ANIMATRONICS FACE: Prof Bhounsule

Link to Youtube Video:
https://youtu.be/pqrjM8rsUEc

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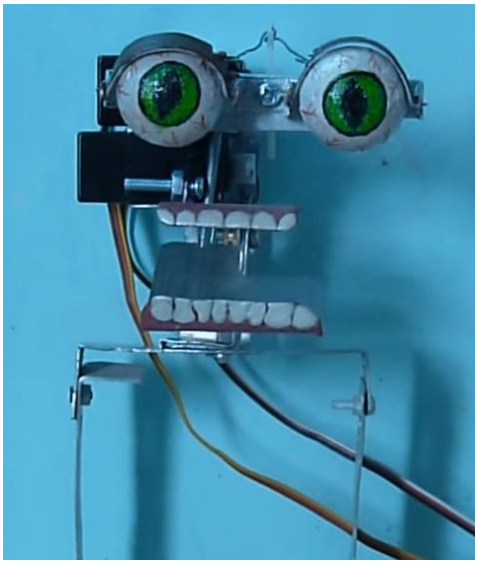
ABSTRACT

For the Mechatronics Animatronics project our group was assigned Dr. Bhounsule and took on the task of of developing an animatronics face that incorporated a recording to make the face speak and the use of servo motors to create facial movements. As a team we constructed a wood base with a metal frame and mounted servo motors to assist in moving the different facial sections. The coding of the servo motors was completed via an Arduino software code and the vocal recording was played via a laptop. One facial movement via servo motor was the jaw bone of which was synched with the recording, and using servo motors to move the eyebrows. For another sensor input, the team also used a temperature sensor to detect the temperature and upon reaching a specific temperature the animatronics face would vocalize another message. Overall the team learned to incorporate the servo motors, arduino boards, breadboard wiring, motion sensors, temperature sensors, and constructing a structure.

Section 1: Literature review

Face 1:



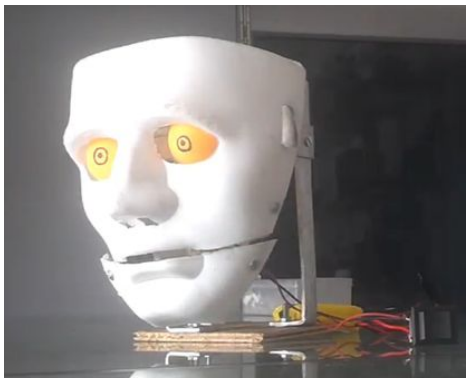
https://www.youtube.com/watch?v=2bN3ZSUr-QQ

For this animatronic face design 2 parts of the face moves which are the mouth and eyebrows. Both are controlled using two different servo motors which rotates the mouth and eyebrows up and down. A multi-turn variable resistor and a potentiometer to limit the angle in which the mouth and eyebrows can move. The control circuit was used with a 555 timer to provide a pulse to the servo motors. The purpose of this project was to bring life like characteristics to a robot to emulate human facial movements.

Face 2:

http://www.pyroelectro.com/tutorials/animatronic_mouths/index.html
http://www.pyroelectro.com/tutorials/animatronic_eyes/index.html

Face 3:



https://www.youtube.com/watch?v=uDBgrfrbBJA

For this face design 3 the face is assembled on a metal frame with the face structure being attached to additional metal crossbars of which are connected to the frame. The material used for this face is a plastic mask that has been cut at the lip separation to allow for realistic jaw movement. The separated jaw is connected to the upper part of the jaw bone area of the main piece. Within the face structure are ping pong balls that are fixed and mounted to the metal frame The motor used for this design is a 30 RPM DC gear motor, of which is wired to a analog/toggle switch. The motor is used to move the bottom jaw only since the eyes do not move.

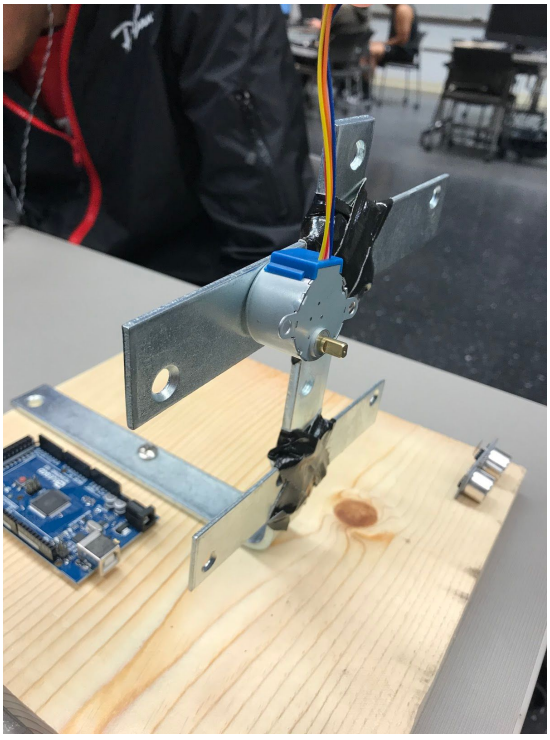
Section 2: Brainstorming (initial planning)

The three things on the animatronic face that we would like to move is the mouth, eyes, and eyebrows. These face movements will sync up with the dialogue that is programmed for the face to say and react accordingly. We will use 5 servo motors; one for each eye, one for each eyebrow, and one for the mouth. The trigger for the face to move will be a ultrasonic sensor which will trigger the code to run if motion is detected. There will also be a speaker for the mp3 file to play For the second sensor we will use a thermal sensor and if the thermal sensor detects a high temperature like a fire and the face would detect that and say “run there's a fire”. These parts will be powered by the arduino which will be powered by the computer. For the soundtrack we will record the professor say a phrase that we decide to use and upload that onto arduino. One way to mount the face would be to create a metal and or wood door frame like structure of which would be fixed on a bottom surface platform. With this structure the face border can be mounted to the exterior side of the frame.

With this frame idea a box structure could be made which would allow this face mounting frame to be inset into the box to allow a closed area to hide the wiring, motors, and various equipment used. One way to overlay the face to the frame is to either use forms of epoxy, super or hot glue, or if needed mounting screws or nails around the border of the face. Additional mounting supports can be made directly behind the frame to mount motors or any equipment needed to move portions of the face.

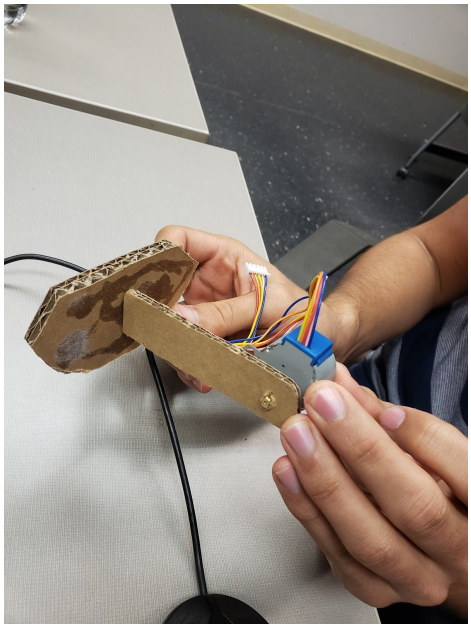
Section 3: Supporting structure

The supporting structure of the project is created by a wood platform of which will allow a spot for the arduino and wiring harnesses to have plenty of room. In terms of the structure for the face and the equipment there is a metal L frame and a metal cross bar. The vertical L frame is screwed to the wood platform to allow the face and components to be up off the platform. The crossbar is connected with gorilla tape to ensure a secure hold but if the height of the bar needs to be adjusted later in the project then removal is easy. The bar is going to be the mounting bar for the motors that will move the eyebrows and to support the face as well.

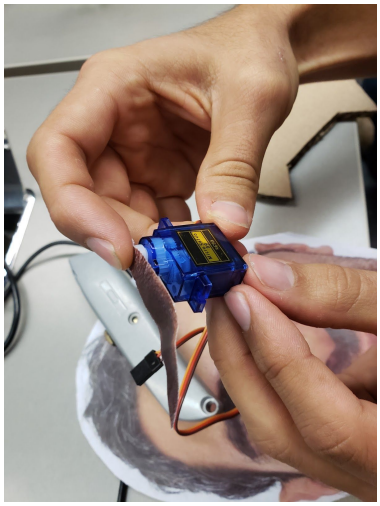


Section 4: Joints and motors

The first joint used was for the movement of the mouth. A piece of cardboard was hot glued to the axle of the servo motor and then another piece of cardboard in the shape of the mouth was glued to the other end of the cardboard. As seen in the image below, a stepper motor was used at first but it was changed to a servo motor at a later date since we found it easier to program.

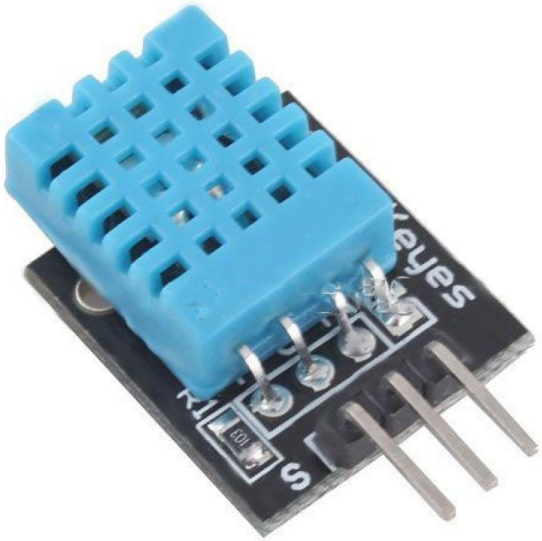


The next joints used is the joint for the movement of the eyebrows. A cutout of the eyebrow in glued directly to the servo motor which will move a set amount while the mouth and audio file is playing. Servo motors were used for the eyebrows since it is a simple movement and the joint at the motor holds a light load.



Section 5: Sensors

Ultrasonic Sensor: We chose to use an ultrasonic sensor because we wanted the face to react to someone waving to it. The ultrasonic sensor in the code it going to sense if someone is within a certain distance if it does the code will run. This sensor is used to measure distance and we can use this feature of the sensor just to see if its being activated.



DHT11 Temperature and Humidity Sensor: This sensor senses the humidity and temperature of the surrounding. We choose this sensor because we wanted to learn how it works as well as we wanted to implement the professor saying “its really hot in here” and this sensor does the job.

The sensor will read the temperature and out put the professor saying its hot in here if it gets above a certain temperature.

Section 6: Programming for interaction

For the project, two different arduino codes were used. The first one used a ultrasonic sensor as an input signal to detect movement, and when it did, the code would move the motor used for the movement of the mouth and eyebrows. For the setup of the ultrasonic code, we defined all three of the servo motors and put them as output PWM signals at 5, 6, and 7 on the arduino board. The echo and trig pins for the ultrasonic sensor were defined and set at pins 8 and 9. We the created a loop function where we programmed the servos to move the certain angles and added delays between the movement. The default angle for the motors was at 90 and the motors were move counterclockwise and clockwise when the angles were set at 140 and 40 respectively. Once the angles were defined we added correct increments of delays between the open and close of the mouth. The delays had to match the voice we recorded of the professor so the delays added has to match. For the temperature sensor code we, had to input the library for the sensor by downloading the zip file from Circuitbasics.com [3]. We then set the pin for the temperature sensor at pin 11 and started the loop function. In the loop function, the serial print command was used to show the temperature of the sensor and a if command was added and if the temperature that was read was 40 C or above, then the servo for the mouth would be moved to an able of 140, then it was delayed for 1500 ms, then the mouth was closed again. It would repeat this process until the temperature reached below 40 C.

Section 7: Lessons learnt and suggestions (1 page)

This project was interesting and it allowed the students to have a hands on learning experience with arduino and helped improve critical thinking.Some of the things that were learned during the making of this project include: how use and code a DHT11 temperature sensor in arduino, understand how to code servo motors to move in certain angles, and how to incorporate arduino with a mechanical device. Some of the problems that we encountered during the project included:

Problem 1: Had trouble attached the parts during final assembly.

How to fix the problem 1: In order to get the parts to attach and stay in put, the team incorporated gorilla adhesive tape and actually applied small amounts of gorilla hot glue.

Problem 2: Synching up the movement of the mouth to the recording.

How to fix problem 2: The team was able to adjust the Arduino code by applying periodic delays to adjust the time of when it moved and also the distance that it moved.

Problem 3: Couldn't decide on a mounting structure.

How to fix problem 3: Contrary to project step order assigned by the lab TA and professor, we actually did not fully assembly the wiring, joints, face, etc till the very last step. This allowed us to not have to remove/install the entire project numerous times. All the coding, wiring, and structure setup was explained in detail during the lab sessions with the TA and each step was explained how it would be carried out. Thus at the end all the parts were assembled and minor adjustments were made one time before presenting. This method was the most successful for us.

Ways to improve:

1. Use a bigger face to really show off the moving features.
2. Also using different material would have made the assembly a little easier.
3. Bringing multiple types of glue and adhesive would have helped to accomodate for the different materials.

Section 8: Personnel and bill of materials

(a) Personnel

Task	Main Personnel	Secondary personnel
Coding	Dhruv	Julian
Creating Joints	Julian	Dhruv
Connecting wire on final Assembly	Julian	DJ
Assembling Main Structure	DJ	Dhruv
Final Assembly of Face	DJ	Julian
Project Write Up	ALL	

(b) Bill of materials

No.	Description	Website/comment	Qty.	Unit $	Total $
1	Arduino MEGA 2560	Provided	1		
2	Servo motor	Provided in box	3		
3	Wood	Scrap	1	1.00	1.00
4	Strap Tie	Provided by colleague			
5	Hot Glue	Provided by colleague			
6	Breadboard	Provided by Instructor	1	0	0
7	Cardboard	Scrap Pieces	2	0	0
8	Printer Paper	Printed face on paper	1	.10	.10
9	Steel bars	Used for the frame of the face	2	3.50	7.00
10	wires	Wires were in arduino kit			
11	DHT11 Temp	Sensor in arduino kit			
12	Ultrasonic Sensor	Sensor in arduino kit			
Total					8.10

The total price for this project excluding the Arduino MEGA was $8.10

Acknowledgements

As a team we would like to thank Dr. Bhounsule for taking the time to allow us to record him and for taking his picture so we could make a successful project. Also, teaching us the material in order to be able to complete a project like this.

References:

[1] P. Bhounsule, “Animatronics Face of UTSA's President, Dr. Ricardo Romo,” YouTube, 12-Apr-2016. [Online]. Available: https://www.youtube.com/watch?v=xkze1_hnam0&feature=youtu.be. [Accessed: 05-Dec-2018].

[2] Instructables, “RomoBOT - Animatronic Face Robot,” Instructables.com, 28-Sep-2017. [Online]. Available: https://www.instructables.com/id/RomoBOT-Animatronic-Face-Robot/. [Accessed: 05-Dec-2018].

[3] “How to Set Up the DHT11 Humidity Sensor on an Arduino,” Circuit Basics, 22-Jun-2018. [Online]. Available: http://www.circuitbasics.com/how-to-set-up-the-dht11-humidity-sensor-on-an-arduino/. [Accessed: 05-Dec-2018].

[4] M. Gray, “Deakin University - Animatronic Face Project - Matt Gray,” YouTube, 30-Sep-2015. [Online]. Available: https://www.youtube.com/watch?v=U1A6DMy2yhk. [Accessed: 05-Dec-2018].

Appendix A: Code

Servo motors

```
#include <Servo.h>

Servo servo1;
Servo servo2;
Servo servo3;

int trigPin = 9;
int echoPin = 8;
long distance;
long duration;

void setup()
{
servo1.attach(7);
servo2.attach(6);
servo3.attach(5);
 pinMode(trigPin, OUTPUT);
```

```
 pinMode(echoPin, INPUT);// put your setup code here, to run once:
}

void loop() {
  ultra();
  if(distance <= 10){
  servo3.write(90);
  delay(100);
  servo3.write(130);
  delay(700);
  servo3.write(90);
   delay(200);
  servo3.write(130);
  delay(200);
  servo3.write(90);
  delay(200);
   servo3.write(130);
  delay(200);
  servo3.write(90);
  delay(200);
   servo3.write(130);
  delay(200);
  servo3.write(90);
  delay(500);

  servo1.write(90);
  servo2.write(90);
  delay(300);
  servo1.write(40);
  servo2.write(140);
   delay(300);
   servo1.write(90);
  servo2.write(90);
  delay(300);
  servo1.write(40);
  servo2.write(140);
   delay(300);
   servo1.write(90);
  servo2.write(90);
  delay(1000);
  servo1.write(40);
  servo2.write(140);
  delay(300);
```

```
  servo1.write(90);
  servo2.write(90);
  delay(100);

  }
}


void ultra(){
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = duration*0.034/2;
  }
```

Temp sensor

http://www.circuitbasics.com/how-to-set-up-the-dht11-humidity-sensor-on-an-arduino/
Download DHT library and insert into arduino

```
#include <dht.h>
#include <Servo.h>
Servo servo3;


dht DHT;

#define DHT11_PIN 11

void setup(){
  Serial.begin(9600);
  servo3.attach(5);

}
```

```
void loop()
{
  int chk = DHT.read11(DHT11_PIN);

  Serial.print("Temperature = ");
  Serial.println(DHT.temperature);
  Serial.print("Humidity = ");
  Serial.println(DHT.humidity);

 delay(1000);

  if(DHT.temperature >= 40){
  servo3.write(90);
  delay(100);
  servo3.write(140);
  delay(1500);
  servo3.write(90);
  delay(1000);
}
  }
```