ANIMATRONICS FACE

PROFESSOR BING DONG

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Submitted as part of project for ME4543 Mechatronics, Fall 2018

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ABSTRACT

` The description of the animatronics project would best be suited as a real life, emulation of UTSA Department of Mechanical Engineering Assistant Professor, Bing Dong. The estimated dimensions of the project were 13" by 15" while the estimated weight was 5 lbs. As it pertains to the appearance, the most distinguishable or recognizable feature of Professor Dong was his eyes which were replicated from the most up to date image of the professor. These were then attached to the supporting structure. The other recognizable and moveable features were the eyebrows which were merely hand drawn by the most experienced artist of the group, Frances Martinez. Contrastingly, the nose and jaw were not modeled after the anatomy of the professor. However, the jaw was the second moveable entity in the animatronic. The placement of the nose and jaw was in accordance to the relative location of the professor's other distinctive attributes. The execution of the project consisted of the main basic human movements of the eyebrows and jaw, which were facilitated by Ultrasonic and PIR infrared sensors in conjunction with Arduino. The Ultrasonic Motion Sensor was the catalyst for the eyebrows' motion by having the capability of a non-contact detection feature facilitated by the transmission of sound within an estimated range of 50 centimeters. Although the sensitivity of the sensor could have been calibrated based on the peer review during demonstration, the performance went as expected with everything considered. In addition, the PIR was the catalyst for the jaw's motion by having the ability to measure the heat emitted by an object.

Section 1: Literature Review

The DIY animatronic shown in reference [1] was more complex than what we intended to do. The face was made out of plywood to keep it sturdy. It had two wooden eyes with eye stickers attached to them. The jaw was attached separately and kept in place with a metal tube that it would rotate around to simulate a mouth moving. The face had multiple servo motors from rc cars and such and a RAPU which would send the signals and codes to the motors to get them moving. It also had a SD card to keep the code mobile instead of using a pc every time. This also stores the audio which would be produced from two small computer speakers in the back.

The animatronic eye project [2] helped with better understanding the way the motors function with code. The project was fairly simply and cheap. a wooden base was used for the eyes and plastic for the eyelids. The eyes themselves were ping pong balls with black dots in the middle. Two mini servos were used to control the eyelids when prompted. Instead of using arduino, the servos were controlled by a servo controller which held all the code needed to work the eyes. Each eye is independent and with the eyelids it made the face much more human in the sense it could show "emotions".

Our third reference [3] was the main inspiration for the project created. This particular face is very simple and use cardboard for the base. It had multiple motors for the eyes and lower jaw. The motors would move each part independently when activated. The face was also give a small screen at the mouth to help visualize teeth or a tongue if need be. The project also had separate motors for each eyebrow. The eyes were made out of ping pong balls and the eyebrows out of plastic. Everything was connected to an arduino board and a breadboard. The sound for the audio was produced from a small speaker behind the face.

Section 2: Brainstorming (Initial Planning)

The animatronics will be able to move its mouth up and down when talking and project a sound that correlates to when the mouth moves. The only parts of the face that we would design to move would be the jaw and eyebrows. To make it move we will either have the jaw on a joint with something that pulls it down and the have it move up with a spring type device or a motor that will move the jaw when programed to do so. The eyebrows will follow the same idea as the jaw. There will be a motion sensor attached on the face to activate it when someone passes it or waves their hand in front of it. The structure of the face will be styrofoam and wood. The wood will be for the jaw and the rest of the face will be styrofoam. To attach the face to the chassis we will either have a printed face of the instructor attached or paint the face to match the instructors face. There will be small speakers in the back of the head to produce the soundtrack and then programed with arduino to sync the soundtrack to the movement of the jaw. All the sensors, arduino and motors will have a power supply attached to the back powered with a battery to make the face more portable. For this particular face we will have the professor say "Engineering is the best major. Get Rowdy".

Section 3: Supporting Structure

For the animatronics project, a proper structural analysis was not performed for as how the potential structure would behave under applied harmonic, axial forces or external stresses and

strain, however after careful deliberation, cardboard was the simple material chosen due to its foldability and flexibility along with its durability; the more advantageous material as opposed to the discussed material, silicone. The structure's material utilized had the capability of accommodating the weight of the numerous sensors, breadboards, and external batteries. Super glue was also incorporated to reconfigure the cardboard into desired applications, while further strengthening the base of the project to emphasize the appearance of the professor's neck. This would simultaneously be the platform for the Arduino Uno Microcontroller while the numerous accessories would exist at different elevations throughout the structure.

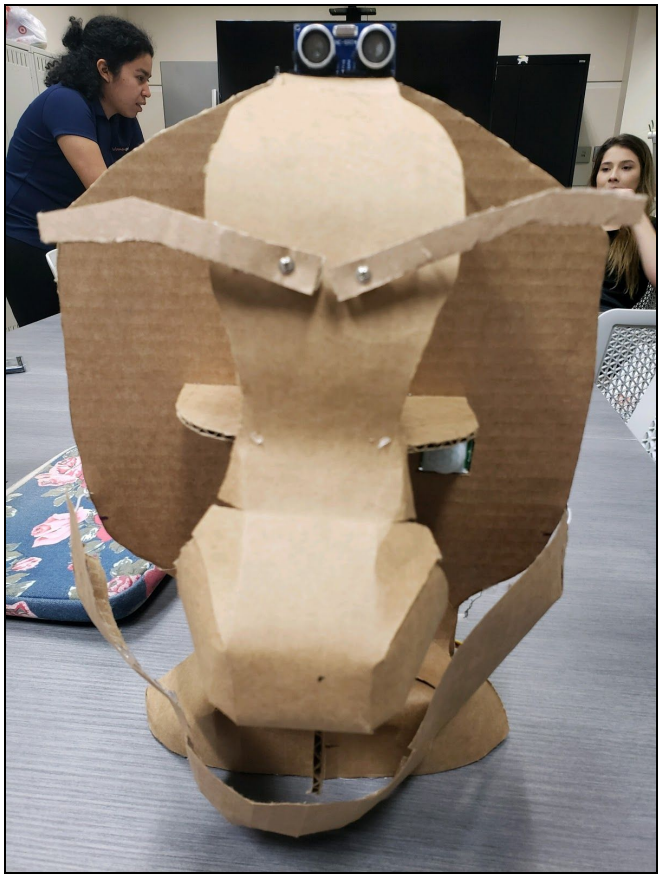

Figure 1: Supporting Structure

Section 4: Joints and Motors

For the project, there were two non-fixed structures, eyebrows and jaw. The mouth was constructed so the lower jaw would move when attached to the motor. It was attached to the structure with wire which also gave it the flexibility to move. The other joint was the eyebrows which were chosen so the face would be capable of having some kind of expression when talking. For the joints, a total of 3 servo motors were used to control the movement of the mouth and the eyebrows. The servo motors were an obvious choice due to how friendly they are with Arduino and being relatively cheap. The motors purchased however required more voltage than the arduino board gave so therefore an extra power source was used. For the mouth, we used a wire to connect it to the motor so when the motor would rotate or activate the lower jaw would

move up and down to simulate talking. The eye brows were directly connected to the servo so movement was directly correlated with the servo.

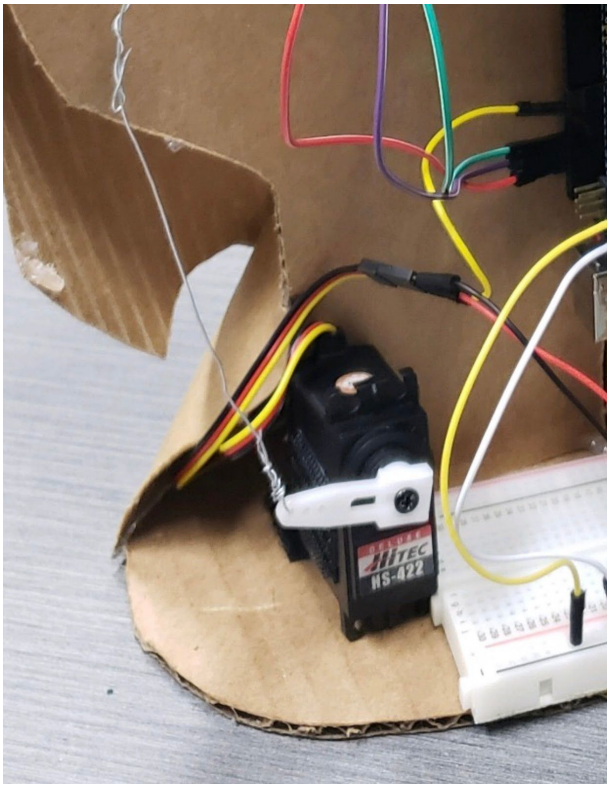

Figure 2: Servo Motor Attachment

Section 5: Sensors

We had chosen three different sensors for the project, ultrasonic, IR, and force touch. Out of the three sensors we only went with two being the ultrasonic and IR sensor. The ultrasonic was attached to the top of the face and the other was behind the nose. The force touch was destroyed in the process. The wires of the force touch were fragile. During manipulation, the negative lead of the force touch came out of place and was unable to be reapplied. We chose the ultrasonic sensor because we wanted the animatronic to activate when someone would pass by it. The sensor was programed to activate when someone would be at least 50 centimeters away from the project. Anything further would not be registered by the sensor and the face would continue to remain still. The infrared sensor would work about the same as the ultrasonic but would use heat from a distance. If the ultrasonic sensor failed to read a person's movement then the IR sensor would pick it up and activate the motors to move.

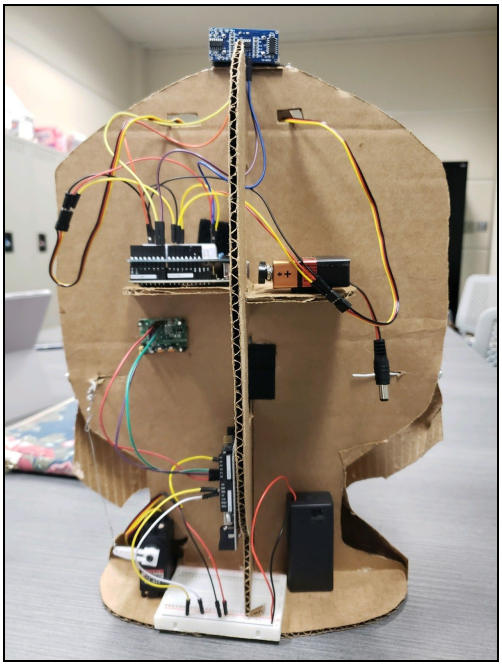

Figure 3: Electronic Configuration

Section 6: Programming For Interaction

For our programing, we had two sets of code. One for the ultrasonic sensor engaging the motors and the other for the PIR to engage the jaw movement. The first set of code for the ultrasonic sensor was made to set the distance it would read up to and what it would tell the motors. The sensor was connected to port 9 and the trig and echo pin on 2 and 4 of the arduino. We used a loop function so it keeps going through the code to see if anything changes or activate it instead of just having the code end and "turn off". The sensor is reading in centimeters and only activates for anything in a distance of 50 centimeters or less. So the sensor will check to see if anything is within the set distance. If not then after a designated time it will tell the motor to move back to the original position. An else statement was used to state that if something is not in the distance given then it will do an different actions. For example instead of activating the motor it would just keep the motor "asleep".

The PIR sensor was a bit more complicated to set up compared to the ultrasonic sensor. We set the int position of the servo and a calibration time of thirty seconds. The sensor is connected to pin 13 and 14. We used the setup command to tell the sensor initial conditions we want for it. We used LOW as off and HIGH as on for the sensor and if it read HIGH then the motors would turn on. The motors were coded to move 50 degrees and then back to zero after a set amount of time. The delay was used to set the amount of time it would wait before going back to the initial position and we used a lower number to make the motors move faster to simulate a person talking normally. The sensor was also given the command "if" to check for other conditions before continuing. We set the if statement to turn off the motors if nothing is within the distance of the sensor. The loop function was used to keep the sensor constantly checking to see if anything enters its range and if it needs to turn on or off.

Section 7: Lessons Learned and Suggestions

1. From this project, we learned how to properly attach motors and sensors to the breadboard. We also learned how to attach a seperate power source to the breadboard and use it with the power from the arduino board.
2. One issue that we ran into is that the motors would not run properly when attached to the breadboard with the sensor. To fix this we had to attach the sensor directly into the board using its own power source and then the motor attached to the breadboard using the power supplied from the external battery.
3. Something that could have been improved was communication between the group. It was difficult to get everyone together and be on the same page for the code and structure of the project.
4. Another thing to improve on was the simplification of the code. It was longer than needed but regardless got the job done.
5. We learned that even though cardboard was a cheap option to use, it was not the best. It was flimsy and easy to distort the face when damaged
6. An issue we ran into was placing the motor. We couldn't attach the motors prematurely to the face without a way to take it off so velcro strips were used to attach and detach as necessary.
7. One difficult issue was the accuracy of the face. Parts of the face were not made correctly or too big which made the face look funny. To fix this we would redo that section of the face.
8. Syncing everything was huge for us. An issue was the mouth moving to slow or not having the full range of motion needed, To address this we had to alter the code and change the speed of when the motor would rotate and how far the motor would rotate.
9. Another issue was where to put all the wires and motors on the face and keep them hidden. To resolve this most of the items were placed behind the main face and little platforms were made to hold up parts that could not fit elsewhere.
10. We learned how important the placement of the wires on a breadboard is. A lot of the issues we would run into would be invalid wires placements that would impede either the code getting to a sensor or motor or having the power and ground not correct.
11. One thing that could have been improved was how realistic the project was. Movable eyes could have been added along with the eyebrows
12. One issue we ran into was having the audio play with the mouth when told to do so. To fix this we had the audio seperate.

Section 8: Personnel and Bill of Materials

(a) Personnel

Task	**Main Personnel**	**Secondary personnel**
Programming	Frances	Joseph
Structure	Frances	Joseph
Report	Joseph	Frances, Marvin

(b) Bill of materials

No.	**Description**	**Website/comment**	**Qty.**	**Unit $**	**Total $**
1	Arduino Uno	Attained by 3rd party	2		
2	3 servo motors	https://www.amazon.com/gp/product/B00B88FIZ0/ref=oh_aui_detailpage_o06_s00?ie=UTF8&psc=1	3	26.00	26.00
3	Cardboard	provided	1	0	0
4	ultrasonic sensor	https://www.amazon.com/gp/product/B01COSN7O6/ref=oh_aui_detailpage_o04_s00?ie=UTF8&psc=1	1	9.00	9.00
5	PIR Sensor	Amazon	1	3.00	3.00
6	Wires	Bought at Altex	1	5.00	5.00

The total price that we paid for the components needed was **$43.**

References:

[1] DIY animatronic face https://www.instructables.com/id/Talking-Animatronic-Robot-Head/

[2] Animatronic eyes https://www.instructables.com/id/Eyes/

[3] Pyroelectric Face Animatronic
http://www.pyroelectro.com/tutorials/animatronic_mouths/conclusion.html