ANIMATRONICS FACE: PROFESSOR WAN

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Submitted as part of project for ME 4543 Mechatronics, Fall 2018

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ABSTRACT

This project is inspired by Disney's Hall of President attraction which demonstrates audio-animatronic figures. The face will be able to interact with the user in some way. The face chosen will be that of a professor in the mechanical engineering department. This will be completed using sensors and actuators along with minimal programming. A presentation towards the end of the semester will demonstrate the face in its entirety.

Section 1: Literature review

For the first section, we researched existing animatronic heads. Our group found this one online in the Instructables website. This is how they made the animatronic head. Arduino was used to program the animatronic head. They first used Microsoft word to write down what they wanted it to say and converted it into a mp3 file. Once they had the audio file, they implemented it into the servos by using Arduino coding. After coding, they downloaded the file both the audio and Arduino file as a single control file onto a compact flash card connected to the single board computer (RAPU). Many servos were used for the animatronic head. Servo motors were used in the following: controlling sunglasses by rotating up out of the way or down in front of the eyes, left and right eye movements, eyelid movements, movement of entire eye section, movement of jaw, movement of head tilting, and left and right head movement. No sensors were used for the animatronic.

Figure 1: Talking Animatronic Robot Head

The next animatronic head our group research was the Fritz head from the website kickstarter. Fritz is a robotic puppet head that you can control. He has moving eyes, jaw, eyelids, eyebrows, and neck. This project uses arduino mega along with several motors and sensors. The face is made from cardboard cutouts of various characters. A joystick can be used to control the facial expressions. This robot face has 15 motions and can be used to interact with people.

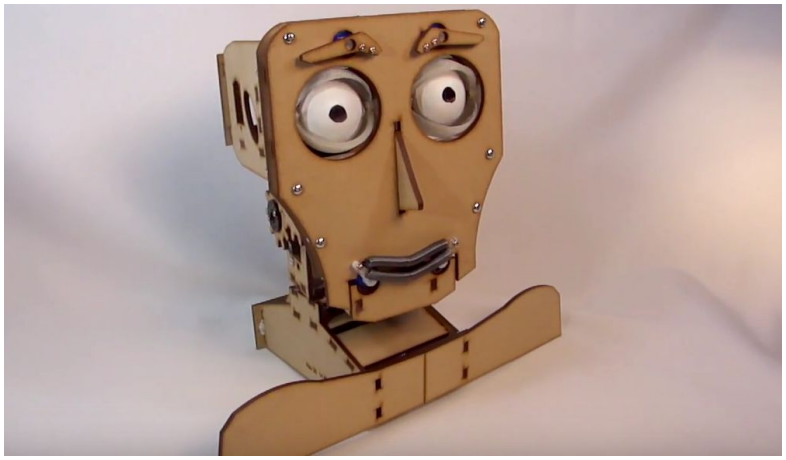

Figure 2: Fritz, A Robotic Puppet

Last example our group researched was a animatronic Sorting Hat from Harry Potter series. This example was found on hackster.io. This example entails multiple animatronic features, and is cost effective. The hardware components of this project includes an Arduino UNO, 5 servo motors, a power supply board, and a 12V DC adaptor. The software included Arduino IDE, and Visual Basic 6. Overall, the method for completing this animatronic face entailed creating a program. This began by using Arduino IDE, and Visual Basic 6 to program the application. Features of this hat include moving mouth, facial expression movements, and audio features.

A shield was made for the completion of this project. The arduino shield needed to control 5 servo motors. This step includes the use of a soldering tools. Mechanical links were made for each servo motor. These mechanical links were made by using the plastic tubes from old markers.

Figure 3: Sorting Hat Animatronic

Section 2: Brainstorming (initial planning)

Our character face for this project is Dr. Wan. We will be asking him to say "Did you know, there's an ME professor here in UTSA that can ride a unicycle while playing the guitar? That would be me!" The sentence was 11 seconds long and will be implemented into our animatronic head. The microcontroller we will be using is Arduino Mega. The two sensors we plan to use are an ultrasonic sensor and a temperature sensor. For the actuators, we will be moving the mouth and eyebrows. The supporting structure will be constructed of cardboard and wooden sticks. We will be using 3 servo motors. Both eyebrows will move, and we are wanting for both upper and lower lips to move for talking purposes. The power of this project will be power through battery. We are using 6 AA batteries joined together by a battery holder, and a backup 12V battery holder. For the speakers, we will be using small computer speakers.

In the first interaction mode, we will be using the movement of the mouth. This will be started by using ultrasonic sensor. We are activating the sensor by placing an object a foot from the ultrasonic sensor. This process will then activate the soundtrack that we recorded from the professor. The second interaction will be to move the characters eyebrows. This will be implemented by using a temperature sensor. When the sensor senses a change in temperature, the eyebrows will move accordingly.

Section 3: Supporting structure

Our supporting structure is made out of cardboard and wooden dowels. It is a three level structure, supported by four wooden dowels. The first level will hold a servo for the mouth, the ultrasonic

distance sensor, and a battery holder. The second level will hold the Arduino Mega and the temperature sensor. And finally, the third level will hold two more servos, controlling the eye brows, and two battery holders.

The face is created by using cardboard. A printed face is attached to the cardboard. The cardboard will be cut into two sections, to create facial expressions. One cut will be at the lower lip and chin, creating the two sections. Other cuts will be placed at the eyebrow regions. We will put the temperature probe behind the ear.

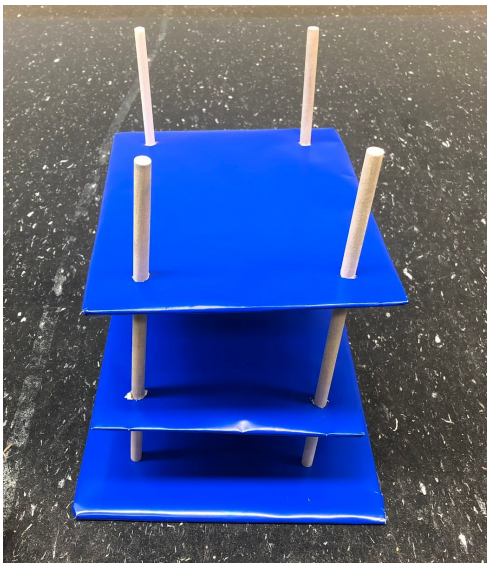

Figure 4: Supporting Structure

Figure 5: Level 1 with Ultrasonic Sensor,Battery Holder, and Servo Motor for the Mouth

Figure 6: Level 2 with Temperature Probe

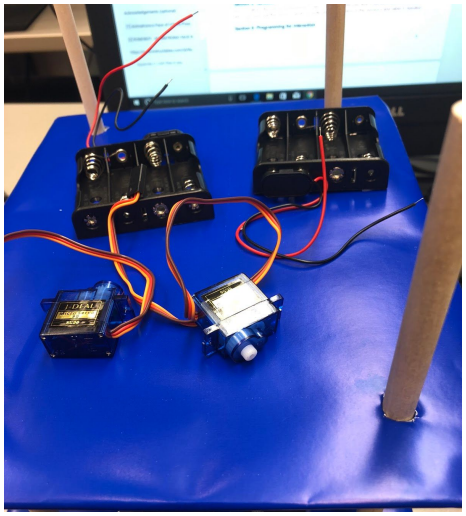
Figure 7: Level 3 with 2 Servo Motors for Eyebrows and 2 Battery Holders

Section 4: Joints and motors

The joint to move the mouth will be connected to a foam block and a wooden dowel for rigidity. The servo will be connected to the mouth by cutting a slit on the foam attached to the back of the mouth. This slit will be cut to the same dimension to that of the servo arm. The servo arm will be taped to a foam block fixed to the base of the supporting structure. This will allow the arm to rotate the mouth smoothly. Tape will be used to attach the servo, foam, and mouth together. The same fixture will be done to both servos rotating the eyebrows.

Section 5: Sensors

The first sensor that we began to work with was the ultrasonic sensor. The ultrasonic sensor will control the movement of the mouth. The lower jaw will be controlled by one servo motor. For this sensor to work, the ultrasonic sensor will detect an object's movement from 20 centimeters away. The second sensor we choose to work with was a temperature sensor. This sensor will control the eyebrows of the face. When activated, the sensor should move the eyebrows in a up and down motion to express the emotion of surprise. For this sensor to work, the temperature sensor will detect an increase in heat (from body temperature) and activate two servos to move the eyebrows.

Figure 8: Ultra-sonic Sensor

Figure 9: Temperature Sensor

Section 6: Programming for interaction

Before any coding took place, the first objective was to set up the circuit on the breadboard, and connect it to the Arduino. Once all shields, sensors, and motors were in place, and connected, the coding could begin. All libraries were called out in the beginning of the code. The first sensor that was called out was the ultrasonic sensor. We set the maximum distance we want the sensor to sense for in centimeters (sensor rated for 400-500 cm). The next call out involved the NewPing library; setting up pins and maximum distance. The following command defined the three servos, one mouth, and two eyebrow. We then initialized the temperature sensor, and defined our temperature range in degrees celsius. The following section was the void setup section. We first set up all servos by naming each servo pin in the arduino. The next objective in the void setup included defining the temperature sensor as an input. Finally, was began the code for the void lood section. The first code call out began with reading the temperature sensor. This was done by converting the voltage into a temperature value. Next, the mapping of the eyebrow servos took place. This was executed by writing the angle of the eyebrow servos. The following code retrieved the the distance in centimeters. Since the mouth was moved by the ultrasonic sensor, we wrote an if/else statement to move the mouth when the sensor is triggered at a certain distance.

Section 7: Lessons learnt and suggestions

This project taught us basic coding and proper hardware handling. The coding done on this

project was completed using Arduino. The team had very little coding experience which made it time consuming for the allotted time. The hardware components were simple to connect together also sync to the arduino mainframe. Some problems we encountered were with the joint sections of the face. Originally, wires were going to be used to connect the servo arms to the mouth. Due to time and resources we replaced the wires with foam blocks. Batteries were also a risk we encountered. We had to use several batteries to operate and maintain the project. Some suggestions that can be implemented is to extend the start date of the animatronic face. This will help students who are also taking senior design prepare for the presentation.

Video of the finished animatronic head: https://www.youtube.com/watch?v=Ru5ts52g7Rw

Section 8: Personnel and Bill of Materials

(a) Personnel

Task	Main Personnel	Secondary personnel
Structure / Chassis Design	Edgar	Theresa
Joints & Motor interfacing	Jenna	Theresa
Integrating Sensors	Theresa	Edgar
Overall Programming & Integration	Jenna	Edgar

(b) Bill of materials

No.	Description	Website/comment	Qty.	Unit $	Total $
1	Arduino MEGA 2560	Provided	1		
2	Waveshare Music Shield	Amazon.com	1	$12.99	$12.99
3	Servo Motors (5 pcs)	Amazon.com	1	$11.78	$11.78
4	Battery Holder (3 pcs)	Amazon.com	1	$7.49	$7.49
5	Blue Wrapping Paper	Hobby Lobby	1	$2.99	$2.99
6	Mask	Hobby Lobby	2	$3.99	$7.98
7	Bike Sticker Decorations	Hobby Lobby	1	$1.25	$1.25
8	Temperature Sensor (10 pcs)	RobotShop	1	$11.99	$11.99
9	Music Shield	SeeedStudio	1	$27.50	$42.71
10	Glue	Target	1	$5.99	$5.99
11	Jumbo Popsicle Sticks (15 pcs)	Target	1	$2.99	$2.99
12	Wooden Dowels (12 pcs)	Target	1	$1.99	$1.99
13	Popsicle Sticks (10 pcs)	Target	1	$2.69	$2.69
14	Scissors	Target	1	$2.39	$2.39
15	Cardboard Poster (2 pcs)	Target	1	$3.29	$3.29

All items were paid by the members, no outside resources were used. The Music Shield (Item number 9) was ordered with 2-day shipping which increased the cost from $27.50 to $42.71. The total price for this project excluding the Arduino MEGA was **$99.31**.

Acknowledgements

We would like to thank Doctor Wan for giving us some time to record his voice for our project and his amazing support. We would also like to thank TA Salvador for his help and also Dr. Bhonsul for the extra helping hand. Lastly, we would like to thank UPS for printing Dr. Wan's face and for their office materials.

References :

[1] Animatronics Face of UTSA's President, Dr. Ricardo Romo, https://youtu.be/xkze1_hnam0

[2] ROMOBOT - ANIMATRONIC FACE ROBOT
https://www.instructables.com/id/RomoBOT-Animatronic-Face-Robot/

[3] Talking Animatronic Robot Head
https://www.instructables.com/id/Talking-Animatronic-Robot-Head/

[4] Fritz, A Talking Puppet https://www.kickstarter.com/projects/1591853389/fritz-a-robotic-puppet

[5] Sorting Hat Animatronic
https://www.hackster.io/jegatheesan/full-animatronic-sorting-hat-with-custom-software-22-433c8f

Appendix A: Code

```
// Mechatronics
// Sensor 1: Temperature Sensor (controls 2 servos)
// Sensor 2: Ultra Sonic Sensor (controls 1 servo)
// Audio Shield: Seeed Studio - Music Shield V2.0

#include<Servo.h>
#include<NewPing.h>
#include <arduino.h>
#include <SD.h>
#include <SPI.h>
#include <MusicPlayer.h>


#define MAX_DISTANCE 100 // setting the maximum distance we want to sense for in
cenimeters (sensor rated for 400-500cm)
#define TRIGGER_PIN 24
#define ECHO_PIN 22

NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE); // NewPing setup of pins and
maximum distance

Servo leftBrow; //define servo objects
Servo rightBrow;

Servo mouth;

int tempSensor = 8; // temperature sensor pin

double lowTemp = 23.5; // define our temperature range in C
double highTemp = 26;
double previousData = 0;

void setup() {

  leftBrow.attach(49); // setting up servo objects
  rightBrow.attach(41);

  mouth.attach(53);

  pinMode(tempSensor, INPUT); // setting the sensor as an input

  Serial.begin(9600);
  player.begin();
  player.playOne("TRACK0~1.MP3");

}
```

```
void loop() {

  int val = analogRead(tempSensor); // read the temperature sensor
  double temp = val * (5 / 10.24); // convert voltage to temp value
  //Serial.println(val);

  //int dataValue = temp;
  // if (dataValue > previousData) {
  //  int browAngle = dataValue;
  // previousData = dataValue;
  // }


  int browAngle = map(temp, lowTemp, highTemp, 0, 10); // mapping the angle of the eyebrow
servos


delay(50);
  leftBrow.write(browAngle);//writing the angle of the eyebrow servos
  delay(50);
  rightBrow.write(browAngle);

  double distance = sonar.ping_cm(); // get the distance in cm
  //Serial.println(distance);

  if (distance < 20)
    do
    {
      player.play();
    }

    while (distance == true);

  {
    delay(500);
    mouth.write(70);
  }

  if (distance < 20)
  {
    mouth.write(90);
  }
  else
  {
    mouth.write(0);
  }

}
```

Appendix B: Wiring Schematic