Bi-pedal robot

Project Documentation

Design with Microprocessors

Vlad Mihali

Group: 30434

CUPRINS

1 CONCEPT

The main objective of this project is to make a bi-pedal robot. The tasks that the robot can do are dance and sing, but unfortunately not very artistic. Tasks are controlled by 2 interrupts (next and standby).

This "humanoid" robot has 5 modes: 3 dances with each one having a Christmas carol; 2 other dances.

This robot only uses 2 (micro) servos per leg. This makes the robot easy to create, code and cheap to make. This robot can be made as a beginner's robot to introduce yourself to the field of robotics. Other components of this robot are: one speaker and two buttons (one for standby and other for the next performance).
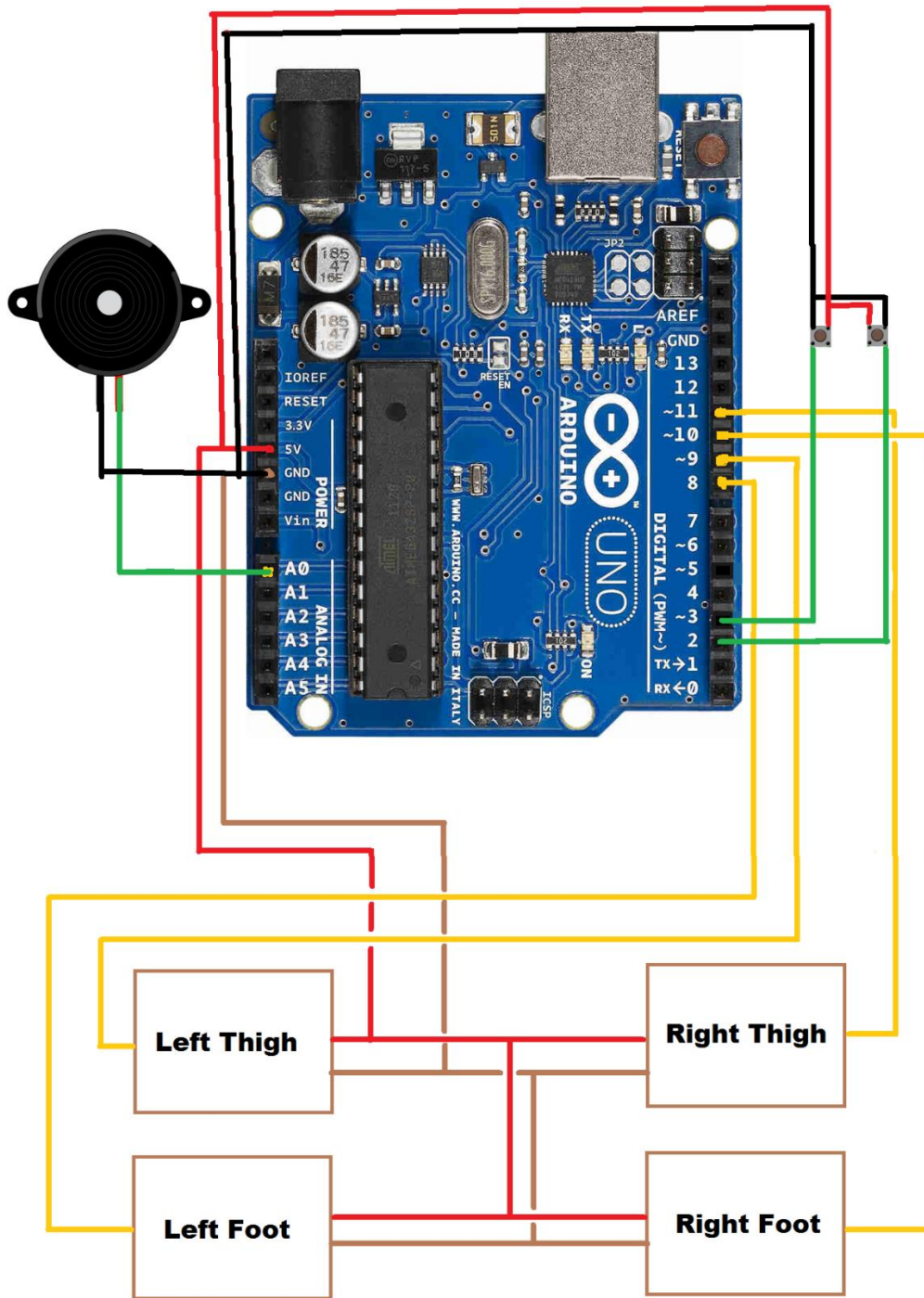
2 DESIGN

2.1 DIAGRAM

This is the physical part of the project with all connections. Int the left part we see Arduino Uno with 2 buttons, one speaker and in the right part is the actual robot compose of 4 servomotors.
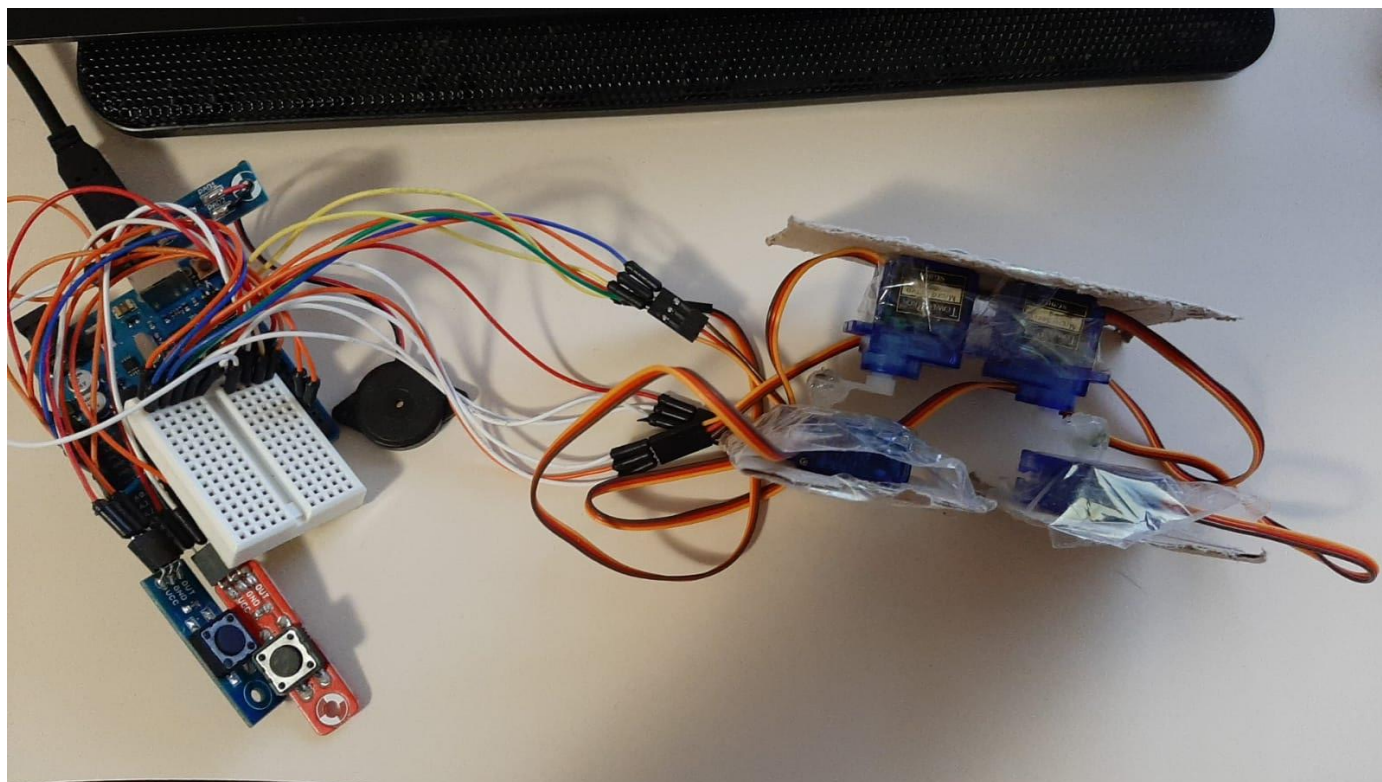
This is the electric scheme: right button is next and left button is "restart"

2.2 COMPONENTS

Arduino UNO

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA

| DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

SERVO MOTOR SG90
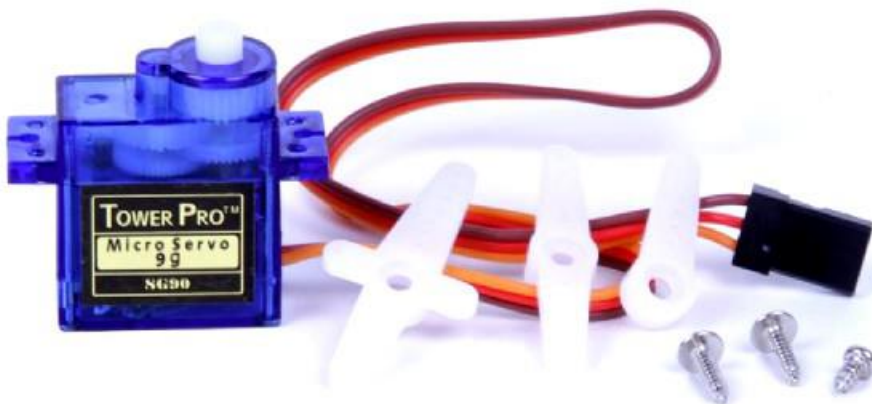
Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds
but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a

motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.
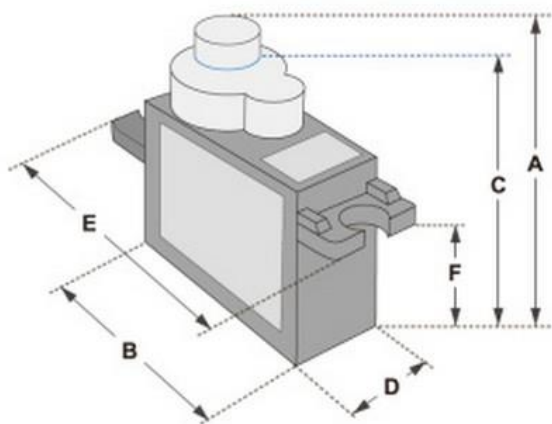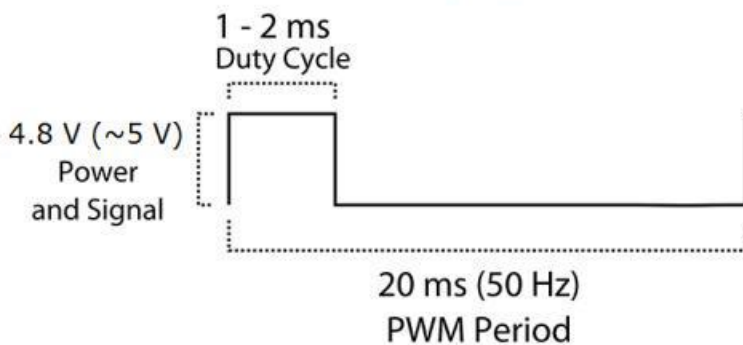
Dimensions & Specifications
A (mm) : 32
B (mm) : 23
C (mm) : 28.5
D (mm) : 12
E (mm) : 32
F (mm) : 19.5
Speed (sec) : 0.1
Torque (kg-cm) : 2.5
Weight (g) : 14.7
Voltage : 4.8 - 6

Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle,
is all the way to the right, "-90" (~1ms pulse) is all the way to the left

PWM=Orange (⊓⊓)
Vcc = Red (+)
Ground=Brown (−)

1 - 2 ms
Duty Cycle

4.8 V (~5 V)
Power
and Signal

20 ms (50 Hz)
PWM Period
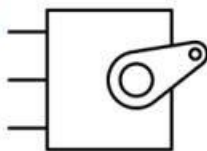
- 2 buttons
- 1 speaker

2.3 CONNECTIONS

Attached the horns to the servos, then glue the servos together. Take a piece of cardboard and glue both servos on it and cut extra cardboard out. One way to ensure that you do this properly is to make sure that the screw mounting part of both the servos is touching. The other two servos glue them on one piece of cardboard like in the picture below. After that, connect to Arduino (see the electric scheme). Connection of the two buttons need to be done on pin 2 and 3 because are causing interrupts. The speaker is connected to pin A0 (pin number 14).
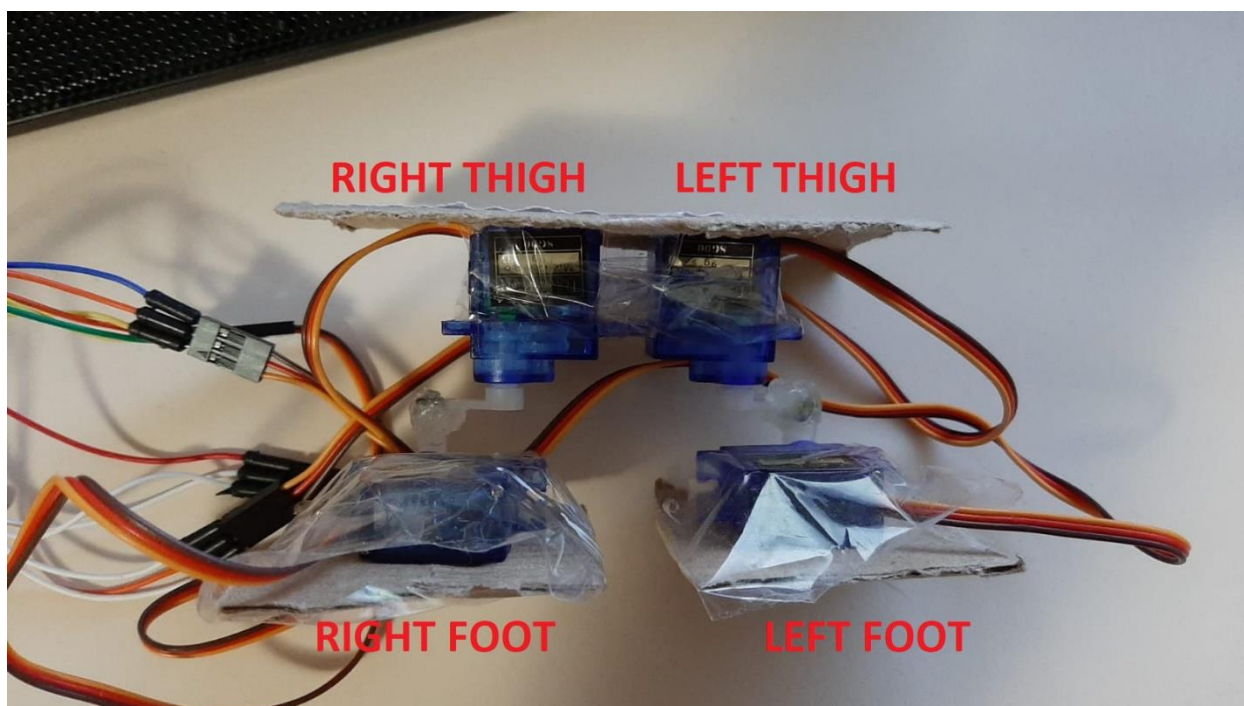
3 IMPLEMENTATION

```
#include <Servo.h>
#include <LiquidCrystal.h>
#include <pt.h>
Servo rightfoot;
Servo rightthigh;
Servo leftfoot;
Servo leftthigh;
int speakerPin = 14;
int interruptPin = 2;
int interruptPin2 = 3;
volatile int nr = 5;

//LiquidCrystal lcd(9, 8, 7, 6, 5, 4);
```

```cpp
int pos = 0;
int pos1 = 0;

#include "pitches.h"

#define melodyPin 14

// Jingle Bells

int melody[] = {
    NOTE_E5, NOTE_E5, NOTE_E5,
    NOTE_E5, NOTE_E5, NOTE_E5,
    NOTE_E5, NOTE_G5, NOTE_C5, NOTE_D5,
    NOTE_E5,
    NOTE_F5, NOTE_F5, NOTE_F5, NOTE_F5,
    NOTE_F5, NOTE_E5, NOTE_E5, NOTE_E5, NOTE_E5,
    NOTE_E5, NOTE_D5, NOTE_D5, NOTE_E5,
    NOTE_D5, NOTE_G5,
    NOTE_E5, NOTE_E5, NOTE_E5,
    NOTE_E5, NOTE_E5, NOTE_E5,
    NOTE_E5, NOTE_G5, NOTE_C5, NOTE_D5,
    NOTE_E5,
    NOTE_F5, NOTE_F5, NOTE_F5, NOTE_F5,
    NOTE_F5, NOTE_E5, NOTE_E5, NOTE_E5, NOTE_E5,
    NOTE_E5, NOTE_D5, NOTE_D5, NOTE_E5,
    NOTE_D5, NOTE_G5 };

int tempo[] = {
    8, 8, 4,
    8, 8, 4,
    8, 8, 8, 8,
    2,
    8, 8, 8, 8,
    8, 8, 8, 16, 16,
    8, 8, 8, 8,
    4, 4,
    8, 8, 4,
    8, 8, 4,
    8, 8, 8, 8,
    2,
    8, 8, 8, 8,
    8, 8, 8, 16, 16,
    8, 8, 8, 8,
    4, 4 };

// We wish you a merry Christmas

int wish_melody[] = {
    NOTE_B3,
    NOTE_F4, NOTE_F4, NOTE_G4, NOTE_F4, NOTE_E4,
    NOTE_D4, NOTE_D4, NOTE_D4,
```

```c
    NOTE_G4, NOTE_G4, NOTE_A4, NOTE_G4, NOTE_F4,
    NOTE_E4, NOTE_E4, NOTE_E4,
    NOTE_A4, NOTE_A4, NOTE_B4, NOTE_A4, NOTE_G4,
    NOTE_F4, NOTE_D4, NOTE_B3, NOTE_B3,
    NOTE_D4, NOTE_G4, NOTE_E4,
    NOTE_F4,
    NOTE_B3,
    NOTE_F4, NOTE_F4, NOTE_G4, NOTE_F4, NOTE_E4,
    NOTE_D4, NOTE_D4, NOTE_D4,
    NOTE_G4, NOTE_G4, NOTE_A4, NOTE_G4, NOTE_F4,
    NOTE_E4, NOTE_E4, NOTE_E4,
    NOTE_A4, NOTE_A4, NOTE_B4, NOTE_A4, NOTE_G4,
    NOTE_F4, NOTE_D4, NOTE_B3, NOTE_B3,
    NOTE_D4, NOTE_G4, NOTE_E4,
    NOTE_F4 };

int wish_tempo[] = {
    4,
    4, 8, 8, 8, 8,
    4, 4, 4,
    4, 8, 8, 8, 8,
    4, 4, 4,
    4, 8, 8, 8, 8,
    4, 4, 8, 8,
    4, 4, 4,
    2,
    4,
    4, 8, 8, 8, 8,
    4, 4, 4,
    4, 8, 8, 8, 8,
    4, 4, 4,
    4, 8, 8, 8, 8,
    4, 4, 8, 8,
    4, 4, 4,
    2 };

// Santa Claus is coming to town

int santa_melody[] = {
    NOTE_G4,
    NOTE_E4, NOTE_F4, NOTE_G4, NOTE_G4, NOTE_G4,
    NOTE_A4, NOTE_B4, NOTE_C5, NOTE_C5, NOTE_C5,
    NOTE_E4, NOTE_F4, NOTE_G4, NOTE_G4, NOTE_G4,
    NOTE_A4, NOTE_G4, NOTE_F4, NOTE_F4,
    NOTE_E4, NOTE_G4, NOTE_C4, NOTE_E4,
    NOTE_D4, NOTE_F4, NOTE_B3,
    NOTE_C4,
    NOTE_G4,
    NOTE_E4, NOTE_F4, NOTE_G4, NOTE_G4, NOTE_G4,
    NOTE_A4, NOTE_B4, NOTE_C5, NOTE_C5, NOTE_C5,
    NOTE_E4, NOTE_F4, NOTE_G4, NOTE_G4, NOTE_G4,
```

```
    NOTE_A4, NOTE_G4, NOTE_F4, NOTE_F4,
    NOTE_E4, NOTE_G4, NOTE_C4, NOTE_E4,
    NOTE_D4, NOTE_F4, NOTE_B3,
    NOTE_C4 };

int santa_tempo[] = {
    8,
    8, 8, 4, 4, 4,
    8, 8, 4, 4, 4,
    8, 8, 4, 4, 4,
    8, 8, 4, 2,
    4, 4, 4, 4,
    4, 2, 4,
    1,
    8,
    8, 8, 4, 4, 4,
    8, 8, 4, 4, 4,
    8, 8, 4, 4, 4,
    8, 8, 4, 2,
    4, 4, 4, 4,
    4, 2, 4,
    1 };

void setup()
{
    rightfoot.attach(12);
    rightthigh.attach(13);
    leftfoot.attach(10);
    leftthigh.attach(11);
    leftfoot.write(10);
    leftthigh.write(90);
    rightthigh.write(105);
    rightfoot.write(180);
    pinMode(14, OUTPUT);
    pinMode(interruptPin, INPUT_PULLUP);
    pinMode(interruptPin2, INPUT_PULLUP);
    attachInterrupt(digitalPinToInterrupt(interruptPin), inter1, RISING);
    attachInterrupt(digitalPinToInterrupt(interruptPin2), inter2, RISING);
}
void loop()
{
startloop:
    switch (nr)
    {
    case 0:
        robotStop();
        break;
    case 1:
        robot();
        break;
    case 2:
```

```
        robot1();
        break;
    case 3:
        robot2();
        break;
    case 4:
        robot3();
        break;
    case 5:
        robot4();
        break;
    }
}

void robot()
{
    int i = 0;
    if (nr == 1)
    {
        rightfoot.write(172);
        music2(i);
        i++;
    }
    if (nr == 1)
    {
        rightfoot.write(164);
        music2(i);
        i++;
    }
    if (nr == 1)
    {
        rightfoot.write(156);
        music2(i);
        i++;
    }
    if (nr == 1)
    {
        rightfoot.write(148);
        music2(i);
        i++;
    }
    if (nr == 1)
    {
        rightfoot.write(140);
        music2(i);
        i++;
    }
    if (nr == 1)
    {
        rightfoot.write(132);
        music2(i);
```

```
    i++;
}
if (nr == 1)
{
    leftfoot.write(16);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(22);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(28);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(34);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(40);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(46);
    music2(i);
    i++;
}
if (nr == 1)
{
    rightfoot.write(172);
    music2(i);
    i++;
}
if (nr == 1)
{
    rightfoot.write(164);
    music2(i);
    i++;
}
if (nr == 1)
```

```
{
    rightfoot.write(156);
    music2(i);
    i++;
}
if (nr == 1)
{
    rightfoot.write(148);
    music2(i);
    i++;
}
if (nr == 1)
{
    rightfoot.write(140);
    music2(i);
    i++;
}
if (nr == 1)
{
    rightfoot.write(132);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(16);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(22);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(28);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(34);
    music2(i);
    i++;
}
if (nr == 1)
{
    leftfoot.write(40);
    music2(i);
```

```cpp
        i++;
    }
    if (nr == 1)
    {
        leftfoot.write(46);
        music2(i);
        i++;
    }
}

void robot1()
{
    for (pos = 85; pos < 130; pos += 1)
    {
        if (nr == 2)
        {
            rightthigh.write(pos);

            delay(15);
        }
    }
    for (pos = 130; pos >= 85; pos -= 1)
    {
        if (nr == 2)
        {
            rightthigh.write(pos);

            delay(15);
        }
    }

    for (pos1 = 50; pos1 < 95; pos1 += 1)
    {
        if (nr == 2)
        {
            leftthigh.write(pos1);

            delay(15);
        }
    }
    for (pos1 = 95; pos1 >= 50; pos1 -= 1)
    {
        if (nr == 2)
        {
            leftthigh.write(pos1);

            delay(15);
        }
    }
}
```

```
void robot2()
{
    leftfoot.write(10);
    leftthigh.write(90);
    rightthigh.write(105);
    rightfoot.write(180);
    //delay(1000);
    int i = 0;
    leftfoot.write(17);
    if (nr == 3)
    {
        music3(i);
        i++;
    }
    if (nr == 3)
    {
        leftthigh.write(95);
        music3(i);
        i++;
    }
    if (nr == 3)
    {
        rightthigh.write(107.5);
        music3(i);
        i++;
    }
    if (nr == 3)
    {
        leftfoot.write(24);
        music3(i);
        i++;
    }
    if (nr == 3)
    {
        leftthigh.write(100);
        music3(i);
        i++;
    }
    if (nr == 3)
    {
        rightthigh.write(110);
        music3(i);
        i++;
    }
    if (nr == 3)
    {
        leftfoot.write(31);
        music3(i);
        i++;
    }
    if (nr == 3)
```

```
{
    leftthigh.write(105);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(112.5);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftfoot.write(38);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftthigh.write(110);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(115);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftfoot.write(45);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftthigh.write(115);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(117.5);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftfoot.write(52);
    music3(i);
```

```
        i++;
}
if (nr == 3)
{
    leftthigh.write(120);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(120);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftfoot.write(59);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftthigh.write(125);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(122.5);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftfoot.write(66);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftthigh.write(130);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(125);
    music3(i);
    i++;
}
if (nr == 3)
```

```
{
    leftfoot.write(73);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftthigh.write(135);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(127.5);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftfoot.write(80);
    music3(i);
    i++;
}
if (nr == 3)
{
    leftthigh.write(140);
    music3(i);
    i++;
}
if (nr == 3)
{
    rightthigh.write(130);
    delay(100);
}
}

void robot3()
{
    int i = 0;
    if (nr == 4)
    {
        rightthigh.write(98);
        music4(i);
        i++;
    }
    if (nr == 4)
    {
        leftthigh.write(78);
        music4(i);
        i++;
    }
```

```
if (nr == 4)
{
    rightthigh.write(96);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(76);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(94);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(74);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(92);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(72);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(90);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(70);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(88);
```

```
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(68);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(86);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(66);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(84);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(64);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(82);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(62);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(80);
    music4(i);
    i++;
}
```

```
if (nr == 4)
{
    leftthigh.write(60);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(103);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(92);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(106);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(94);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(109);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(96);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(112);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(98);
```

```
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(115);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(100);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(118);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(102);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(121);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(104);
    music4(i);
    i++;
}
if (nr == 4)
{
    rightthigh.write(124);
    music4(i);
    i++;
}
if (nr == 4)
{
    leftthigh.write(106);
    music4(i);
    i++;
}
```

```
    if (nr == 4)
    {
        rightthigh.write(127);
        music4(i);
        i++;
    }
    if (nr == 4)
    {
        leftthigh.write(108);
        music4(i);
        i++;
    }
    if (nr == 4)
    {
        rightthigh.write(130);
        music4(i);
        i++;
    }
    if (nr == 4)
    {
        leftthigh.write(110);
        music4(i);
        i++;
    }
}
void robot4()
{
    if (nr == 5)
    {
        delay(700);
        leftfoot.write(20);
    }
    if (nr == 5)
    {
        delay(300);
        leftfoot.write(30);
    }
    if (nr == 5)
    {
        delay(300);
        leftfoot.write(40);
    }
    if (nr == 5)
    {
        delay(300);
        leftfoot.write(50);
    }
    if (nr == 5)
    {
        delay(300);
        leftfoot.write(60);
```

```
}
if (nr == 5)
{
    delay(700);
    rightfoot.write(160);
}
if (nr == 5)
{
    delay(700);
    rightfoot.write(150);
}
if (nr == 5)
{
    delay(700);
    rightfoot.write(140);
}
if (nr == 5)
{
    delay(700);
    rightfoot.write(130);
}
if (nr == 5)
{
    delay(1000);
    leftfoot.write(35);
}
if (nr == 5)
{
    delay(500);
    leftfoot.write(10);
}
if (nr == 5)
{
    delay(700);
    rightthigh.write(90);
}
if (nr == 5)
{
    delay(700);
    rightthigh.write(80);
}
if (nr == 5)
{
    delay(700);
    leftthigh.write(65);
}
if (nr == 5)
{
    delay(700);
    rightthigh.write(70);
}
```

```
if (nr == 5)
{
    delay(700);
    rightfoot.write(140);
}
if (nr == 5)
{
    delay(500);
    rightfoot.write(150);
}
if (nr == 5)
{
    delay(500);
    rightfoot.write(160);
}
if (nr == 5)
{
    delay(500);
    rightfoot.write(170);
}
if (nr == 5)
{
    delay(500);
    rightfoot.write(180);
}
if (nr == 5)
{
    delay(700);
    rightthigh.write(100);
}
if (nr == 5)
{
    delay(700);
    rightfoot.write(150);
}
if (nr == 5)
{
    delay(300);
    rightfoot.write(140);
}
if (nr == 5)
{
    delay(300);
    rightfoot.write(130);
}
if (nr == 5)
{
    delay(300);
    rightfoot.write(120);
}
if (nr == 5)
```

```
{
    delay(700);
    leftfoot.write(20);
}
if (nr == 5)
{
    delay(300);
    leftfoot.write(30);
}
if (nr == 5)
{
    delay(300);
    leftfoot.write(40);
}
if (nr == 5)
{
    delay(300);
    leftfoot.write(50);
}
if (nr == 5)
{
    delay(1200);
    leftthigh.write(80);
}
if (nr == 5)
{
    delay(700);
    leftthigh.write(90);
}
if (nr == 5)
{
    delay(700);
    leftthigh.write(100);
}
if (nr == 5)
{
    delay(700);
    rightfoot.write(150);
}
if (nr == 5)
{
    delay(700);
    rightfoot.write(180);
}
if (nr == 5)
{
    delay(700);
    leftfoot.write(40);
}
if (nr == 5)
{
```

```
        delay(300);
        leftfoot.write(30);
    }
    if (nr == 5)
    {
        delay(300);
        leftfoot.write(20);
    }
    if (nr == 5)
    {
        delay(300);
        leftfoot.write(10);
    }
    if (nr == 5)
    {
        delay(300);
        leftfoot.write(10);
    }
    if (nr == 5)
    {
        delay(300);
        leftthigh.write(90);
    }
    if (nr == 5)
    {
        delay(300);
        rightthigh.write(100);
    }
    if (nr == 5)
    {
        delay(300);
        rightfoot.write(180);
    }
}

void robotStop()
{
    leftfoot.write(10);
    leftthigh.write(90);
    rightthigh.write(105);
    rightfoot.write(180);
}

void inter1()
{
    nr = nr + 1;
    if (nr == 6) {
        nr = 0;
    }
    delayMicroseconds(1000);
    robotStop();
```

```
}

void inter2()
{
    nr = 0;
    robotStop();
}

void music2(int i)
{
    int noteDuration = 1000 / tempo[i];

    buzz(melodyPin, melody[i], noteDuration);
    delay(20);
}

void music3(int i)
{
    int noteDuration = 1000 / wish_tempo[i];

    buzz(melodyPin, wish_melody[i], noteDuration);
    delay(20);
}

void music4(int i)
{
    int noteDuration = 900 / santa_tempo[i];

    buzz(melodyPin, santa_melody[i], noteDuration);
    delay(20);
}

void buzz(int targetPin, long frequency, long length)
{
    long delayValue = 1000000 / frequency / 2;
    long numCycles = frequency * length / 1000;
    for (long i = 0; i < numCycles; i++)
    {
        digitalWrite(targetPin, HIGH);
        delayMicroseconds(delayValue);
        digitalWrite(targetPin, LOW);
        delayMicroseconds(delayValue);
    }
}
```

4 RESULTS

The result is visible in the presentation video.

5 CONCLUSION

The project which consist in making a robot that moves (dance) and making him sing (play music) is done using an Arduino uno board, 4 servos, 2 buttons, 1 speaker.

The project can be extended furthermore by adding extra movement (more servos). The robot can be improved by making him move more realistic and more complex dance moves (and on the bit).