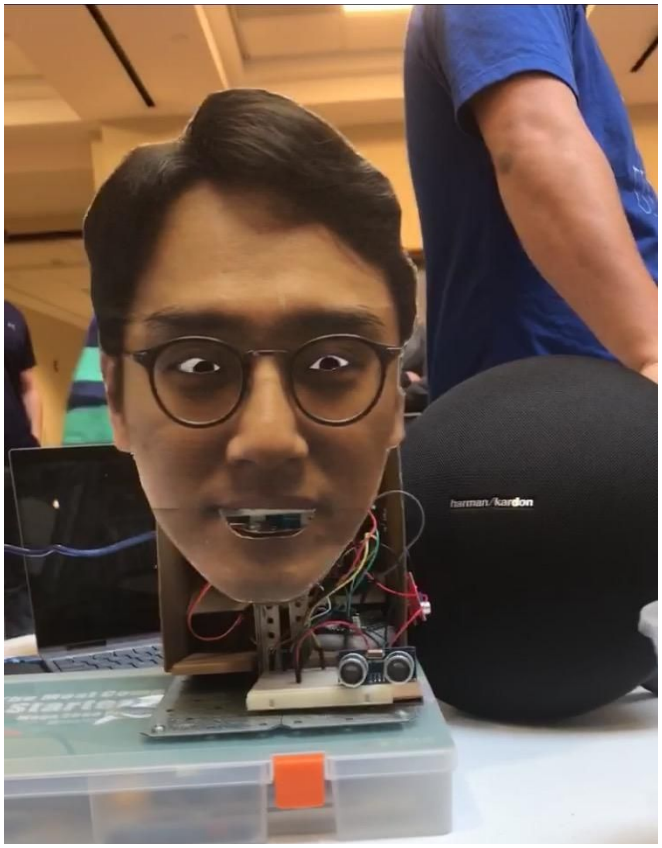
ANIMATRONICS FACE: YOONEUN LEE (MINI-LEE)



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ABSTRACT

Animatronics is a project which was new to all the engineering students, it was the first time we were exposed to it and it went really well. Our team, was inspired by a few animatronics projects that were found on youtube, and from some science fiction movies. Our teams animatronics had to replicate Professor Lee, by recording his voice and taking a picture of him. We named the project “Mini-Lee”, and used a motion sensor and a sound sensor to have the project interactable. If somebody approaches Mini-Lee, he will respond with a certain quote, and if the sound sensor detects loud noise Mni-Lee will respond with a comment talking about how loud the noise is. The project was a success and is a worthy topic to add to our resumes.

Section 1: Literature review

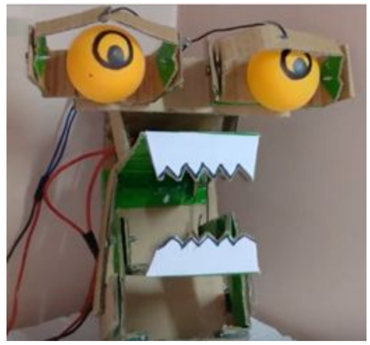

Figure 1: Animatronic robot face

This animatronic face of a robot character was made by JugadMachine on YouTube as shown in reference (How to Make ….). This design is mostly made up of ordinary materials at hand, such as cardboard, screws, and ping-pong balls for eyes. Pieces of cardboard were cut into smaller portions in order to construct basic structure and allowed for movement of the animatronic robot face. Hot glue was used to marry the pieces of cardboard together, as well as flexible steel wire to help with eye and mouth movement. From the video, DC motors are used to operate the movements of the animatronic face. The reference video shows the making of the design step-by-step for easy assembly. The purpose of this design was to demonstrate basic movements and use of minimal, simplistic materials and motors to create an animatronic face.

Figure 2: “Animatronic Robot Face, “Cosmo””

The animatronic face called “Cosmo”, was designed by “LOOK MUM NO COMPUTER”, from Youtube. This design was used from 2 ping pong balls, a synthesizer, chattering teeth, plastic nose, scrap wood, scrap metal bent into a two semi-circle, 2 axials, 2 nuts, 2 bolts, multiple screws, micro-servos, and an Arduino kit with an electric circuit board. The two ping pong balls that were used as the eyes, needed to have holes drilled in them. They were then mounted on the two semi-circle scrap metals using the 2 axials, 2 nuts, and 2 bolts. Scrap wood was used as the base plate for the skull, which was where the teeth and eyes were connected to. The eyes that were mounted on the metal, were then mounted on 2 micro-servos so that they could spin around in a 360 horizontal motion. 2 more micro-servos are used to allow motion in the vertical axis, so that the eyes could move up and down as well. The purpose of this animatronic face was to demonstrate how to make a face using a synthesizer (Build A Robot...).

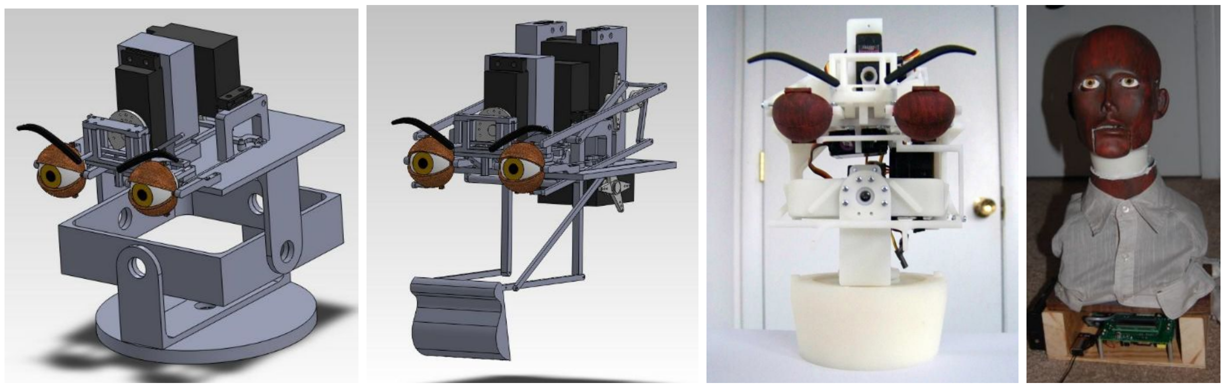

Figure 3:" Designing and Constructing an Animatronic Head Capable of Human Motion Programm"

Robert Fitzpatrick a master's student at Worcester Polytechnic Institute in 2010, researched and built an animatronic head using a mannequin fiberglass bust. Mr. Fitzpatrick used actual human body constraints as a basis for the animation on his head. In his capstone paper he goes into detail on how he researched the degrees of motion in the human body and implemented into his design. The design was based on the mannequins' dimensions which were then printed using a 3d software and 3d printer. The design used a mini SSCII Servo Controller, a RAPU 5.0, 5xHSG-504MG servo motors, 2xHS-7775MG servo motors, and a HK47011DMG. Mr. Fitzpatrick's' paper exemplifies what is needed to properly built an animatronic head. He also provides insight on his process, and issues he encountered (Fitzpatrick).

Section 2: Brainstorming (initial planning)

Goals that were kept in mind when planning the project initially, included having the eyes move in both the vertical and horizontal directions using only 2 micro servos, have the jaw move up and down using one micro servo, and have both a touch and motion sensor as the stimulus. The chassis will be built on a type of free standing metal structure, something very strong and metallic looking, using parts from toy model cars called, "Constructors". The face will overlay the chassis by printing out the face on a piece of paper and cutting and gluing it on a cardboard. The cardboard will be cut in the same shape as the face, and will be attached to the metal structure by having a nail screwed through it. Professor Lee's voice will be recorded using a regular phone (iPhone). A motion sensor will be used so when there is motion nearby, the speaker will then turn on as to start speaking. For the soundtrack overlay, we will have a base recording of Professor Lee speaking and time it with jaw (mouth) movement. Movements will be preset to better synchronize with the audio. The Arduino, motors, and sensors will all be powered using some power from a laptop and an external 9 volt battery. Since the servos took up much more power than the sensors, the external 9 volt battery was necessary. The eyes will consist of one ping pong ball cut in half (one for each eye socket). We plan on asking him the following quotes: "Greetings, my name is Yooneun Lee", "Hello, I am Mini-Lee", and "Step back! You are too close!"

Section 3: Supporting structure

The idea and methodology of how the structure was initially, ended up having to be changed over the course of this project. At the beginning of the project, the chassis merely a cardboard box and the face was mounted onto the cardboard box and some metal pieces from the toy car parts. The lower jaw moved with the metal pieces, as it is cut out and taped to the metal tracks. One micro servo that came with the toy car was used to move the lower jaw piece. As it can be seen in Figure 4.

Figure 4: Phase 1

The ping pong balls (the eyes) were originally supposed to turn in both the vertical and horizontal directions. They were supposed to turn using a method found on YouTube, where two half circle metal beams were to hold the eyes and allow them to turn in the left and right directions. They would've been mounted on two micro servos that would turn at the same time to turn them left and right. Figure 5 shows how the second phase started look.

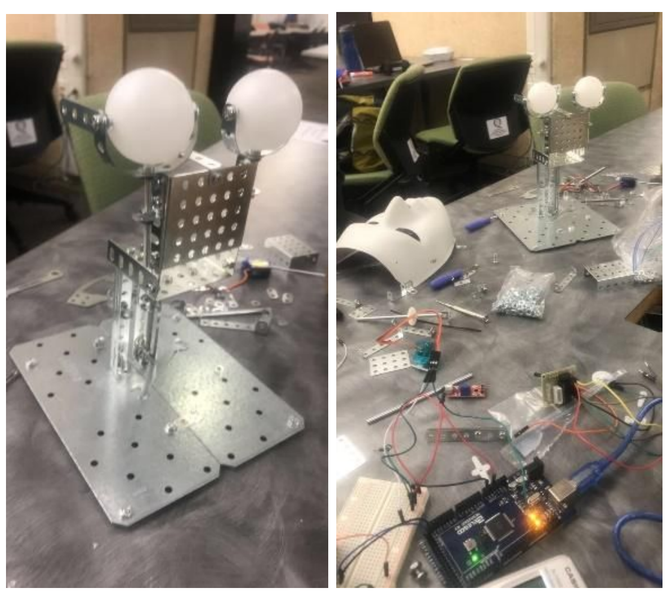

Figure 5: Phase 2

The final phase of the project ended up using gears made out of foam and cardboard. The gears were drawn out in AutoCAD first, then printed out so that they could be traced over the foam and cardboard. The foam and cardboard were carved out using a knife and scissors tracing over the AutoCAD pictures. The three gears that were drawn out were all used together to allow motion in the eyes in the left and right direction, using only 1 micro servo. The only downfall of this method was that it limited the eye motion to only the left and right direction, and wouldn't allow motion in the vertical axis (up and down). The ping pong balls were cut in half and taped onto the top of the gears where the foam was. The bottom of the gears is where the gear shaped cardboards were glued. The mouth was cut open on the face, and another mouth was placed behind where the hole was on the face, to make the chassis look more realistic. The final phase of the project is shown below in Figure 6.

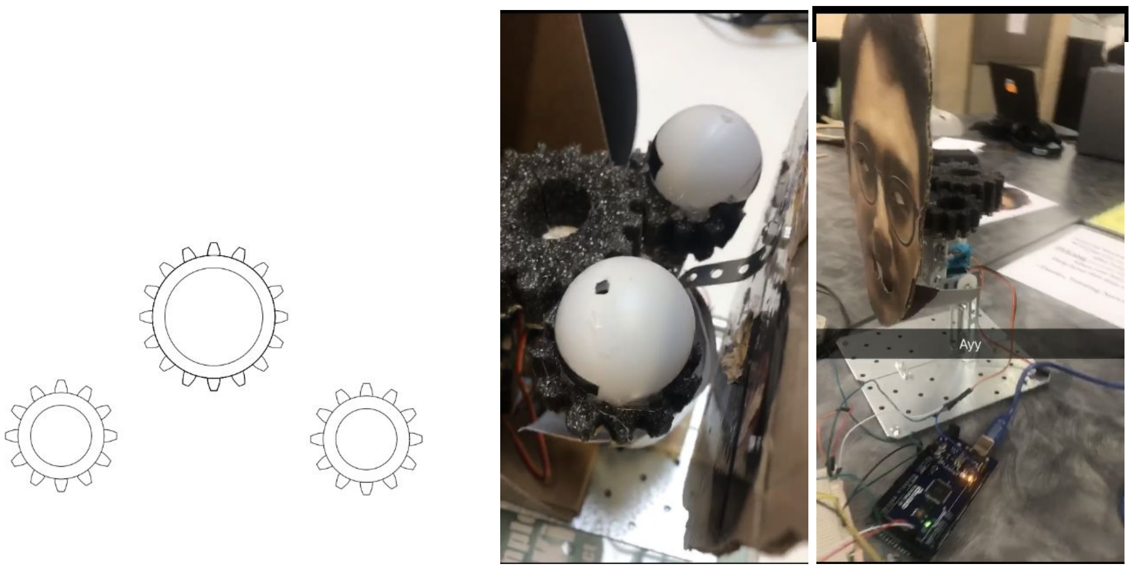

Figure 6: Phase 3

Section 4: Joints and motors

The lower jaw joint was moved using a micro servo, the servo was installed sideways on the body structure with metal members along with hot and super glue and actually had the fins changed out from a blade like fin to a full circular fin as you can see in Figure 7. The circular fin was installed into the arduino servo with a half-circle metal track in between the servo and fin, which allowed the servo to move the joint up and down. The half-circle metal track was the main structure as far as the jaw joint goes. The other micro servo was used to move the eyes in the left and right directions. The eyes moved by creating 3 gears made out of foam and cardboard, where the two smaller gears were taped to the eyes. The main large gear was installed with a micro servo with a wooden thin stick that was glued to the servo and gear. So when micro servo moved, the large gear moved, which moved both the smaller gears at the same time to allow the eyes to move. These small micro servo motors were used because the one that was used for the eyes came with the toy car that was bought prior to the final phase of the project, and the other servo that was used for the jaw had a good amount torque for a small price. The main purpose was to have a design that did more output at a lower cost.

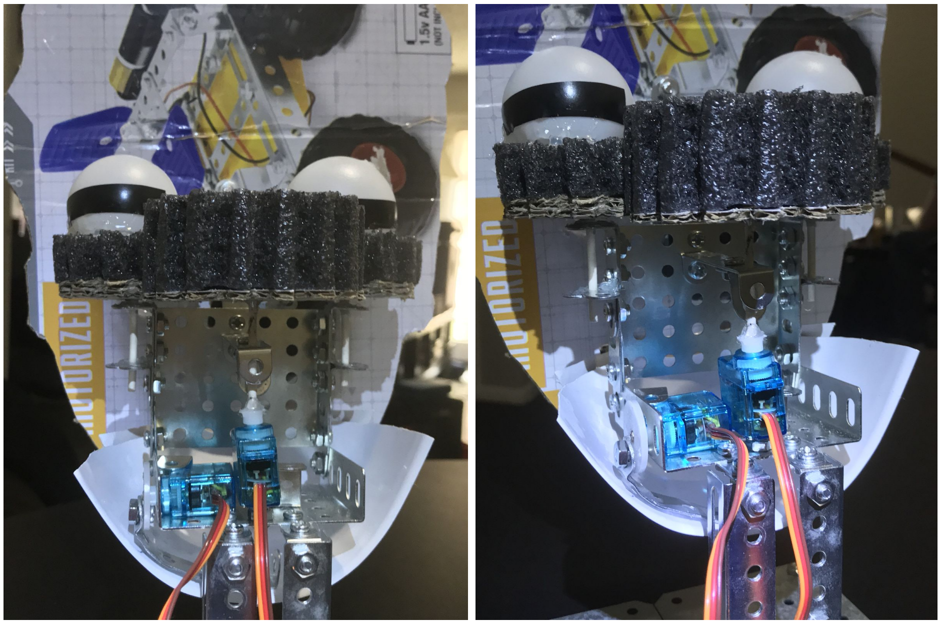

Figure 7: Servos

Section 5: Sensors

The two type of sensors that were used in our project was a KY-038 sound sensor (left side of Figure 8), and an ultrasonic motion sensor (right side of Figure 8). The sound sensor was used to have "Mini-Lee" speak a certain line talking about how loud the noise was that triggered the sound sensor. Something along the lines of, "Hey keep it down!". The motion sensor was used to trigger certain quotes from Mini-Lee depending on how close the ultrasonic sensor picked up motion. Both sensors were available to us so they were implemented into the project.

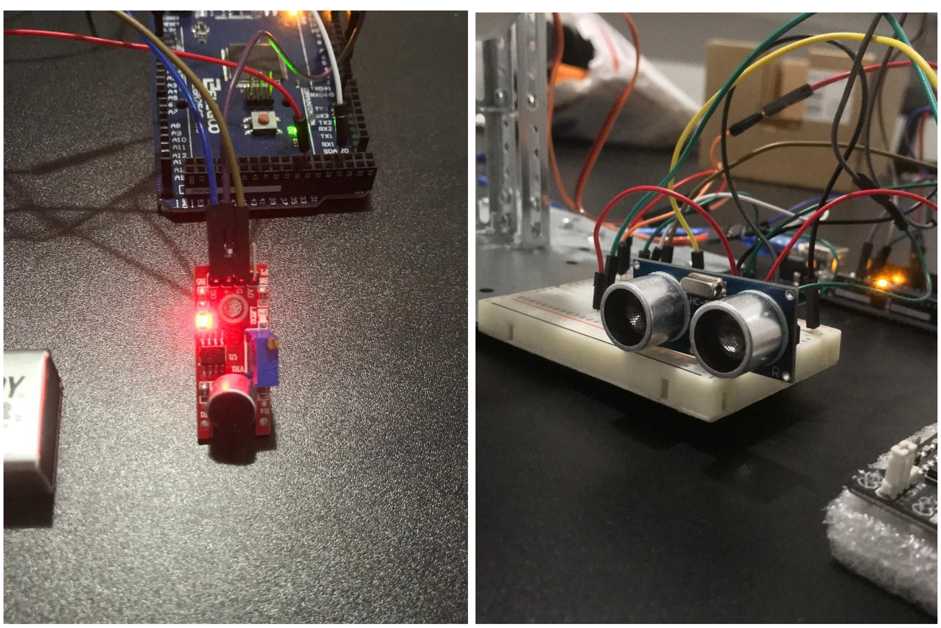

Figure 8: Sensors

Section 6: Programming for interaction

The code was designed to emulate human speech as best as possible. This was difficult due to the arduino only having one microcontroller. This limited the amount of simultaneous actions a servo could do to just one. Therefore our recourse was to program the arduino to only move one servo at any given time. To do this we used a countdown function to count limit the void loop to only one iteration. Once this function was complete we programmed the jaw arduino to open and close at different angles. The eyes arduino was used to move the eyes before or after the jaw movements. The sensors used were an ultrasonic , and sound sensor. In total there were a total of three speech patterns that were uniquely programmed on the arduino. Two of which were to be used in conjunction with the supersonic sensor and two different sensors. If the sensor picked up anything at a distance greater than or equal to fifty the face would introduce itself, and if the sensor picked up anything at very close distances it would exclaim that the person was to close and to back away. The third speech pattern programmed was used and activated when the sound sensor picked up a sound loud enough to trigger it. Luckily the sound recorded from the profess in conjunction with a large speaker was good enough to trigger the wanted result. Originally we had more speech patterns ready to go, however, the professor was shy and refused to lend his voice. The project could have been more interesting and fun otherwise. The speech pattern was programmed to move the jaw to the speech of "Siri won't answer my texts so I'll just call Alexa". The supersonic sensor gave the most trouble because it was failing. Every other ping the sensor would report a zero. To fix this we excluded zero from the number ranges we used to trigger analyzing. For example if the code said "If distance <= 10{ trigger voice}. The aforementioned code caused turrets in the robot. To combat we used " if distance <=10 && !=0{Triggervoice} The sound sensor was difficult to program because there was no clear indication what the sensor would write when requested to do Serial.print
When the serial monitor was examined the output of the sound sensor was gibberish. Not letters or numbers, it was printing out gibberish. To fix this and still use the sound sensor I did the opposite of the super sonic fix. The code read If Sound !=0 {Trigger sound}. This in conjunction with setting the potentiometer on the sound sensor to a critical sensitivity allowed the sensor to be of use. Overall the arduino is very limiting and much rather use hardware like raspberry pi. The link to the video on YouTube is: https://youtu.be/aMHLDH9SRWY

Section 7: Lessons learnt and suggestions (1 page)

1. First lesson that was learned from this project was knowing your sensors. Research should be done on any sensors you use because the sound sensor had a sensitivity knob on it so when we first tried using it, we thought it was broken because the knob was on off.
2. Another Lesson that was learned was not only just doing research on other animatronics projects, but to try to calculate if it would be feasible for you to turn in a certain amount of time with the tools that you have access to. Although we were given a budget of $30 per student, it was still hard to gain access to certain sensors and motors that we wanted to use due to ordering parts and having to wait for them.

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

Task	Main Personnel	Secondary Personnel
Structure/Chassis design	Lawrence Narvaez	Adriane Garza
Creating joints and motor interfacing	Lawrence Narvaez, Carlos Mendoza	Adriane Garza
Integrating Sensors and Interfacing Sensors	Carlos Mendoza, Lawrence Narvaez	Adriane Garza
Overall Programming	Carlos Mendoza	-
Report Writing	Adriane Garza	Carlos Mendoza, Lawrence Narvaez

(b) Bill of materials

No.	Description	Store	Qty.	Unit	Total $
1	Medium Micro Sensor	Intertex Electronics Inc.	1	$11.95	$11.95
2	Screws (bag)	Intertex Electronics Inc.	1	$3.99	$3.99
3	Nuts (bag)	Intertex Electronics Inc.	1	$2.99	$2.99
4	"Constructors" Toy Cars	Five Below	3	$5.49	$16.47
5	Metal Base Plate	Home Depot	1	$6.45	$6.45
6	Heavy Tie Plate	Home Depot	2	$4.48	$8.96
total					$50.81

References

[1] “Build A Robot Animatronic Face For 30 Quid for a modular synth?” YouTube, LOOK MUM NO COMPUTER, Apr 2, 2018, https://www.youtube.com/watch?v=mDe6q6RMUtY.

[2] Fitzpatrick, Robert. “Designing and Constructing an Animatronic Head Capable of Human Motion Programmed Using Face-Tracking Software.” *WORCESTER POLYTECHNIC INSTITUTE*, 1 May 2010, web.wpi.edu/Pubs/ETD/Available/etd-050112-072212/unrestricted/Fitzpatrick.pdf.

[3] “How to Make an Animatronics Robot Face.” *YouTube*, JugadMachine, 26 July 2017, https://www.youtube.com/watch?v=ycE_IDdh5NA.