遠端遙控挖土機製作

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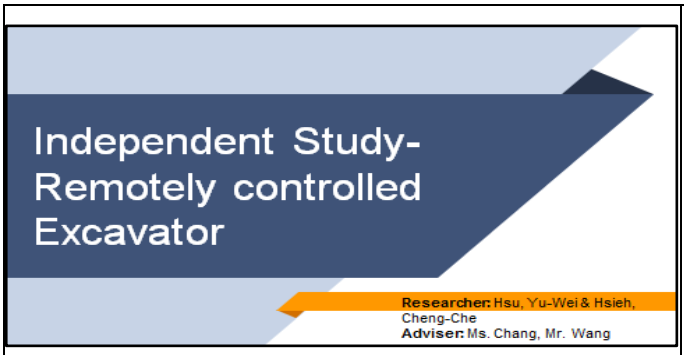
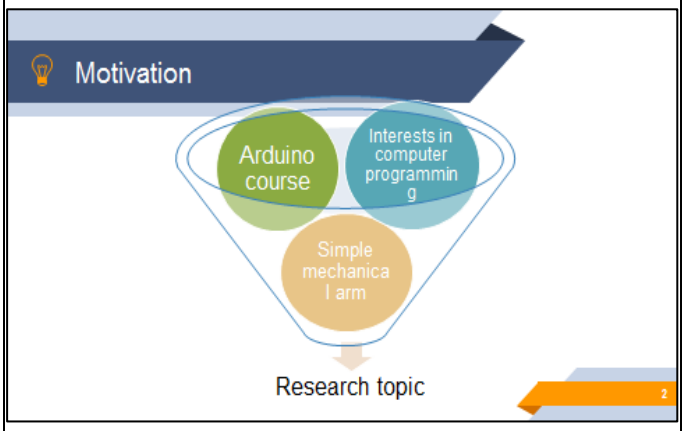
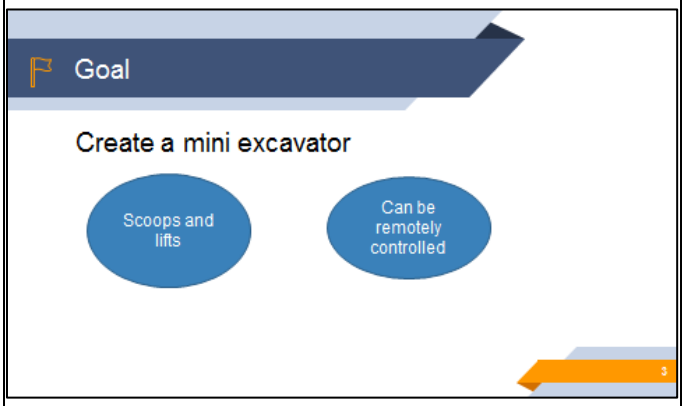
指導者：王璽崴老師 (Mr. Wang)　張馨文老師 (Ms. Chang)

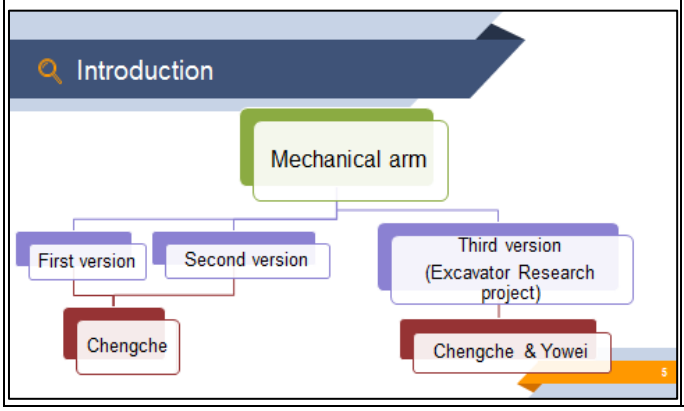




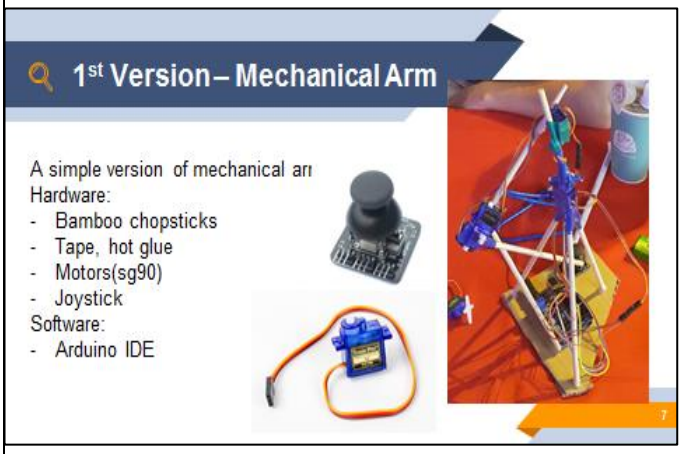
Yuwei:
We took a course on Arduino program in Grade 5, and became interested in computer programming. My teammate Chenche wanted to make use of what we learnt to create something, so he started making a simple mechanical arm. I was also interested in robots and machines, so we decided to work together to make a better version of the mechanical arm, which was later upgraded to a “mini-excavator”, for our independent research project.



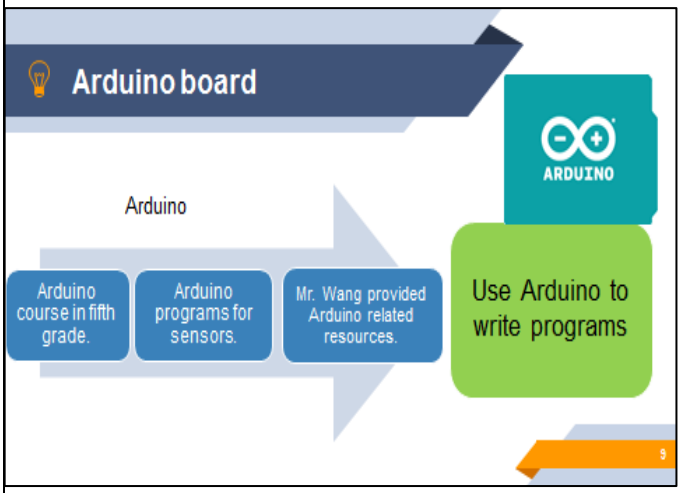
Our goal was to create a mini-excavator, which scoops and lifts, and it can be remotely controlled.



Chengche:
We can divide the project into three parts (versions). The first and second versions were more focused on the mechanical arm, and were done by me with the help of Mr. Wang. The third version was to transform the mechanical arm into a mini-excavator. It was done by Yuwei and me together.

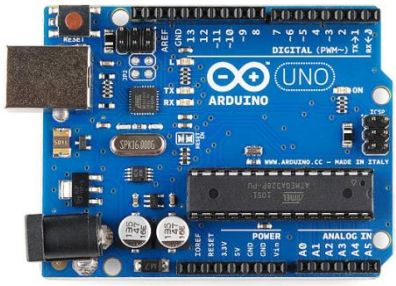


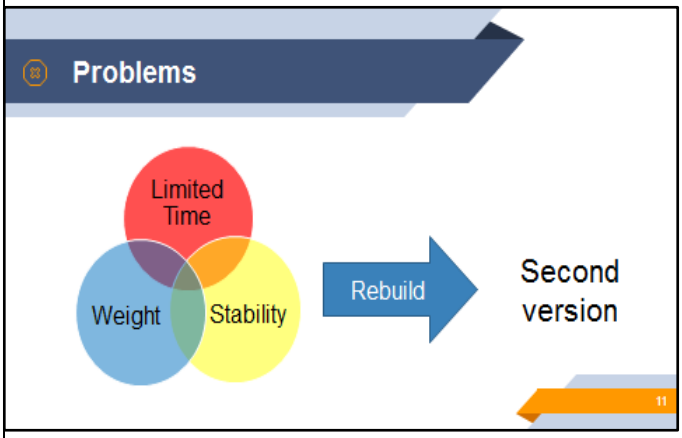
The first version of the mechanical arm looked like this. The main structure was made with bamboo chopsticks. I used hot glue and tape to hold the chopsticks together.
The motors were used for the joints of the arm.
The joystick was used to control the direction of the arm movement.
The software was Arduino IDE.



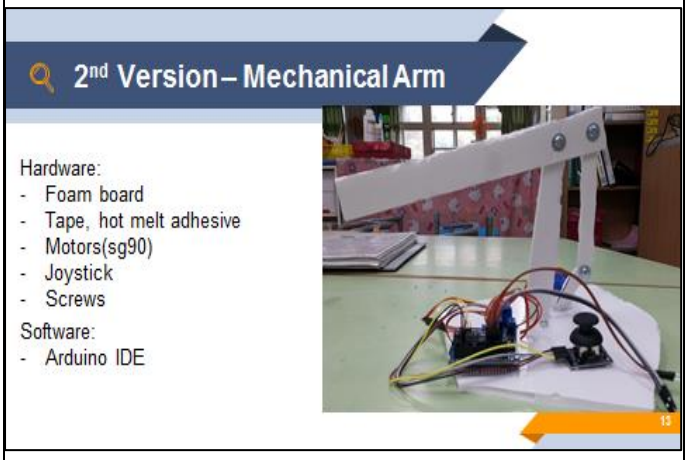
I used Arduino IDE because I've learnt how to write codes for the Arduino board in Grade 5.

Arduino board can be used to control lights, motors, and other actuators. I used it to control the motors for the mechanical arm.

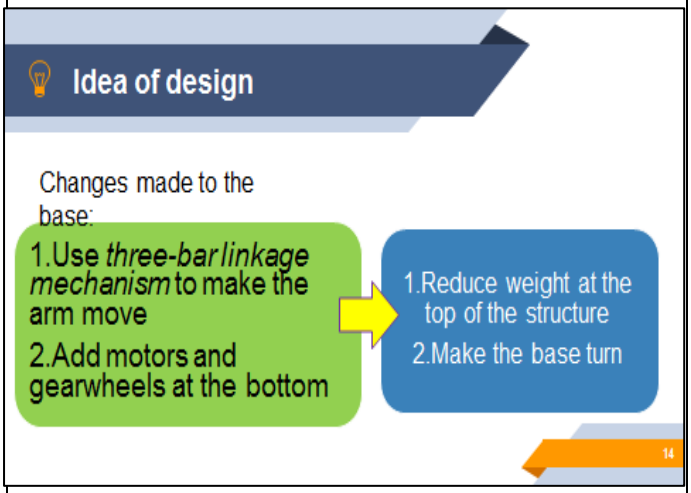




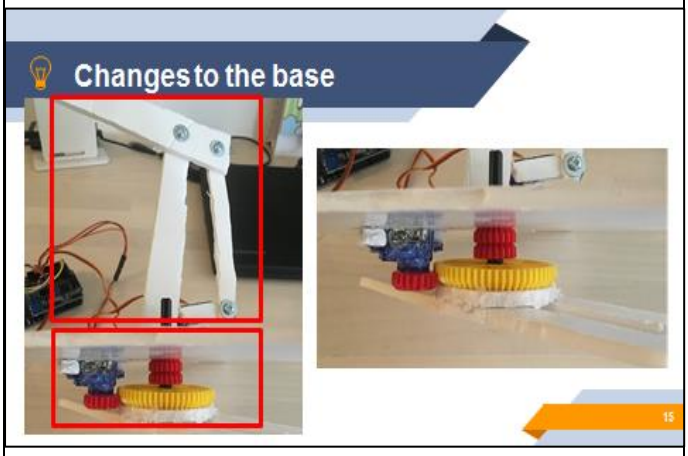
I came across some problems, such as the chopsticks were hard to be glued together and came apart easily. Also, the weight of the arm was too heavy at the top, so the whole thing would tip over easily. But I didn't have time to fix all the problems because of the teachers' exhibition.
After the exhibition, I made a second version of the mechanical arm.

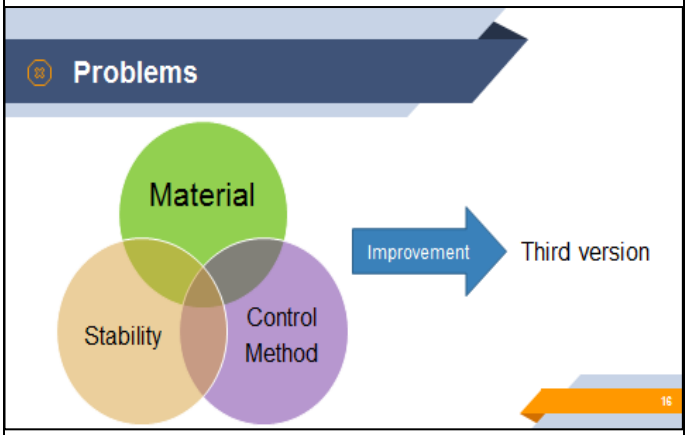


For the second version, I used foam board for the main structure. One reason why I used it was because we had a lot of it in our classroom. Also, it was much lighter, and easier to be shaped and stay attached.

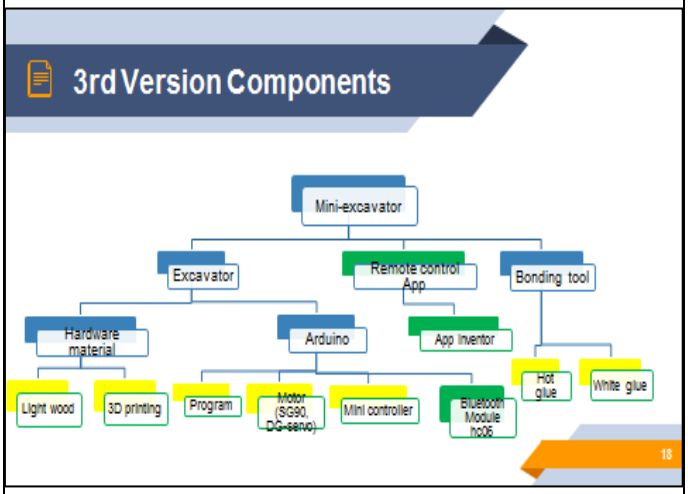


A big difference between the first and second version, other than the material, was the base of the structure. I added a motor at the bottom, and use the three-bar linkage mechanism to make the arm move. So no motors were needed at the joints of the arm. Also, gear wheels were added at the bottom to make the base turn to different directions. That way, the weight of the whole structure became heavier at the bottom, and lighter at the top. So there was no more problem with the arm tipping over. The same concept was continued in the third version.

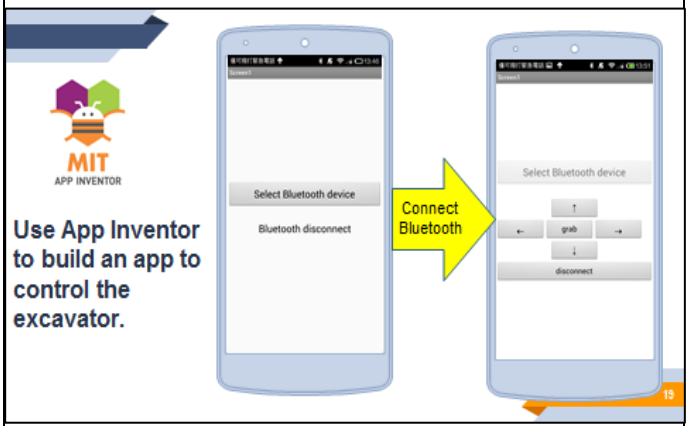




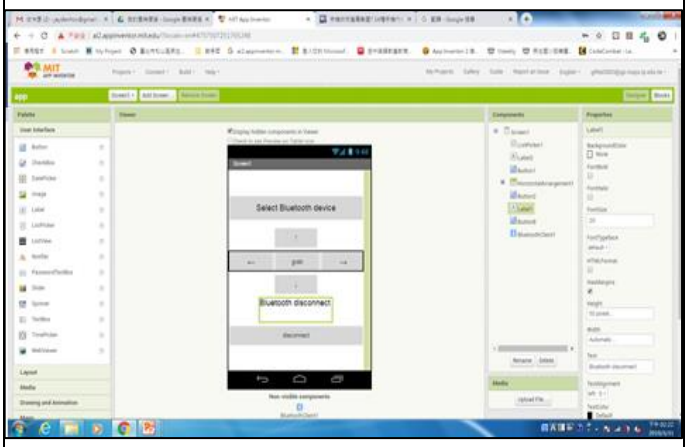
There were still problems with the second version. The material obviously was not strong enough for the arm, and using the joystick was not very convenient for the control method. Yuwei joined in at that time, so we decided to make an improved version together.



For the third version, we want it to look more like a mini-excavator, be more functional, stable, and of course better looking.
It was made of 3D printing material and lightwood. We also added a shovel to the arm. The most different part is that the excavator can be remotely controlled via a smart phone because it is equipped with a remote control App and a Bluetooth module.

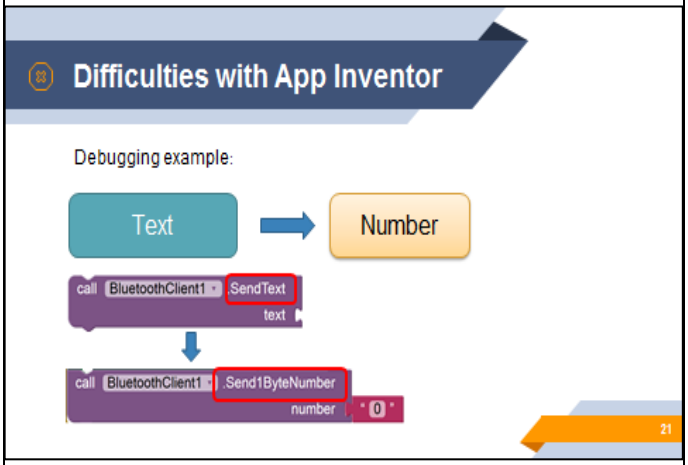


We used App Inventor to build an App, which looked like this. After it's connected to Bluetooth, this is what appears on the screen, and then we can touch the buttons to control the excavator.

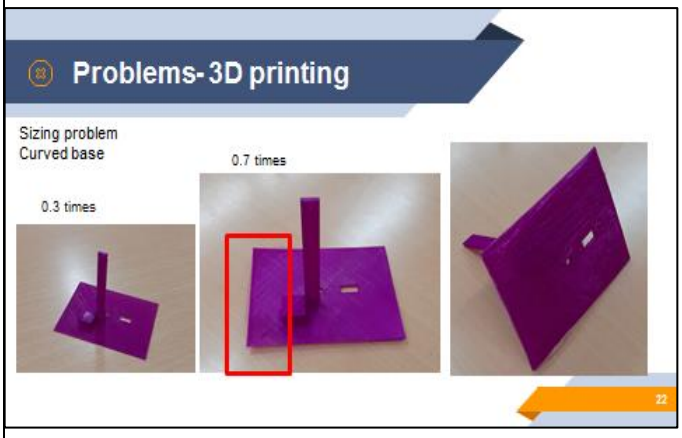


This is the interface in App Inventor for creating elements, such as buttons and labels.

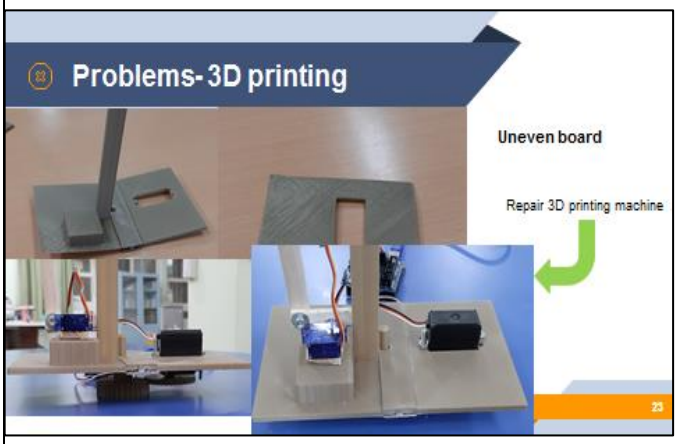
This is my coding in App Inventor. The interface is similar to Scratch. We make up the codes by moving the coding blocks into places.



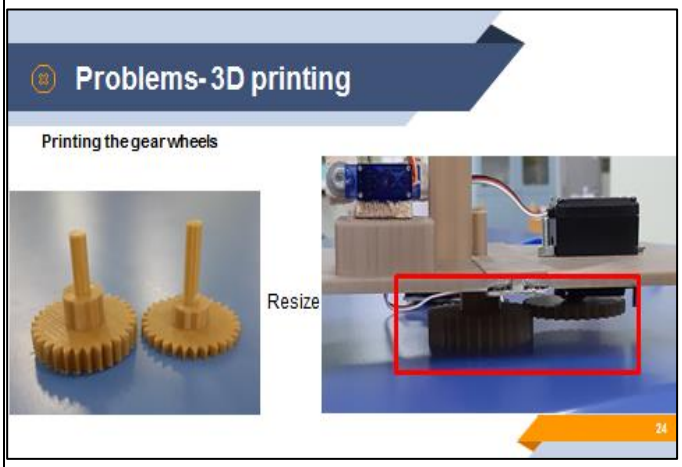
I did spend a lot of time learning to use App Inventor. The coding and debugging itself was also time consuming. For example, we had a byte text mismatch. The coding block should be “Send1ByteNumber”, not “SendText”. It took us a very long time to find out this error. But I’m glad that we solved the problems in the end and the App is now working.



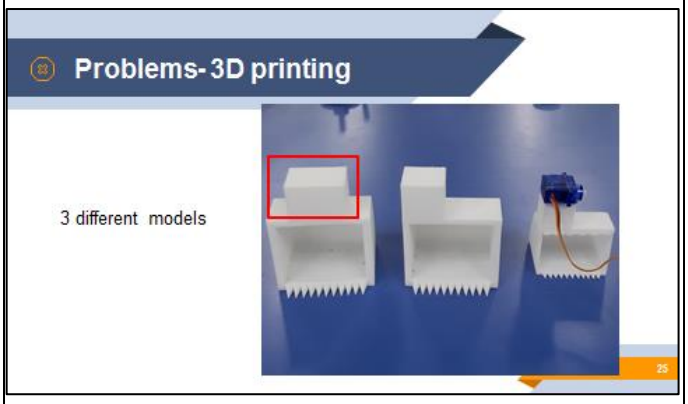
Yuwei:
Here is the 3D printing part. Most part of the mini-excavator was made by 3D printing. We started testing 3D printing in smaller sizes. One problem was that our 3D printing machine was not able to print out big objects. So we had to print into small pieces and assemble the parts together for the base of the excavator.



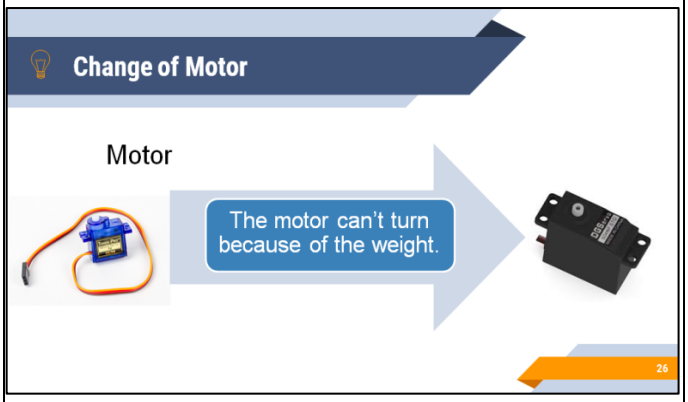
Another problem with the printing machine was that it couldn't print out a completely flat board. There was something wrong with the machine, it had been fixed for a while. After the machine was repaired, we could finally print out flat pieces for the base.



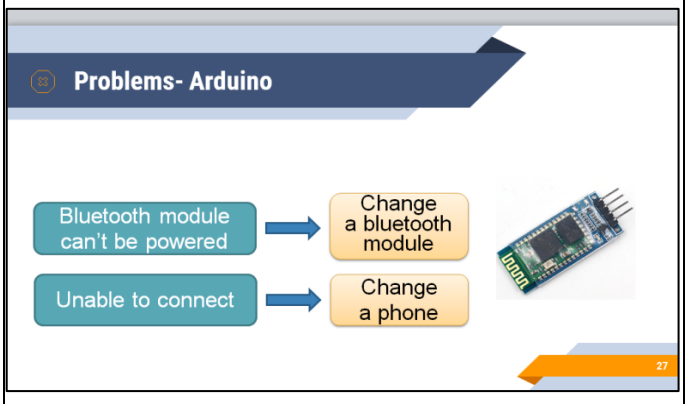
After many trials, we modeled the gear wheels with Tinkercad and successfully printed in the right sizes.



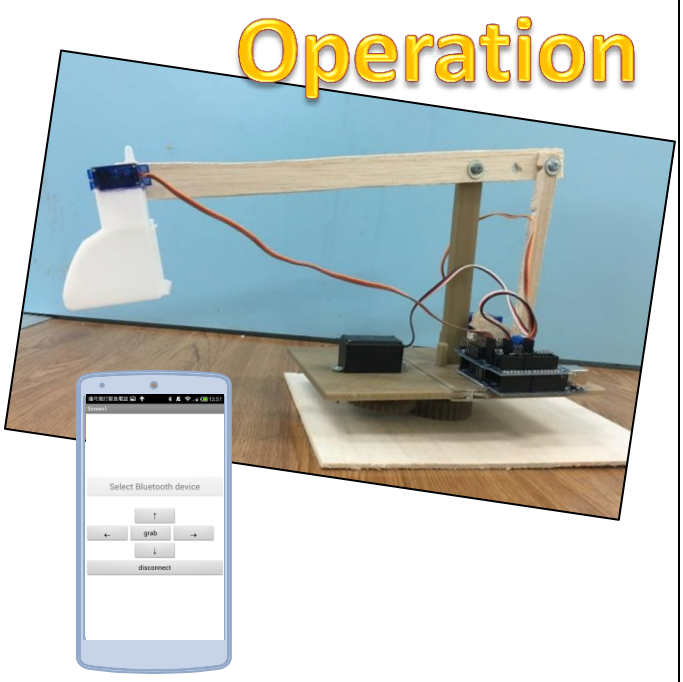
The shovel was also printed in three different sizes. We realized that the two bigger sizes were too heavy for the motor.

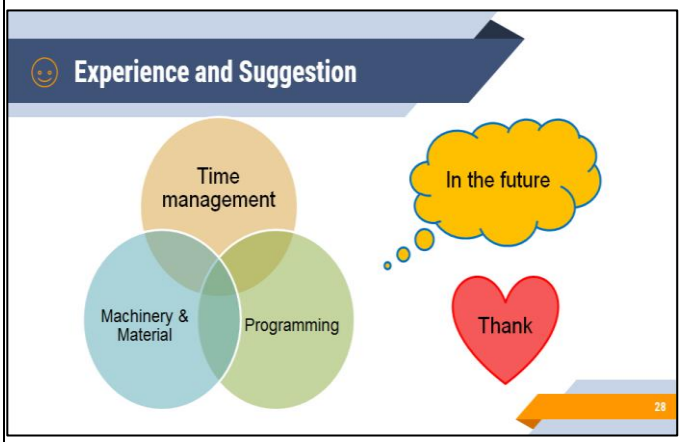


By using 3D printing, the third version is stronger and heavier than before. Because of the weight, a more powerful motor is also needed.
So we changed the motor at the base to DG-servo.



We also encountered two problems in the part of Bluetooth.
First, the Bluetooth module wasn't able to be powered. Then, the signals couldn't be transmitted.
It was solved after changing the Bluetooth module and the smart phone.





Here is how the excavator works.
When we press the left or right button, the motor under the excavator will rotate so that the entire excavator turns left and right.
When we press the up or down button, the motor will make the joint of the arm move.
And when we press the grab button, the shovel scoops and the button 'grab' will turn to 'open', when we press it again, the shovel will drop things down.

At last, this is our experience and suggestion. First, time is tight, so the efficiency of doing things must be strengthened. Second, program debugging takes us a lot of time and patience. Third, we find out that machinery is the hardest part, and we recommend that students who want to do similar topics should pay special attention to the parts of machinery and material.
Although this time our work hasn't reached our ideal, in the future we will want to continue to innovate, such as adding wheels.
We want to thank Mr. Wang and Ms. Chang for their guidance. Also thanks to the 3D printing machine in the school so that we can complete the project.