Animatronics Face: Prof. Kiran Bhaganagar

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ABSTRACT

The project undertaken by the students was to make an animatronic face of an assigned professor. The group decided that the two motions on the face that would be in motion would be the nose and the mouth. To create the animatronic face of Prof. Kiran Bhaganagar the group by utilizing a cardboard shoe box. The nose and mouth were cut from the mask and servo motors were attached by superglue to allow these two to move. The servo motor connected to the nose was controlled by a potentiometer. The servo motor attached to the mouth was controlled by an ultrasonic sensor. The codes of these two functions were combined into one Arduino code. Once completed the face of Prof. Bhaganagar's was able to move.

Section 1: Literature Review

The animatronic face of Abraham Lincoln was created and developed by Garner Holt productions as shown in Figure 1. This specific animatronic face of Abe Lincoln in currently being used for Walt Disney World's Hall of President in Orlando Florida. So far, this animatronic of Abe Lincoln is the most realistic having very realistic facial expressions. Abe operates with 45

actuators in the head alone and runs 1000 frames per second. He is operated on by more advanced servo motor that the average servo motors creating smooth face motions. [1]

Figure 1: Abraham Lincoln animatronic face

For the second face researched, the romoBOT was selected. The RomoBOT was created by a UTSA student named Geoffrey Toombs as part of his senior independent study. The is still owned by Toombs and he shows it to mechatronic students at UTSA for inspiration and research purposes. The parts list for this build are not long because the creator said he had a limited budget. He indicated that the face was supported by an erector set and the microcontroller used was an arduino mega because he had one laying around not in use. The face itself is moved by servo motors for the eyes nose and mouth. The servo motors are connected with push-rods and actuators. Overall the face works enough but the creator did state having problems with getting the eyes to move in the right directions and consistently follow people.

Figure 2: RomoBOT

The third face was built by A graduate student named Robert Fitzpatrick back in 2010-2012 as his capstone project. The goal was to have the face mimic human emotion and speech in order to seem more life like. The creator found the correct range for its movements by plugging in his head and eye movements into face and eye tracking softwares. file that would then program the servo motor angles for speech and movement from the eyebrows, mouth and other features. The constructor indicates that the base frame for the robot was steel and the servo motors were attached directly to the frame and lastly the skin and other features were put in the correct places. To control the movements of the face a proprietary software called Visual Show Automation software allowed the user to input servo pulse values along with their timestamps and create performance routines. The group is still researching into the fate of the robot.

Figure 3. Robert Fitzpatrick’s project completed

Figure 4: skinless animatronic face

Looking into all three designs shows that there are conventions when building robots. The most obvious one was the way that the creators mimicked motion. Many Servo motors were used to control movements in mouths and eyes and all the faces have some sort of motion tracking.

Section 2: Brainstorming (initial planning)

The group decided that the two moving were parts were going to be the mouth, because it was supposed to be able to talk, and the nose because it was a simple matter of either wiggling or rotating and hoped it would be less creepy in the face. THe motors chosen for the project are servo motors because they can do a rotation of over 360 degrees and with wires can create a linear actuation. The face will be pasted to a cardboard slab and cut to shape. The then cut face will be taped to a shoebox which will be stable enough to hold the lightweight cardboard cutout face. Sound will be added using a calatex mp3 shield that can integrate with arduino and be triggered by an ultrasonic sensor. The sound should be the professor saying something and it doesn't matter what, but in the event that we cannot record her voice we can go and download christmas tunes and do our best to sync it up with the face.

Section 3: Supporting structure

The supporting structure is a vans shoe box. The reason it was chosen was because it was available for free, and it nicely hid away the arduino kit and motors. After some manipulation with the help of superglue the box was intact. The back of the box was open and allowed us to quickly access the motors if a problem occurred. Underneath the head there was an opening to allow the the ultrasonic sensor to be utilized.

Section 4: Joints and motors

The mouth and the nose were chosen as the joint to move. These two joints used servo motors to allow for movement. The servo motors were glued to the back of the head and were allowed to pivot while freely floating in front of the cardboard face. The nosed with a starting position at the center will be able to turn 90° to the left and to the right. The mouth moved at an angle of 90° from the left corner of the mouth.

Figure 5. Servo motor

Section 5: Sensors

The first sensor we chose was an ultrasonic sensor. The reason the sensor was chosen is because it is a decently accurate sensor. In other words, the ultrasonic provided a way for the audience to interact with the face on their own to see it move. The ultrasonic sensor works by sending out noise frequencies into the range area and those sounds are measured in the time it takes to return to the sensor, the time it takes to return can also be used to measure distance. Once the object is detected then the sensor sends the signal to move the servo motors on the mouth of our face.

The second sensor chosen was a potentiometer, this works in the fashion of turning a knob in order to provide positive or negative voltage to a second servo motor in order to turn the nose back and forth.A potentiometer was selected because we could not choose two devices that picked up sound and it was available to use. A potentiometer is a variable resistor that can have it's resistance changed by turning a knob. THere are three connections to the potentiometer. The first is the analog input sensor that feeds a value into the arduino. THe other two pins are the ground and Vin for the power to flow.

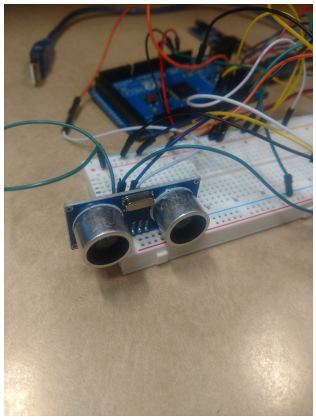

Figure 6. Ultrasonic sensor

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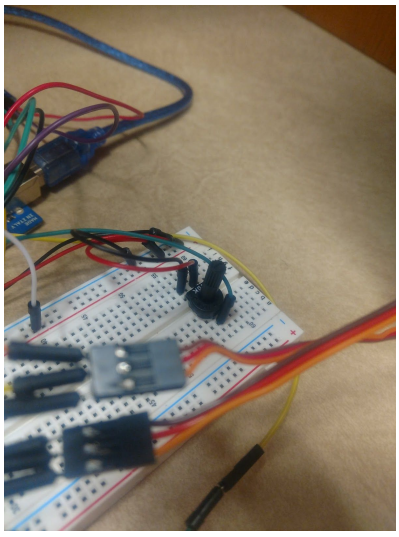


Figure 7. Potentiometer

Section 6: Programming for interaction

The first part of the code was the initial setup. The devices were given pinouts and variables were stated. Next the servos myPointer and myServo were created. For the void setup the pin modes were initiated from the callouts in the from all the int.

The void loop had the set up code for the range sensor using ping from an ultrasonic sensor and using the ping time in the calculation for distance knowing the speed of sound. The next part of the code after coding the ultrasonic sensor was assigning a value to the potentiometer also known as the potpin using the command line val = analogRead(potpin);. The potpin resistance value and programmed the myServo to write the val.

The myPointer used the ultrasonic sensor in an if loop. The if statement went if the distance was under 3 inches it would activate case 1 with a count of 10. If case 1 was activated, an else statement would trigger the servo would trigger 90 degrees in two direction until the

count hit 0. Once the count hit zero a break statement was called for. The next part was an else statement that said if the sensor wasn't reading 3 or under, the servo would not trigger.

Section 7: Lessons learnt and suggestions (1 page)

1. Initial plans with sensors do not always work. When the team first started the animatronics project we wanted to use temperature sensors to get the face to do an animation but the team did not find it practical where to put the sensor without it looking awkward
2. Troubleshoot all hardware and software. For this project we wasted a lot of time assuming it was our sensors were malfunctioning when in reality it was our code that was incorrect along with some wiring mistakes on the breadboard. We learned to think of systems as a whole instead of assuming it's a specific part.
3. Time management. Working as a team we realized that we all had different schedules and classes, so that required us to meet at unusual times, or not meet at all. At first this put the team behind with a couple of the major milestones but once we realized this takes much more time than anticipated we managed the time well and finished the project on time.
4. You get what you pay for. Although the sensors worked very well our team actually had to go through two ultrasonic sensors and an extra servo since we fried them the first time. The sensors are cheap and that explains why they malfunction at times or move parts without being commanded to. All in all, just order decently priced parts and don't go the cheap route if you do not have to.

Things that went wrong

1. Learning the code was difficult but i was able to slog through it when a friend gave me some pointers.
2. I know it wasn't much and we were offered reimbursement, having to go out and buy stuff was a pain
3. Trying to flag down the professor was a challenge for us and we were not able to record her so we just made her sing a song.

Improvement

1. Set up and aesthetic of the face could be improved upon because our project did look janky with its jutting nose and mouth. Hiding the arduino inside felt strange as well
2. Making the two servos move together was not possible because of the if statement. Being able to move both servos at a time would be a big success.

Section 8: Personnel and bill of materials
(a) Personnel

Task	Main Personnel	Secondary personnel
Chassis design	Eric Chavez	Victor Avila
Creating joints and sensor	Victoria Lopez	Eric Chavez
Integrating sensor	Victor Avila	Eric Chavez
Overall Programming	Victor Avila	Eric Chavez

(b) Bill of materials

No.	Description	Website/comment	Qty.	Unit $	Total $
1	Arduino MEGA 2560	Provided	1		
2	Small stepper motor	https://www.sparkfun.com/products/10551	1	6.95	6.95
3	Vans Shoe box	Scrap	1	0	0
4	Kinex case	Target.com	1	27.00	33.95
5	Calatez MP3 shield	Amazon	1	8	41.95
6	SD card	Walmart	1	7	48.95

The total price for this project excluding the Arduino MEGA was **$48.95**

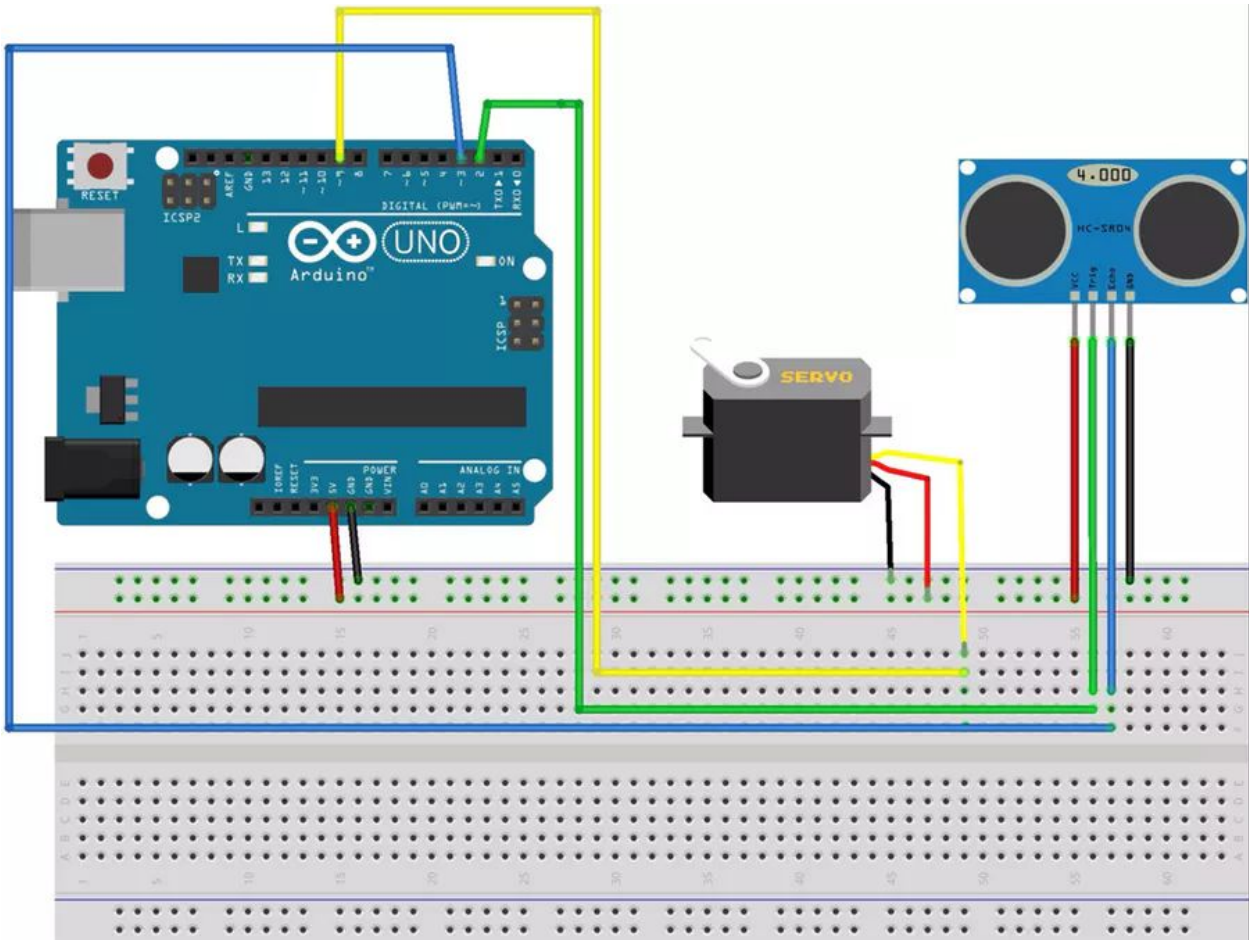
Acknowledgements
I want to Thank Anuragg for helping me understand how to code the project

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/


RESET
ICSP2
UNO
Arduino
TX
RX
ON
ICSP
DIGITAL (PWM~)
POWER
ANALOG IN
SERVO
4.000
HC-SR04