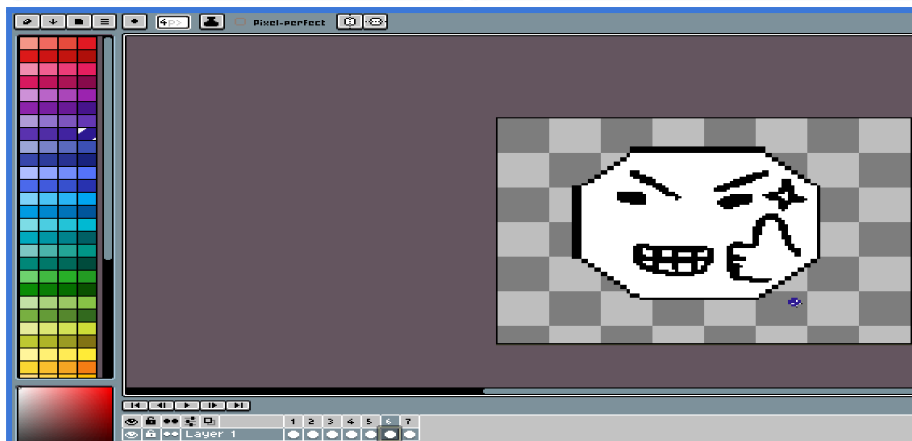
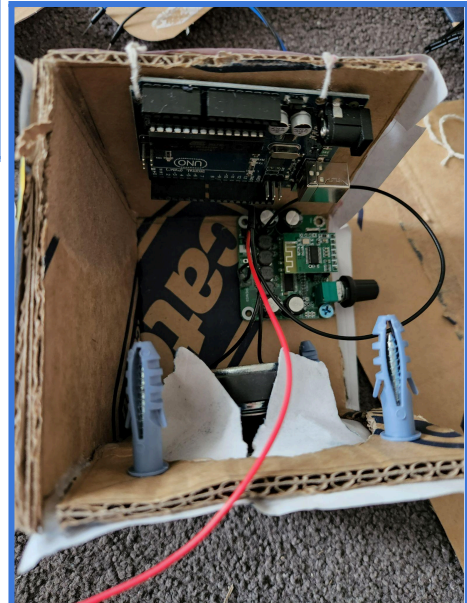
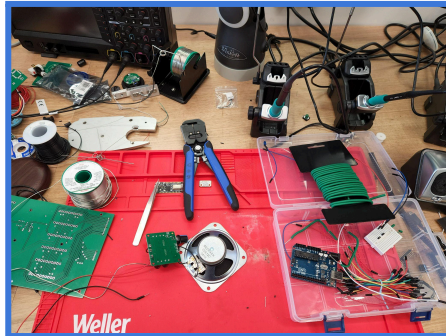
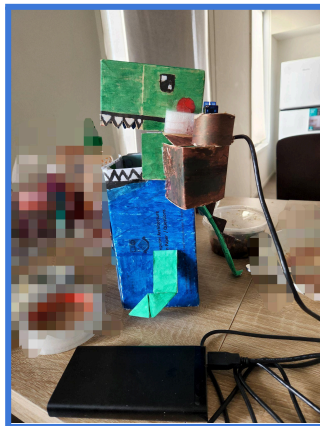
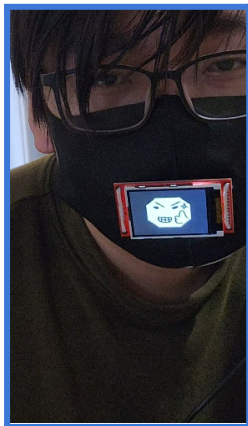


FIT3146 Maker Lab

Assignment 1&2

Dongzheng Wu



1. Table of Contents

1. Table of Contents	1
A1	3
2. Overview Of Plan	3
2.1 Brief Overview	3
General Idea	3
About Technology	3
About Material	3
2.2 Motivations	3
2.2.1 Curtain Auto Switch Car	3
2.2.2 Emo Mask	4
2.2.3 Table Trash Bin (Dinosaur)	4
2.2.4 Tech Speaker	5
2.3 Technology Metric	6
3. Making Progress	7
3.1 Table Trash Bin Dinosaur (TTBD)	7
Used Material	7
Used Technology	7
Faced Issues	7
Effort Evaluation	7
Final Product	8
Detailed Making Progress	8
3.2 Curtain Auto Switch Car (CASC)	14
Used Material	14
Used Technology	14
Faced Issues	14
Effort Evaluation	15
Final Product	15
Detailed Making Progress	15
3.3 Tech Speaker	20
Used Material	20
Used Technology	20
Faced Issues	20
Effort Evaluation	20
Final Product	21
Detailed Making Progress	22
3.4 EMO Mask	27
Used Material	27
Used Technology	27
Faced Issues	27
Effort Evaluation	27

Final Product	28
Detailed Making Progress	28
4. Summary	32
A2	32

A1

2. Overview Of Plan

2.1 Brief Overview

General Idea

Before actually starting the hands-on experiment, I thought for a long time about what kind of artefacts I am going to make. Personally, I hope they are useful and practical which can be used in my daily life. After brainstorming, I decided to make four relatively complex crafts that each required technical involvement which are Curtain Auto Switch Car, Emo mask, Table Trash Bin (Dinosaur), and a Tech Speaker. I will make them sequentially (but random order) so that I can reuse some generic materials to avoid waste.

About Technology

As for the technology, I'm going to use Arduino as I found it very interesting when I explored it during the first workshop. Secondly it has various components and libraries that are powerful enough to support what I want to achieve in my design. If I found any other technology that would be more suitable for my product during the making process, I may consider using them as well and it will be documented with reason behind it.

About Material

Regarding materials, I intend to be environmentally friendly and use existing unwanted waste in the home. Such as empty bottles, cartons, used paper and so on. Doing so saves unnecessary waste, and turns this trash into treasure. In general, recycled materials will be the major material used, and other things like glue, pigment, wires will also be used according to need.

2.2 Motivations

This section discusses the initial motivations behind products, whereas the actual features will depend on the making progress so the final product may differ from the plan in terms of functionalities but the main idea should be the same.

2.2.1 Curtain Auto Switch Car

I was planning to make a toy car at the very beginning, whereas it does not fit my idea as it is not practical. So I started thinking about what a toy car can do. My first idea is to use that toy car to transport items. Imagine that you can drop your trash on the toy car and it will carry the trash to the trash bin. I believe that many people may have the similar idea, and I want it to be more special, so here is my second idea which is a Curtain Auto Switch Car.

For most people, they have to manually open and close the curtain at home, every day, every morning and every night which is very tedious especially for a lazy person like me. So I would like to make a small car, fasten it to the pole of the curtain and connect one end of the car with the curtain so it can drag the curtain to perform a close. To open the curtain, control the car and move toward the same direction where to open the curtain, and the car will eventually push all the curtain to the side.

The car could be used through a remote control to make it move either forward or backward, an advanced feature I am planning to do is use a light sensor to detect whether it is the evening or morning currently and close or open the curtain accordingly.

Summary:

- It is a curtain auto switch car.
- It is used to open/close the curtain automatically.
- It is made with recycled materials, arduino techs.
- It is built for anyone who uses traditional curtains at home, especially for those who are reluctant to manually open and close curtains.

2.2.2 Emo Mask

Since the outbreak of the covid-19, the vast majority of people have worn masks in their daily lives. And this mask covers people's faces, making it impossible for people to read information and perceive emotions through each other's facial expressions, which potentially widens the distance between people and creates a barrier to communication.

So I want to make a mask and put sensors inside the mask to detect the current emotion through facial expressions. A display screen is then placed on the outside of the mask to show the person's emotions. It can draw different levels of smiling faces, calm faces, depressed faces, etc. in the form of cartoons.

Also, during the first week of the workshop, a teacher complained about the difficulty of using the ear-worn mic, which inspired me too. Because of the existence of masks, people's voices will be blocked to a certain extent, and a microphone embedded in the mask will solve this problem very well. Also it can replace the ear-worn mic as it is more sturdy and easy to carry. This feature will be implemented if everything goes well.

Summary:

- It is an emotion mask.
- It is used to show your face to other people while wearing the mask.
- It is made with recycled materials, arduino techs and a decent medical mask.
- It is built for anyone who would like to show their emotion to others and who wants a cooler mask.

2.2.3 Table Trash Bin (Dinosaur)

The trash bins at home are usually placed in the bedroom, kitchen, or bathroom to store different types of garbage. But in the dining room, more specifically, it is hard to find any trash bins on the table. Instead, place trash on a plate or wrap it in a paper towel. This is done mostly for convenience. The trash bin itself may feel too dirty to sit on the table, but

making a clean, fun trash bin that fits on the dining table will be more convenient and make the dining environment tidier.

So, I would like to make a trash bin that is suitable to be placed on the table. I will design and make the trash bin to look like a cute dinosaur rather than a simple container. And every time you need to drop trash into it, it will open its mouth to 'eat' the trash. To make it more challenging, I would place a sensor to detect if there is a hand reaching out, if it does so it will open its mouth automatically by using some mechanism.

Summary:

- It is a table trash bin dinosaur.
- It is used to store the rubbish generated during meals.
- It is made with recycled materials, arduino techs.
- It is built for anyone who would like to keep a tidier dining environment.

2.2.4 Tech Speaker

There is an interesting trick, playing music through your phone's speaker and placing your phone into a bowl, you will get a music player with better sound quality as the sound wave is reflected and more centralised. I think I can use the same principle to make a speaker that fits the phone. In general, it will be a closed box, and there will be a spot where I can place the phone's sound outlet inside the box, and then the bulk of the phone will be supported above the box with a stand. From the other direction, I would leave a hole to ensure that the phone's charging cable can power the phone.

Summary:

- It is a speaker made for mobile phones.
- It is used to improve the quality of music played on mobile phones.
- It is made with recycled materials, arduino techs.
- It is built for anyone who doesn't have speakers and want to improve the quality of music played on their phone.

2.3 Technology Metric

Products	Curtain Auto Switch Car		Emo Mask		Table Trash Bin Dinosaur				Tech Speaker
	Activities								
Suggested Possible Skill	Make it Move		Make a costume/ wearable/c lothing	Hack a Toy	Make a container / house/ castle	Create a Character / Pet	Make with Food	Make for Water	Make for Music
Programmed Circuit	y		y		y				
Use a sensor					y				
Breadboard Circuit	y				y				
Wired Circuit	y		y		y				y
Light it up			y						
Switch it	y		y		y				y
Paper craft	y		y		y				y
Painting	y		y		y				y
Soldering									y
Mark Percentage	20%		25%		30%				25%

3. Making Progress

3.1 Table Trash Bin Dinosaur (TTBD)

Used Material

- Boxes, cardboard, paper tube and paper
- Plastic
- Disposable spoon
- Foam
- Pigment
- Solid glue, glue and tape

Used Technology

Arduino

- Ultrasonic Sensor
- Servo Motor
- Arduino UNO board

Other

- Charging cable
- Power bank

Referred resources:

- Ultrasonic Sensor :
<https://howtomechatronics.com/tutorials/arduino/ultrasonic-sensor-hc-sr04/>
- Servo Motor:
<https://www.makerguides.com/servo-arduino-tutorial/>

Faced Issues

- Ultrasonic Sensor will influenced by other sounds
 - Solved through codes - filtering invalid data
- Not enough weight to against torque force when Servo Motor rotating
 - Solved by adding a firmly paper tube under Servo Motor to against torque
- Hard to hide the wires and components as they are placed outside
 - Solved by adding extra components outside the body

Effort Evaluation

The main difficulty of this product is it involves a lot of handmade processes which I am least good at. Also, it is my first time working with an Arduino and making artefact, so a lot of research and experiments is required. I had a very detailed plan on every step to avoid screwing it up.

Final Product



A short live demonstration can be found here:

<https://youtube.com/shorts/uXJm0I8HVul?feature=share>

Detailed Making Progress

Before starting to make TTB, I did some research to find out what sorts of components I need for this product. As I am new to arduino, this takes quite a bit of time to do. I was planning to use a motion sensor to implement the distance detection but from my research it would be complex since it has to cooperate with several different components. In the end, I decided to use ultrasonic sensors (sound wave sensor) and servo motors. The tradeoff of using ultrasonic sensors would be that it has less accuracy.

To prove that my theory worked, I bought the components needed from the store and started coding and testing, and the results were quite satisfactory. (A demonstration video here: <https://youtube.com/shorts/3FZAqDHj2Dw?feature=share>)

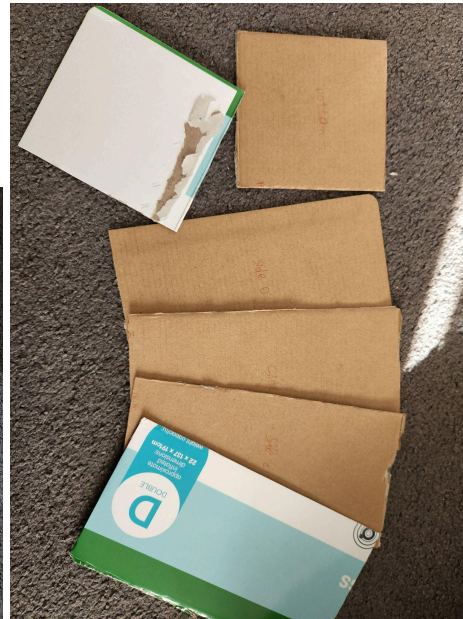
While exploring the components and codes, the first issue came up. I found that sometimes the servo motor will rotate back even if my hand is within the detection range which is undesirable. After a little more testing and research, I realised that since the ultrasonic sensor is using sound waves with some computation to detect the distance, the data would be affected by any sounds from surroundings.

A commonly used solution from my research is to shorten the detection period which allows more data to be collected and then filter the invalid data. From my observations, all the invalid data comes to a very high value so rather than using the approach above, I set a fixed range for valid data, if an undesired data occurs, the program will use the previous valid data instead so it won't affect the servo motor. I would say my approach is better because it requires less frequent detection which is more energy efficient and it is easier.

In order to start making the TTB, I first thought about the materials I would need. For the trash bin/dinosaur body I decide to use thicker cardboard as it will be stronger and more durable than thin cardboard and will provide better stability due to its heavier weight. As for the lid of the trash bin/the head of the dinosaur, I plan to use thin cardboard, because

considering that the motor may be used to realise the automatic opening trash bin, the heavier cardboard may burden the motor or require a higher power supply.

After deciding what materials to use, I started crafting. First, I found a thick cardboard box then cut and unfolded it along the edges which gave me a piece of cardboard with an irregular pattern. Then I thought about the size of the product I was going to make. It couldn't take up too much space because it had to be placed on the table, otherwise it would look crowded. Secondly I want it to have good capacity, or it won't be practical enough. So it will be a vertical cuboid structure. After measuring the size, I decided to make a container with a length and width of 10cm and a height of 18.8cm. The lines and data are marked on the cardboard so that I can cut it later on.



The next step is to cut the cardboard along the lines drawn, and then you can get the four sides and bottom of the container.

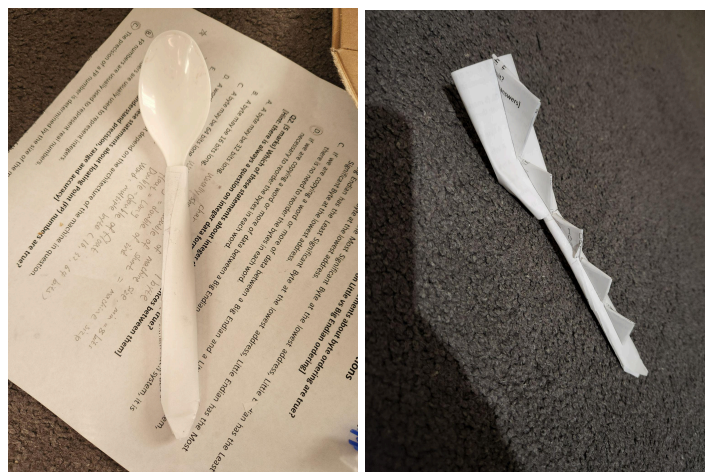
The outside of the original carton was patterned, so I got several cardboards with different sides. Before glueing the sides together, I considered that since it may be necessary to paint on the outside later, and this is a trash bin for a dining table, the inside of the container should preferably have better waterproofness. So I put the unpatterned and rougher side of the cardboard face out and the patterned and smooth side in. In order to further improve the waterproofness, I cut out a slightly larger size than the cardboard out of a discarded plastic bag to cover the inward side of the cardboard and stick them together.



In the next step I glued cardboard together and completed the initial container structure.

Regarding paste, I used different paste methods. For sticking the paper, I use solid glue because it has enough strength and is convenient to use. When pasting the cardboard, I need to use a stronger glue. If I need to change the shape of the cardboard by pasting, in addition to using glue, I will also use tape for reinforcement, and for the sake of beauty, I try to stick the tape to the inside of the container rather than outside.

While waiting for the glue on the main body to dry, I started working on the other parts. First of all, I made the tail of the dinosaur. I found a used disposable spoon. After I washed it, wrapped it with waste paper and pasted them together.



Then I reused some wasted paper, folded them into some triangles and pasted them with the spoon to make the bone plate of the dinosaur. The reason for using paper is to make it easier to be coloured later, and it is easier to make the desired shape with paper.

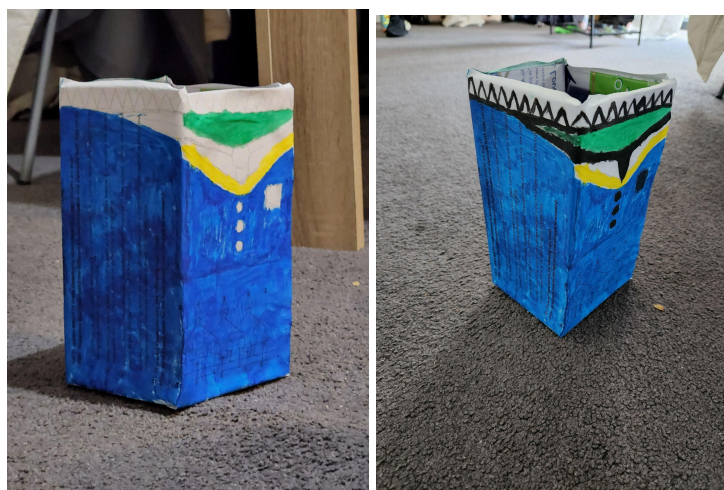
It has some flaws since I attached the plastic to the cardboard and some corners were not glued finely enough. To cover up these imperfections I pasted used paper at the outside of the container, which also makes it easier for me to paint.



I also made the dinosaur feet and claws by further reusing the scrap paper I created during the making process. Specifically, the feet are made of cut waste paper by folding, and the claws are made of leftovers from light cardboard. Its tail is designed so that the base of the tail extends beyond the body and touches the ground, which provides extra support for the trash can and improves stability.

After finishing the parts, I'm going to start colouring the whole thing because if I glue them on first it will be difficult to paint in many places as I've learned my lesson from colouring the tail. (I forgot to take a picture when I colored the tail alone.)

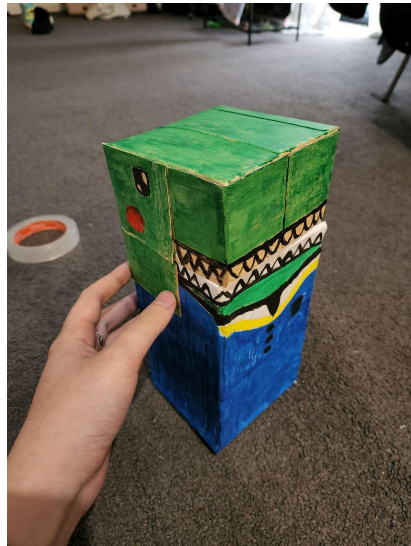
First I drew a rough outline with a pencil. I was going to put a suit on my dinosaur, so I drew a coat, a bow tie. I'm going to use a dark blue theme with a little bit of yellow, which in my opinion will match the green of the dinosaur itself.



As planned, I made the dinosaur's head out of light cardboard. I first unfolded the carton, measured the size and started cutting. After cutting I realised I had mismeasured the height of the head, to fix this I cut out a light cardboard again and glued it to the first light cardboard.



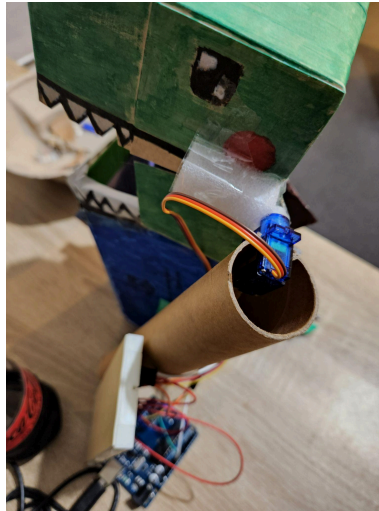
Using the same method as the body, after colouring the dinosaur's head, a cute dinosaur is born. Since the used paper is the question sheet from the computer architecture unit, I named this dinosaur "Binary".



The next step is to place the circuit and components onto "Binary". In week 3's tutorial, my homeroom tutor Rebecca gave me a suggestion that I could connect a LED to illustrate that the bin is full. Based on this suggestion, I decided to put the sensor inside the container rather than my original idea which is outside. This way the sensor will detect when the bin is fully filled, and the bin will keep open to show it is full.

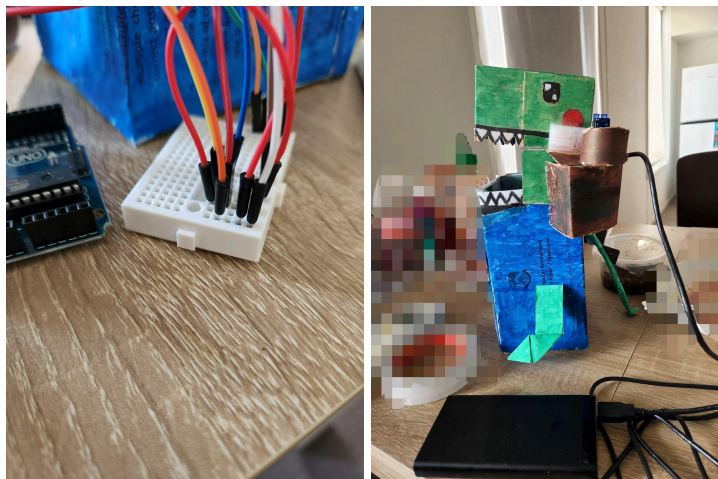


The servo motor and other components like arduino board and breadboard are placed outside. When I first tested it, the dinosaur's mouth didn't open, instead, the body of the servo motor was rotated since the weight of it cannot withstand the torque force opposite to rotate the cardboard. I tried several ways to paste the motor with the container body, however the pasting still is not strong enough to resist the force.



After a few experiments, I figured out a way that works perfectly. A strong paper tube is used against the torque force as it is heavy and not deformed. To ease the burden of tape I also used foam to increase the contact area of the pasting which reduces the pressure. This combination allows the trash bin to be opened and closed by the servo motor without breaking any pasting.

The final step is to hide all the wires and components, and cut the paper tube into the desired size.



It is hard to hide the components inside the body because the inner is used to store the rubbish, they may break the circuit. To hide them, I first mitigated the wires to a smaller breadboard, then built a box using other cardboards and placed all the components into the box. I am trying to make it look like a backpack so it does not look weird.

The only wire left outside is the charging cable and it connects to the power supply. At this point, my first product is completed.

3.2 Curtain Auto Switch Car (CASC)

Used Material

- Boxes, cardboard and paper
- cotton thread
- Screw and nut
- Pigment
- Solid glue, glue and tape
- Bottle caps, sticks, plastic bags

Used Technology

Arduino

- IR remote control
- IR receiver
- Stepper Motor
- Arduino UNO board

Other

- Charging cable
- Power bank

Referred resources:

- IR-remote :
<https://github.com/Arduino-IRremote/Arduino-IRremote>
- StepperMotor:
https://robojax.com/learn/arduino/?vid=robojax_stepper_28BYJ-48_STPB-1

Faced Issues

- IR-remote keeps receiving zero.
 - Solved by looking through the repository in github for the corresponding library.
- IR-remote cannot continuously receive signals.
 - Solved by looking through the repository in github for the corresponding library.
- IR-remote receives zero when long press.
 - Solved through code - record previous data, filter the invalid value.
- StepperMotor cannot rotate back.
 - Solved by discarding the Stepper library, using code manually controlling the stepper motor.
- The car cannot balance on the pole

- I have tried following to solve the problem but none of them work:
 - Attach and balance weight on both sides.
 - Replace the rod with a more uniform material.
 - Increase contact area between car and pole.
 - Increase size/number of wheel
 - Increase the area of car body
 - Add extra parts for fixing
- Revised the initial idea.

Effort Evaluation

This is the product that I have to revise my initial idea to get it works due to lack of consideration about physics when designing. Given that my expected plan didn't work out, I finished the product on the exploring and spent a lot of time experimenting. Some technical issues were raised which bothered me for a while but they were solved eventually.

Final Product



A short live demonstration can be found here
(set the video speed to 2x would get better experience):

<https://youtu.be/V3xV3NWRiz4> Open curtain

<https://youtu.be/hXevuqtQgE8> Close curtain

Detailed Making Progress

To achieve the desired feature of this product, I decided to use an infrared remote control and a stepper motor. My initial idea was to use an infrared remote to control a stepper motor which is used to drive the car by rotating the wheel, and let the car move forward and backward on the pole of the curtain to perform opening and closing.

To ensure my idea works, I start with researching and implementing the circuit code needed for this product. But this process was a little difficult because of some issues.

I firstly found some examples about the IR remote control and started to mimic the circuit and code for learning purposes. However I keep receiving zero whenever I press the button on the remote control. After many experiments and research I found that the examples from the internet are mostly out of date, as the library is updating, the old methods and some usage are changed. I was looking for a solution directly from google with gaining nothing at the beginning, then I found the github repository of used library for reference and it does help a lot. By looking into the README file, I get to know how to use the new version of this library and the IR remote control starts working properly. The instruction provided also solved the next issue which is the IR remote control cannot receive signal continuously i.e it does not resume properly.

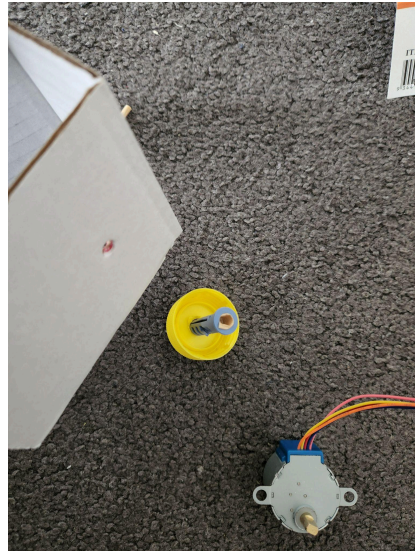
After getting the IR remote works, I started exploring how the stepper motor works. From my research, most of the stepper motor examples used stepper libraries and it works well at the start. However, my motor stopped working when I tried to let it rotate in the opposite direction for unknown reasons. I thought it could be the same problem with the IR remote library, that some methods might be changed along with updating. I went through the repository and confirmed that my code is consistent with the guidelines. It is very hard to find the solution as the same code works for others but not my motor. After a very long time researching, I found someone made a set of tutorials about using stepper motors without using the stepper library. I looked into the code in detail and found out that the author manually interacts with the stepper signal to achieve the rotation in both directions. After I revised the codes and composed them with IR remote codes, the main technical feature of this product was achieved.

In order to make a rotatable wheel, I used a wooden stick to pass through the two bottle caps and fixed a section of the wooden stick to the rotor of the motor, which made the most preliminary function of the product.

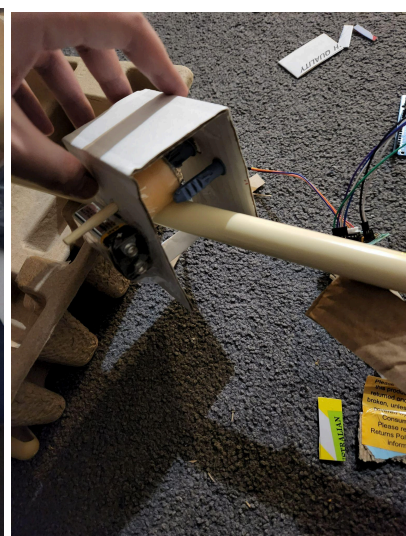
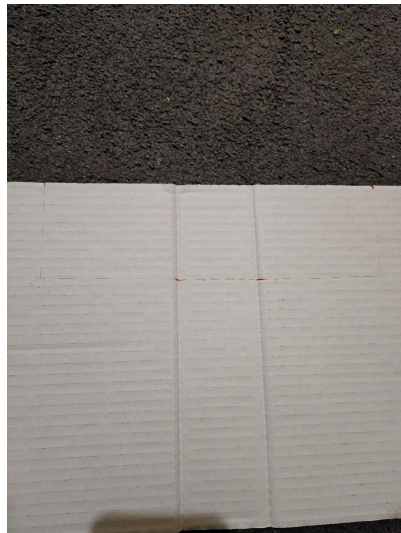
A short live demonstration can be found here:

<https://youtube.com/shorts/UDC06ryZ0U0?feature=share>

As you can see from the video above, the stick will have a certain offset when the motor rotates, because the centre of the stick is not on the same line as the centre of the rotor, which will prevent the wheel from rolling smoothly. So I replaced the stick with a nut that goes with the screw. There is a hole in the centre of the nut, and by stuffing paper scraps in it, it can hold the motor rotor firmly. And since it is shorter, the resulting offset will be smaller.



Next, I am going to make the car body first so that I can test out my equipment. Start with measuring the size and cutting it to the shape I want. Folder the cardboard to get the car body. The stepper motor is screwed to one side of the body, and the wheels are placed under the body. Then the initial car body is finished.



I got a pole for testing my car, however the car cannot even stand on it properly. Then I made many changes as you can see from the pictures. I forgot to take many photos during this process, because the whole process was not smooth, and I was constantly trying and changing to find the solution of the problem.

To make the car more stable I tried following:

- I replaced the cap with a ring with a more even texture and a larger contact area.
- I balanced the weight by attaching a battery on the other side of the car body.
- Glue cardboard inside the body to hold where the poles go through.
- Make the front cover and trunk to increase the contact area.
- Slow down the rotating speed of the motor.

After the above changes, the car can move on the pole for about 3 seconds before falling to the ground. I've spent a lot of time trying to overcome the problem so far, but obviously this is not acceptable and I don't have any chance to get it to work. So I temporarily changed the plan.

Rather than let the car run on the pole, I decided to use a motor to directly control the curtain by dragging a wire. The working principle of this method is very simple, first tie one end of the wire to the rotor of the motor and the other end to the curtain. When the motor starts to turn, the wire is wound around the rotor to pull the curtains.



For safety reasons, I used a drying rack at home, clothes hangers, and a plastic bag to make a simple curtain for the simulation. I tested it with a previously made car body and confirmed that the method works. But for the curtains to open and close I need two motors working at the same time, and they need to turn in opposite directions. I put the second motor upside down so I don't need extra code to make it work. I ran into some issues during this time, such as a "wheel" placed on the first motor that would cause the two motors to wrap around different lengths of wire at the same time, which would cause the first motor to wrap extra wire and stop working. Another issue is that the wire is wrapped around the root of the motor and the motor gets stuck and stops working. But after a series of improvements, these problems have been solved.

Remembering my original plan was to make a small car, now I'm going to present it in a different way. I first found an origami tutorial for a small car online, and folded and colored a small car from a piece of used paper. And paste it with the wire, when the wire is pulled, the car will also “drive” in the same direction. I also colored the original car body and am trying to make it like a garage now.



The lighting sensor idea is dropped as it is over complex, things like following need to be considered:

- Detects if the curtain is already opened or closed. (There will be problems when it tries to open curtains that are already open.)
- Determine when to trigger the switch via a light sensor. (It is possible that the user does not want to automatically open/close according to the light in some circumstances.)
- Decide under which light intensity to open and close curtains. (Different users may have different preferences. To make the setting custom would be very complex.)

Therefore, my second product is finished here.

3.3 Tech Speaker

Used Material

- Boxes, cardboard and paper
- Screw and nut
- cotton thread
- Pigment
- Solid glue, glue, glue gun and tape
- Foam
- Soldering

Used Technology

Arduino

- Bluetooth Module
- Amplifier Module
- Arduino UNO board

Other

- Plugpack DC
- Speaker

Referred resources:

- Altronics: <https://www.altronics.com.au/>

(A lot of related websites, videos, blogs, tutorials, datasheets of components are not recorded as I have viewed too many. The final components are from altronics. Their official website and clerks provide many valuable information helps me to complete this product.)

Faced Issues

- Difficult to stick sturdy cardboard.
 - Glue gun is used to solve this.
- Hard to find out the components needed.
 - More research, ask for advice from professionals.
- Wires hard to directly connect to components.
 - Soldering is used.
- No available port can be used for power supply directly.
 - The Arduino board is used as a middleman to transmit the power.

Effort Evaluation

The initial plan of this product was basically to put a phone into a box and the sound quality would be improved as sound waves reflected. Apparently, this would be too easy so I made it more challenging. Now I am going to make a real speaker that could be used by phone through the bluetooth. As the plan changed suddenly, I had to do a lot of investigating to find a way to achieve the desired feature.

I gained the experience with the first two products and started to understand arduino and developed some investigation and self-learning skills. But I have never been exposed to similar components and functions so the process of researching was a bit difficult for me. Soldering is used in this product and it is a bit challenging at the beginning. I also spent a lot of time on decoration, in particular I painted on every face of the speaker.

Final Product



A short live demonstration can be found here
(You may need to adjust the volume to hear the sound)

<https://youtu.be/sTR4TQPhS-Y>

Detailed Making Progress

To get started with building this product, I have to do research and figure out the components needed first. As there are too many different resources online showing how to make the speaker, I start getting confused as I do not exactly know which components are necessary for this product, and it is definitely meaningless if I follow everything from other people's projects. Therefore, I decided to get some advice from professionals.

I went to an altronics store in person and expressed my thoughts to the clerk. They gave me many suggestions and valuable information that eventually helped me to finish this product. They showed me many components they have which may potentially be used in this product and gave me a datasheet for each component so that I know the details and difference between them. They are patiently answering my questions which makes my thinking gradually clearer. Combining the research I did before, I finally decided on the components I needed.

Basically I will need a bluetooth module to handle the connection between the mobile device and the speaker. And I start looking into it first. There are many aspects need to be considered for instance:

- Power consumption.
- Audio quality.
- Bluetooth connection range.
- Protocols Compatibility.
- Difficulty of implementation.
- Cost

In the end I chose the CSR8635 Bluetooth V4.0 Module not only because of its outstanding performance in all aspects, but also because it is specially made for audio streaming. At the same time, I also get to know the differences between various versions of Bluetooth, many of which are mainly due to the different protocols used. The advanced version can even support multiple devices at the same time, but it is not very useful for this product. It is worth knowing that the Bluetooth version is backward compatible, which means that as long as the version supported by the mobile phone is higher than the version of the Bluetooth module, it can be used successfully.

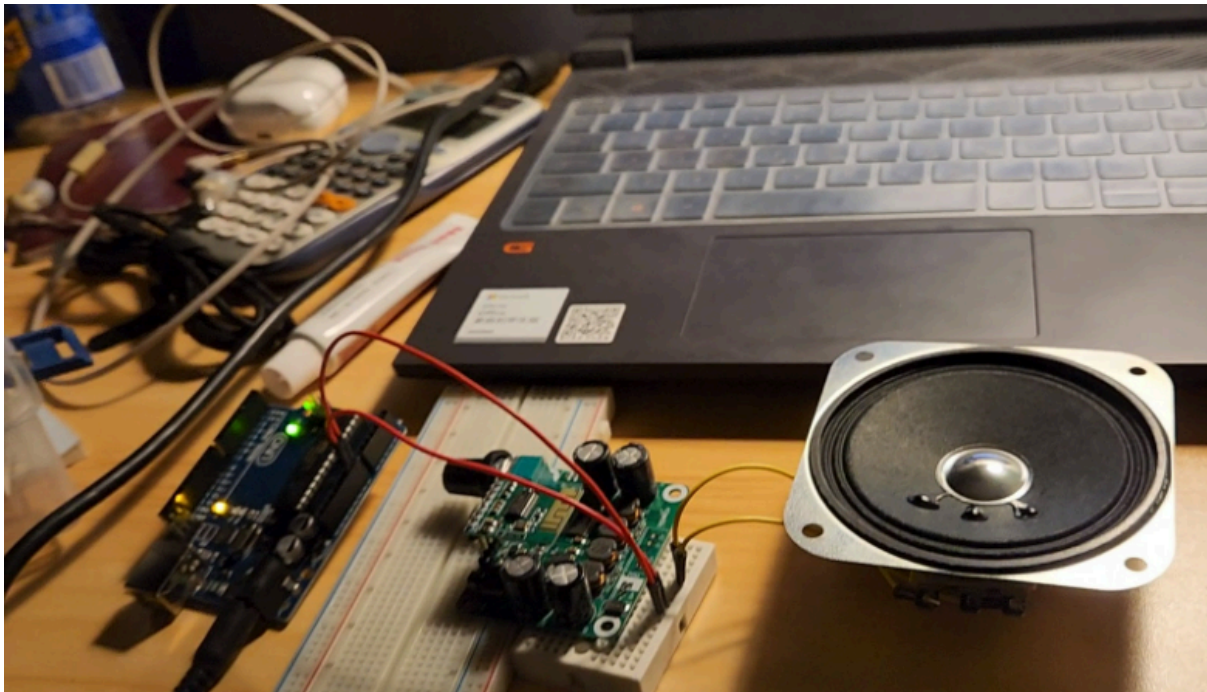
Also, an amplifier module is necessary in my opinion. It keeps the volume level and can provide additional volume control. So I found a preliminary amplifier module with a knob to adjust the volume. Link the Bluetooth module with the interface of the amplifier module according to the guidelines, and the core of the entire product is completed.

Next step, I need to find a proper speaker for my product. Things like required power, resistance, music quality and cost are taken into consideration. When I tried to put everything together, my first issue of this product came up. There is no port that allows me to charge the components directly. In most cases, people will cut the wire of the charger, and solder the wires directly onto the components to get power supply. Whereas I felt that this is a bit of a risk because I have no experience on this sort of work.

After a while of thinking and researching, I had a better idea which was to use an arduino board as a middleman and connect the charger to the arduino's port. Then using jump wires to connect the arduino board to the other components. From my research, there are two

ports on an Arduino UNO board, the USB port will limit the voltage and constantly give 5V charge, whereas the other port will give whatever the voltage from the charger itself. And this voltage can be gained by connecting another component to the “Vin” pin of the board.

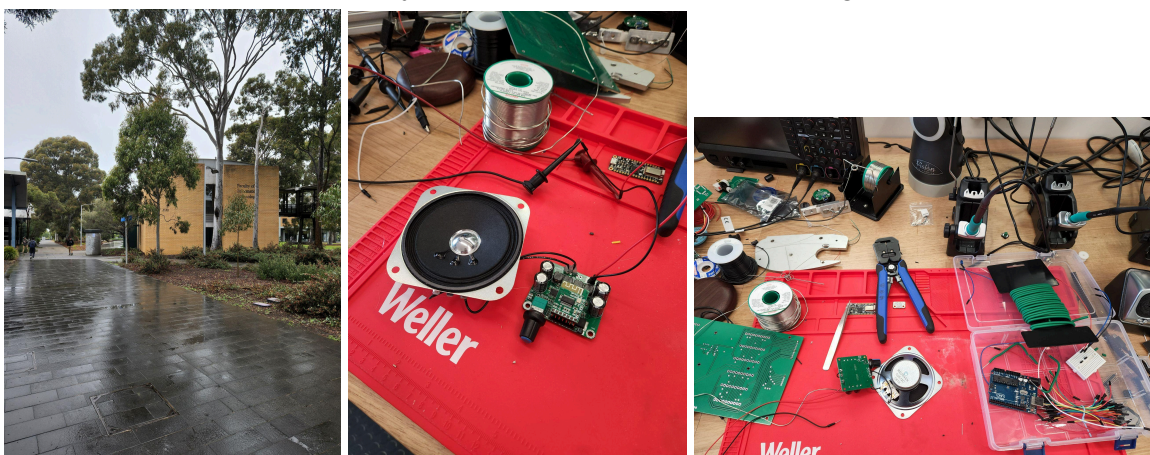
So, I bought a plug pack DC which is well chosen to suit this product. Since the power, current, voltage and size of the charger are crucial to the proper functioning of the speaker



Then I tried to put everything together again, this time the speaker started working. A short demonstration video is available here:

<https://youtu.be/FW7KC5TrKk>

As you can see from the figure or video above, the wires are connected using a breadboard and in fact, some wires just touch each other and are not really firmly connected which is my second issue. These components are different from previously used components, they do not have male or female pin directly on the board, thus it is hard to connect them without soldering. After posting an enquiry about soldering on ed forum, Jim Smiley replied to me and we met on week 5 Thursday in an inclusive lab to do soldering.



At the beginning, Jim let me try soldering the components myself first to see if I need to learn it first or not. As I am not familiar with soldering, there are some procedures that are not

correct. He pointed me out on those incorrect operations and taught me some soldering techniques.

- Clean the soldering iron before and after soldering.
- The flat of soldering iron should touch on both components you want to solder.
- The solder rod should touch all the components and soldering iron to get melted.
- Ideally the melted solder rod should go through the whole if soldering the wire on board.
- The extra wires need to be cut off.
- To make the wires more stable, the root of wires should be glued by glue gun.

Before I actually soldered my parts, Jim prepared some mockups of the wires and parts for me to practice soldering, until after I was getting proficient, I started soldering my wiring. Although the process for soldering took some time and effort to meet the standard, the final product was satisfying. And I am very thankful to Jim for his patience.



The next step was the upgrading of the speaker. Firstly, I marked on the cardboard to measure the required length, width and height of the body of the speaker. Second, following the markings, I cut the shape of the speaker body and then folded them to get a square box. After getting the body of the speaker, I estimated the size required to put the speaker on the front of the square box and cut the shape out of it.



Next, I put the speaker inside of the hole cut out in the last step to see if it fits the size. After that I started glueing the boxes together. Because it was made by folding heavy cardboard, normal glue was not strong enough to hold them together. I've tried to use tape, but again, the tape doesn't hold it firmly, it comes loose a bit. In the end I chose to use a hot glue gun. It is not hard to use a glue gun since I used it a lot in my first year unit of engineering. The solid glue is melted by a charging glue gun and applied to the cardboard, and when the glue cools and solidifies, it forms a strong bond. After I finished glueing, I started making decorations. To avoid the speaker being damaged by the paint, I did not fix the speaker directly on the box, instead, I drew on the white paper first and stuck them on each side of the box. After thinking for a while I decided on the topic of the drawing - sky. Because looking up at the sky is as relaxing as listening to music, personally, there is no conflict in combining them. At the same time, painting and music belong to the category of art, which makes this product more artistic. In particular, each side of the box used a different colour and style to make the look more interesting. In addition, it pays homage to the paintings of Van Gogh and Monet.



After this, the speaker was fixed on the box with screws and nuts. Other components were also attached inside of the box as same as the speaker. The Arduino board was connected with the cotton wires and the amplifier module was fixed at the bottom of the box. To avoid leaving scratches on the table, I also cut a few pieces of foam at the four corners of the box and they also make the whole speaker box higher and more stable.



I used the same method to make both the top and right sides of the box. Because of the special design needed for them, the two sides were separated from the previous design process to make. The right side of the box has two holes which were the place left for putting the charging cable and the knob of volume control. Additionally, I used similar colours to paint the box to make the look more balanced. Only one side of the top of the box was fixed by using the tape so that the top can be opened freely in case I need to check the wires inside the boxes in future. This is the end of my third product.



3.4 EMO Mask

Used Material

- Masks - one medical mask and one non-medical mask
- cotton thread

Used Technology

Arduino

- LCD display (TFT)
- Arduino UNO board
- IR-remote control
- IR-receiver

Other

- Charging cable
- Powerbank

Referred resources:

- TFT_22_ILI9225 Library for LCD display
https://github.com/Nkawu/TFT_22_ILI9225
- Image2Code cannot be run properly
<https://9to5tutorial.com/using-img2code-to-display-a-bitmap-on-an-ili9341-lcd-with-the-arduino-esp32>
- Reduce size and memory usage
<https://support.arduino.cc/hc/en-us/articles/360013825179>
- IR-remote :
<https://github.com/Arduino-IRremote/Arduino-IRremote>

Faced Issues

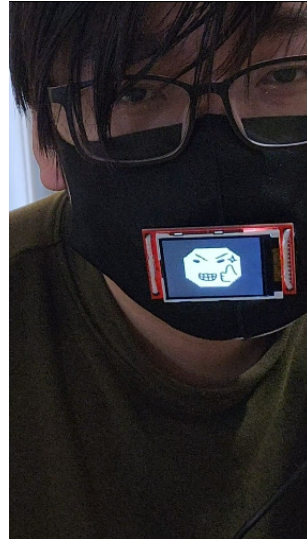
- The LCD display is complex to use.
 - Read through the github repository for instruction.
- Required program cannot be run properly.
 - Fixed by finding a solution online.
- The infrared remote control not working properly
 - Reduced library version.
- The Arduino board ran out of memory spaces.
 - Read through arduino supports, explore the code, cut down the content.

Effort Evaluation

The difficulty in making this product is that it is highly technical, the display screen is more complex than previous components in terms of both wiring and code. At the same time, some technical problems appeared in the production process, making the whole process

more challenging. Several different software were used in the production process to achieve different features, and the investigation time was quite lengthy.

Final Product



A short live demonstration can be found here
(You may need to adjust the volume to hear the sound)
https://youtube.com/shorts/I3eMCnOG_1c?feature=share

Detailed Making Progress

At the beginning, I was trying to start with embedding the microphone into the mask as I thought I got every clear understanding about those components I needed, since I did a lot of research on previous products (Tech Speaker). However, it is way more complicated than expected. In short, I have to give up with this feature due to the following reasons:

- I cannot find any available small speaker that could be embedded into the mask, this is essential as it will be used to output the voice.
- From my research, arduino is not suitable for doing this job, as it is not good at audio processing and the power is very limited. This would lead to a significant latency between input and output voices. And also negatively affect the quality of output voice.

Also, the detection of emotion is depreciated since:

- There is not enough space to put the sensor and circuit inside the mask. (The detection would be inaccurate as it is too close to the face.)
- It would hurt the user when wearing it if there are some components inside the mask.

Therefore, I decided to focus on the displaying graphic part and using infrared remote control for this product.

Before starting, I did some research on what materials and components I need for this product. My initial idea is to use a flexible screen that is similar in size with the mask, and

then paste them together, so that the whole mask can be covered by the screen easily.

However, the price of a flexible screen far exceeded my expectations.

Then I thought I could use some programmable light strips to form the screen by cutting and pasting them line by line, but this approach requires a lot of soldering and testing which is inefficient as I do not have required equipment at home.

Therefore, I used a medium size LCD screen for displaying the emoji rather than a large size of graphic.

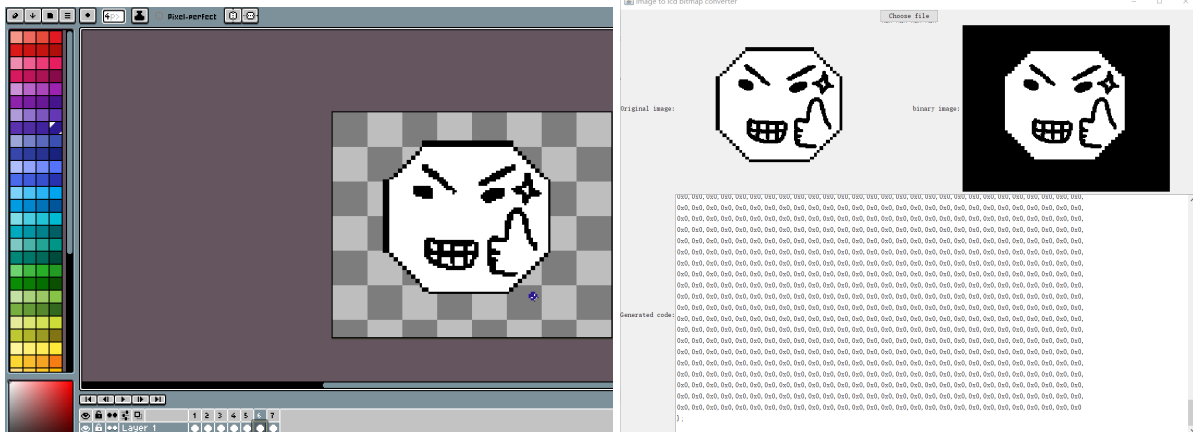
My first issue is that I found the LCD screen is relatively complex to use, in terms of both connecting circuit and coding. As usual, I went through the github repository of the used library as they often provide detailed instructions and some examples about the components. By reading the documentation I understood the function of each interface, and successfully displayed the screen after a long time experimenting. Then I start to modify the circuit and codes to suit the feature I am targeting. What I didn't expect was that the second problem followed.

Because the infrared remote control was used in my second product (CASC), I used the same wiring and code to save time, but unexpectedly it didn't work this time. I have followed instructions from the github repository of the infrared remote library and checked the wiring and codes several times, but it is still not working. Whenever I try to call functions after receiving an IR signal, the `irrecv.resume` is not working. Which means the IR receiver can only receive one signal at each time it starts running. After a long time of testing and gaining nothing, I decided to use the old version of library (v 2.8) which solved the issue immediately.

After confirming the IR-remote and LCD display are working properly, I start drawing the figure. There are several ways to achieve this, you can directly draw the picture to the display by using code, but that would be very difficult as you cannot see the graph while you are drawing, instead you have to compile the program and upload to an arduino board to see the drawing from the display screen. Another way is to use the `drawBitmap` method, it takes an array of data representing the graphic and draws that figure directly on the screen which is obviously the best way to do.

I used aseprite to draw all the emoji I need, it is a pixel art drawing tool which has following benefits:

- Pixel drawing is easier than normal drawing, as you can draw the image pixel by pixel which ensures having a desired shape.
- It can resize the picture freely by changing the resolution. And resolution is not a primary concern in my product.
- Pictures can be drawn in frames so that you do not need to repeatedly draw the same parts.
- I am very familiar with this software, because I used it a lot when I was drawing sprite for my game project.



And then I need to convert the graphic to the data that could be interpreted by the TFT library. In the repository of this library, the author provides a program that could convert diagrams to data which is called Image2Code. I followed the instructions provided and tried to run that program but nothing happened. I spent a long time looking for the solution online and finally I found a post that provides the solution. In short, the files of the program were not placed under the proper folder and that led to the program unable to be executed. After I resolved the problem, everything went well. Moving on, I draw six different emoji to represent different motions and convert them into codes. While compiling the codes, another issue came up. The Arduino board ran out of memory.

As there are six emoji and each of them needs a very big size array (the size of the array depends on the resolution of the image.) Each element in that array is a hexadecimal number. It is conceivable how much memory these graphs will take up. It is very kind that the arduino IDE provides a website link inside error messages which provide some approaches to reduce the size.

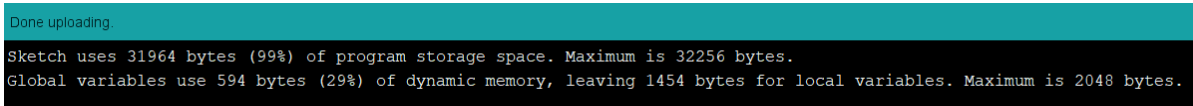
To reduce the size and memory usage of my sketch, I tried following:

- Removed all the unnecessary variables, methods and libraries.
- Optimised the code by packaging repeatedly used codes into methods.
- Used PROGMEM stores constant data in storage rather than memory.

Even though the above methods cut down memory usage significantly, it still far exceeds the memory capacity. In the end I had to use following methods:

- Reduced the resolution of images.
- Removed two images with lower priority.
- Simplified the details of images.

After all of the optimizations, I'm barely within the bounds of the memory capacity.

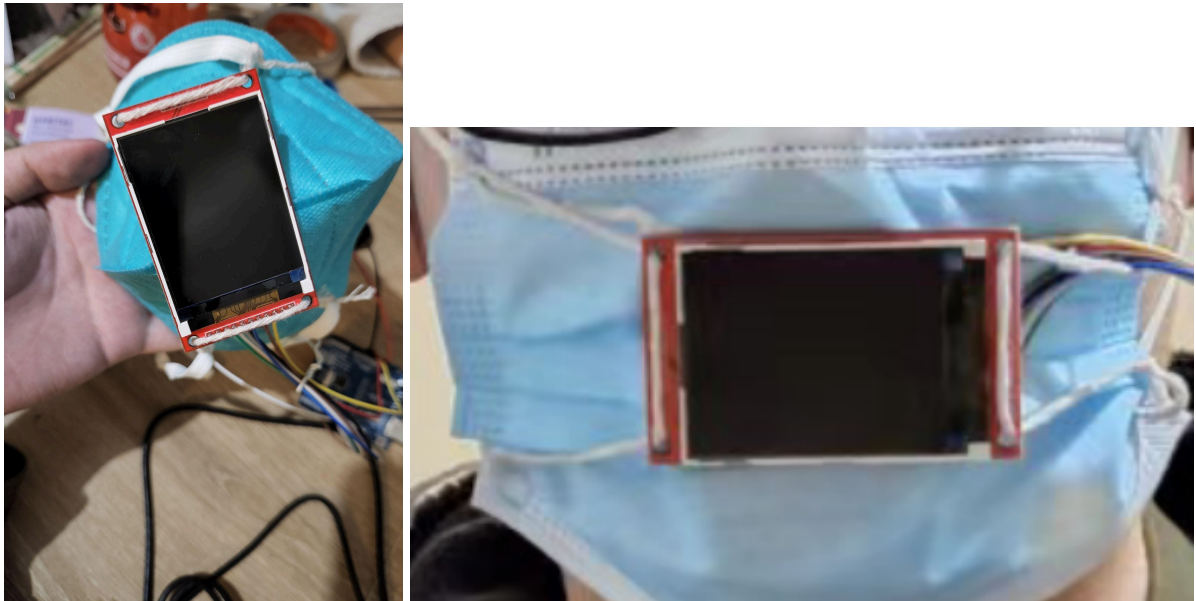


At this point, the displaying function is completed. A short demonstration is shown below: (An interesting feature is that the long press will make the display blinking as it triggers the light up and light off methods. I kept it as I thought this was cool, and a possible usage would be catching someone's attention or showing you are talking.)

<https://youtube.com/shorts/2Co31bmCen0?feature=share>

The next step is to place the screen and circuit on a mask, as mentioned in the designing stage, the meaning of wearing a mask is to prevent the spread of virus so a medical mask will be used in this case. I initially decided to use a professional surgery mask which is much stronger and can be used in the long term. But since it is not flat, the screen will be pushed up and cannot be held firmly.

Then I used a daily medical mask instead and tied the screen and the mask with cotton thread. After adjusting the length of the cotton thread and the position of the screen, I tried wearing the mask, and although it is now stable and comfortable to wear, it will look a little unsightly on the outside.



To make it look better, I'm going to put a black non-medical mask over the outside of the medical mask. This will not only cover the wires and cotton threads, but also look more harmonious in colour.



First I needed to cut the black mask out an opening just enough to pass through the display. (Picture 1 above failed because the opening was cut too large. Picture 2 used another black mask.) Then threading the two masks and adjusting the outer mask to completely cover the inner mask. After this, the final product is done.

4. Summary

The entire production process was challenging and interesting, and I had an unprecedented sense of accomplishment when I finished the product, so I felt excited and enjoyed the whole process. Despite the twists and turns of the process, I ended up with four products as planned, and the main features were implemented. This could not have been possible without the help of many people, and I would like to express my gratitude. Meantime, many skills were learnt and practised in this assignment which is essential for the next assignment and even the future learning.

A2

Process video: <https://youtu.be/5Tg0BsUH3Ik>

Showreel video: <https://youtu.be/YP1QhOv-bNA>