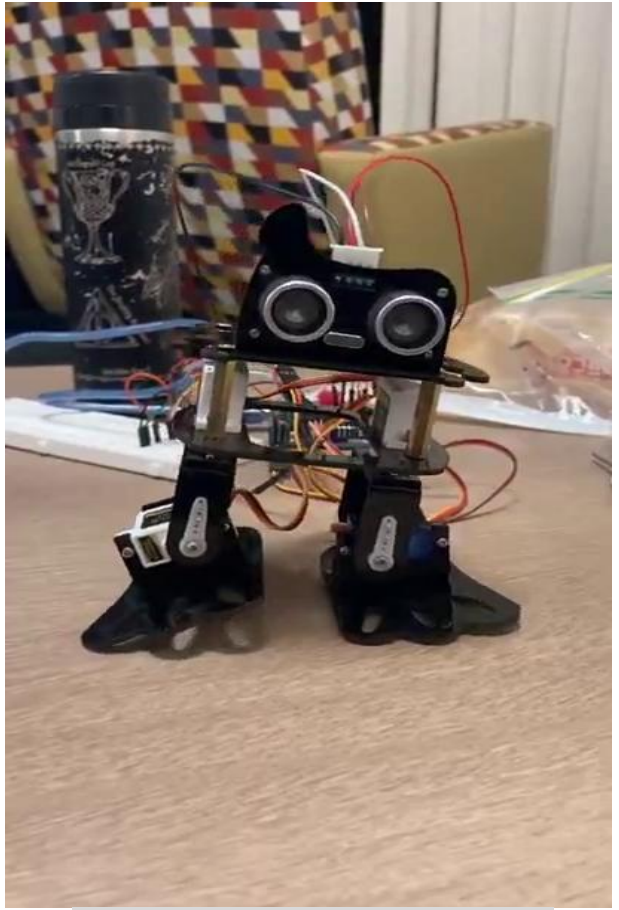
```
void loop(){
    a=sr04.Distance();
    Serial.print(a);
    Serial.println("cm");
    delay(1000);
```

Sensing distance

Move forward

```
else {
   // move forward
  // move left leg
  for (i = 90; i < 130; i++) {
    myservo2.write(i);
    myservo1.write(i);
    delay(20);
  }

  for (i = 90; i > 60; i--) {
    myservo3.write(i);
    delay(20);
  }

  for (i = 130; i > 90; i--) {
    myservo2.write(i);
    myservo1.write(i);
    delay(20);
  }

  for (i = 60; i < 90; i++) {
    myservo3.write(i);
    delay(20);
  }
```

```
// move right leg
for (i = 90; i > 50; i--) {
  myservo2.write(i);
  myservo1.write(i);
  delay(20);
}

for (i = 90; i < 120; i++) {
  myservo4.write(i);
  delay(20);
}

for (i = 50; i < 90; i++) {
  myservo2.write(i);
  myservo1.write(i);
  delay(20);
}

 for (i = 120; i > 90; i--) {
  myservo4.write(i);
  delay(20);
}
```



Video of moving forward

Sense obstacle and move backwards

```
if (a < 5) {
    // move backward
   // move left leg
  for (i = 90; i < 120; i++) {
    myservo2.write(i);
    myservo1.write(i);
    delay(20);
  }

  for (i = 90; i < 120; i++) {
    myservo3.write(i);
    delay(20);
  }

  for (i = 120; i > 90; i--) {
    myservo2.write(i);
    myservo1.write(i);
    delay(20);
  }

  for (i = 120; i > 90; i--) {
    myservo3.write(i);
    delay(20);
  }
```

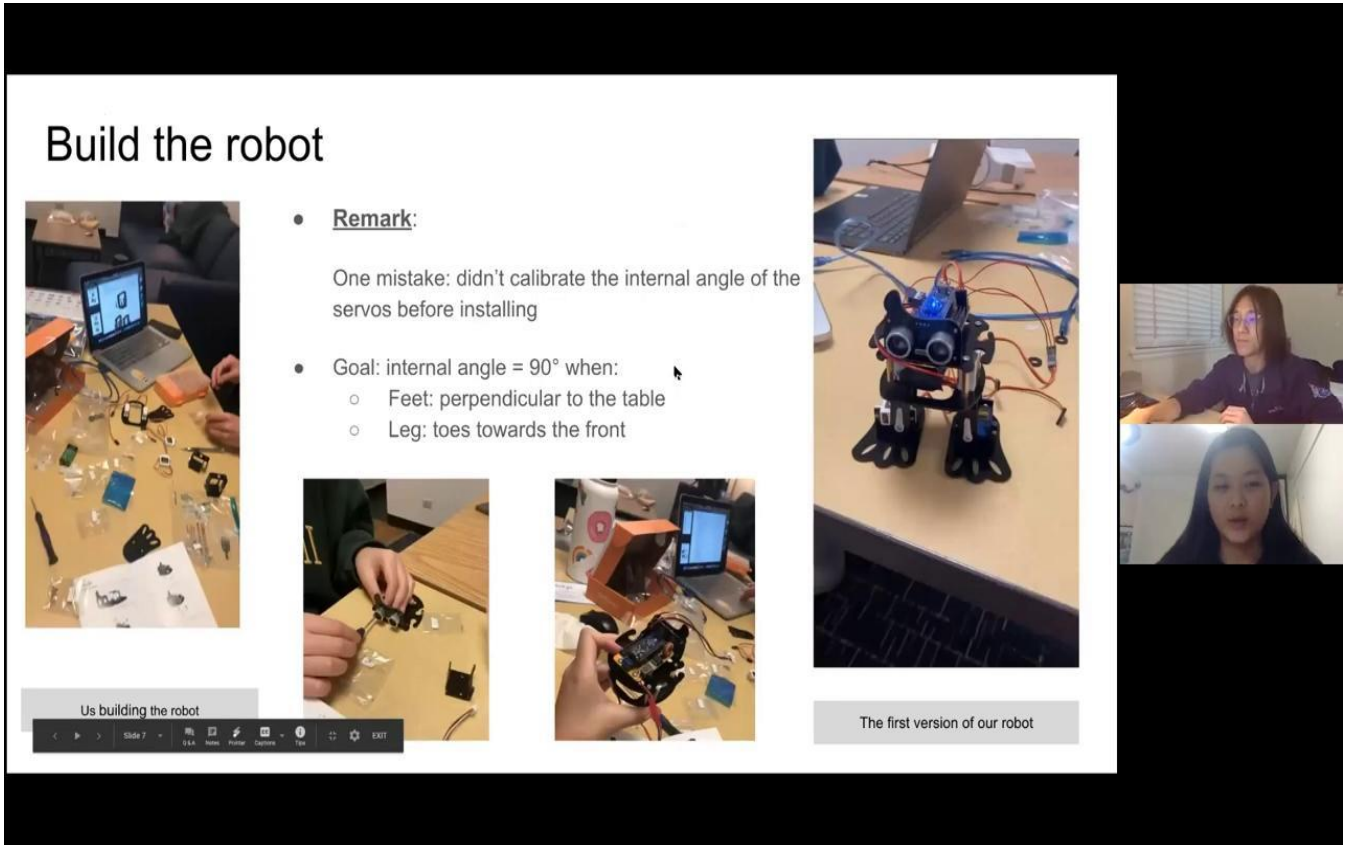
```
// move right leg
for (i = 90; i > 50; i--) {
  myservo2.write(i);
  myservo1.write(i);
  delay(20);
}

for (i = 90; i > 60; i--) {
  myservo4.write(i);
  delay(20);
}

for (i = 50; i < 90; i++) {
  myservo2.write(i);
  myservo1.write(i);
  delay(20);
}

 for (i = 60; i < 90; i++) {
  myservo4.write(i);
  delay(20);
}
```

Video of moving backward

Thank you!

Special thanks to our TA, Phuong Truong, for providing us the kit!

Demo of project



A link to our google doc presentation (in case the video doesn't work.): https://docs.google.com/presentation/d/1DY0iMlciiEMNmzehVBZ2Bj8aK8kp8G-zquDmWkwIDno/edit#slide=id.gaf64e626c1_7_0

(Since we've showcased many short clips, our presentation might be a little bit longer than 10 mins.)