Final Report - Prototyping Methodology for Engineering Design

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Prototype name: Immersive Skateboard

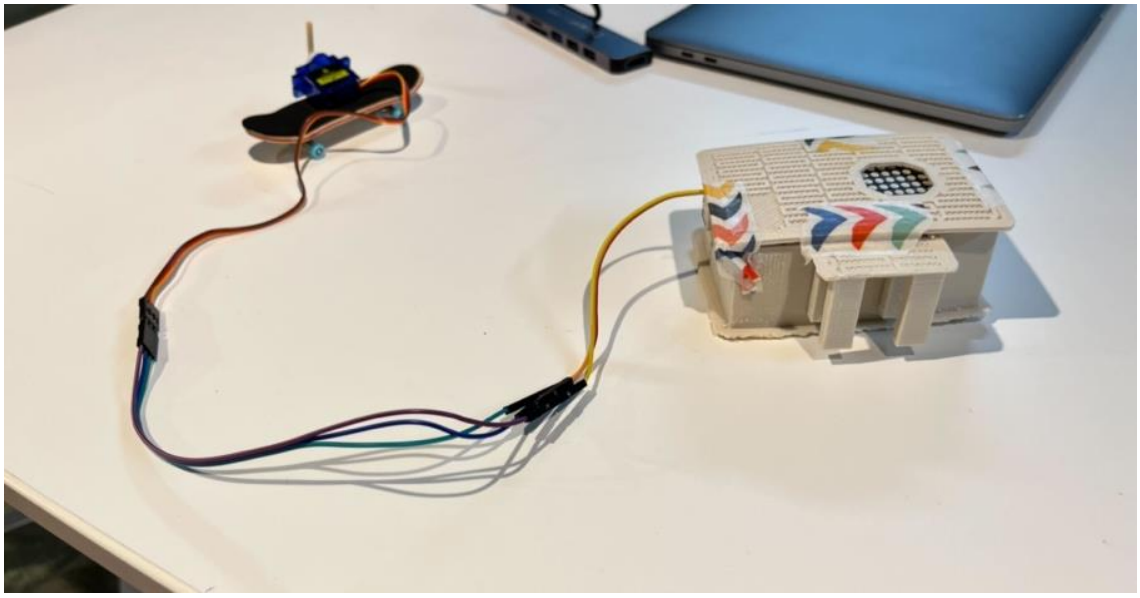

Fig. 1: Overall Prototype

Introduction of my prototype:

These days, there is not enough place to skateboard because people guess that skateboarding is a dangerous sport. Then, a skateboard is one of the sports that people cannot try to do. Moreover, some games about skateboarding are just used arrow keyboards or center of gravity shifts.

Therefore, we must create a new type of game about skateboarding. So, this prototype (Fig. 1) can lead us to do skateboard-like immersive experiences without real skateboards and places. If users move forward, the small skateboard will move forward as well. This small skateboard can move, depending on users' movement. Now, users can move only forward or backward.

Skateboard tricks are most fun for skateboard lovers. So, in the future, we need to incorporate the Z-value and Y-value of the move of users into this prototype. Furthermore, the small skateboards should move, depending on the strength of acceleration of users. I believe that this prototype has a big potential to use in real situations.

Equipment and Tools used:

- Tools

  Arduino Uno

  Accelerometer

  LED 8×8 Matrix

  Servo Motor

  MakerBot Replicator 2X

Fabrication step:

- 1st step – To Detect Acceleration.

I utilized an accelerometer in order to detect a user's acceleration. This is just a prototype, so I use only the Z-value of users. So, I connected Arduino Uno and Accelerometer like Fig 1. As Fig. 2 I can obtain the X-value of acceleration via A0 (Analog in).

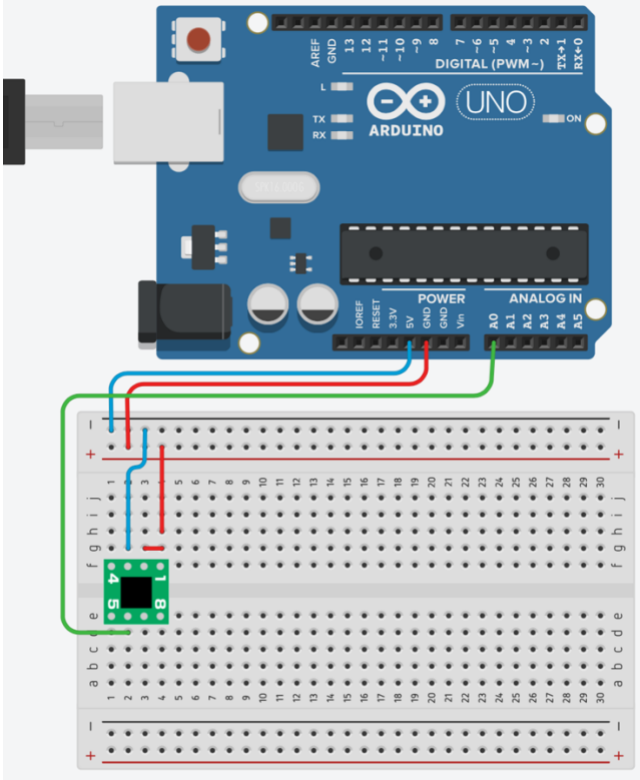

Fig. 2: Circuit of Accelerometer

- 2nd step – To Define acceleration forward or backward.

In step 1, I can detect the user's acceleration, but the raw data of acceleration has a lot of errors. So, I should analyze the raw data to define the direction of acceleration. Fig. 3 depicts the Serial Plotter on Arduino IDE when I used this detector and moved forward.

Whereas Fig. 4 shows the Serial Plotter on Arduino IDE when I moved backward.

We can understand more than half of the data are negative per about 20ms when I moved backward. On the other hand, more than half of the data are positive per about 20ms when I moved forward. So, I can define the direction acceleration based on the number of positive or negative accelerations per 20ms. However, these thresholds depend on users, so I should decide the thresholds for each user. I want to make a prototype, so I decided on these thresholds this time.

Fig. 3: Serial Plotter when I moved backward.

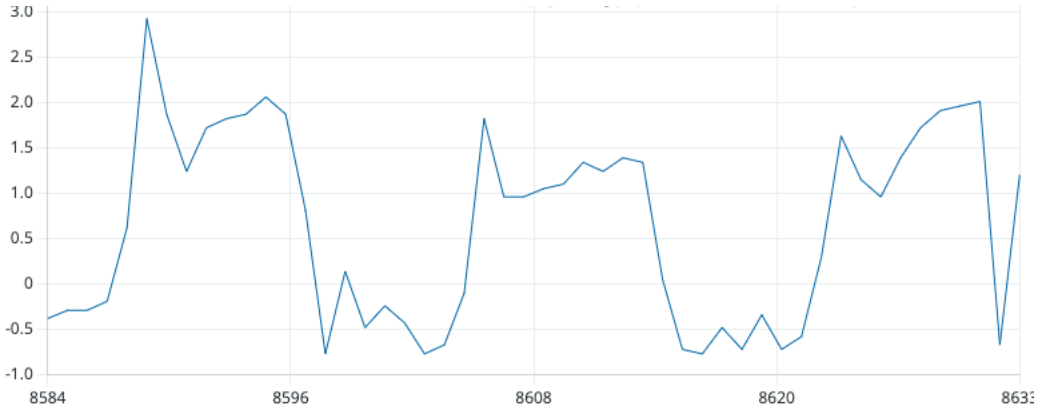

Fig. 4: Serial Plotter when I moved forward.

- 3rd step – To Watch current Acceleration.

Observing current acceleration provides users ease of use of a prototype. So, I incorporate this system into my prototype. I utilize an LED matrix (8×8) and made a circuit like Fig. 5. I wrote long code to use an LED matrix because this matrix forces us to recreate the array and set up details (Arduino Code).

When users do not move, the LED matrix shows ② in Fig. 6. Moreover, when users

move forward or backward, the Led illustrates ③ or ② in Fig. 6 (The forward is the Right hand because many skateboarders use the right foot as a forward side.).

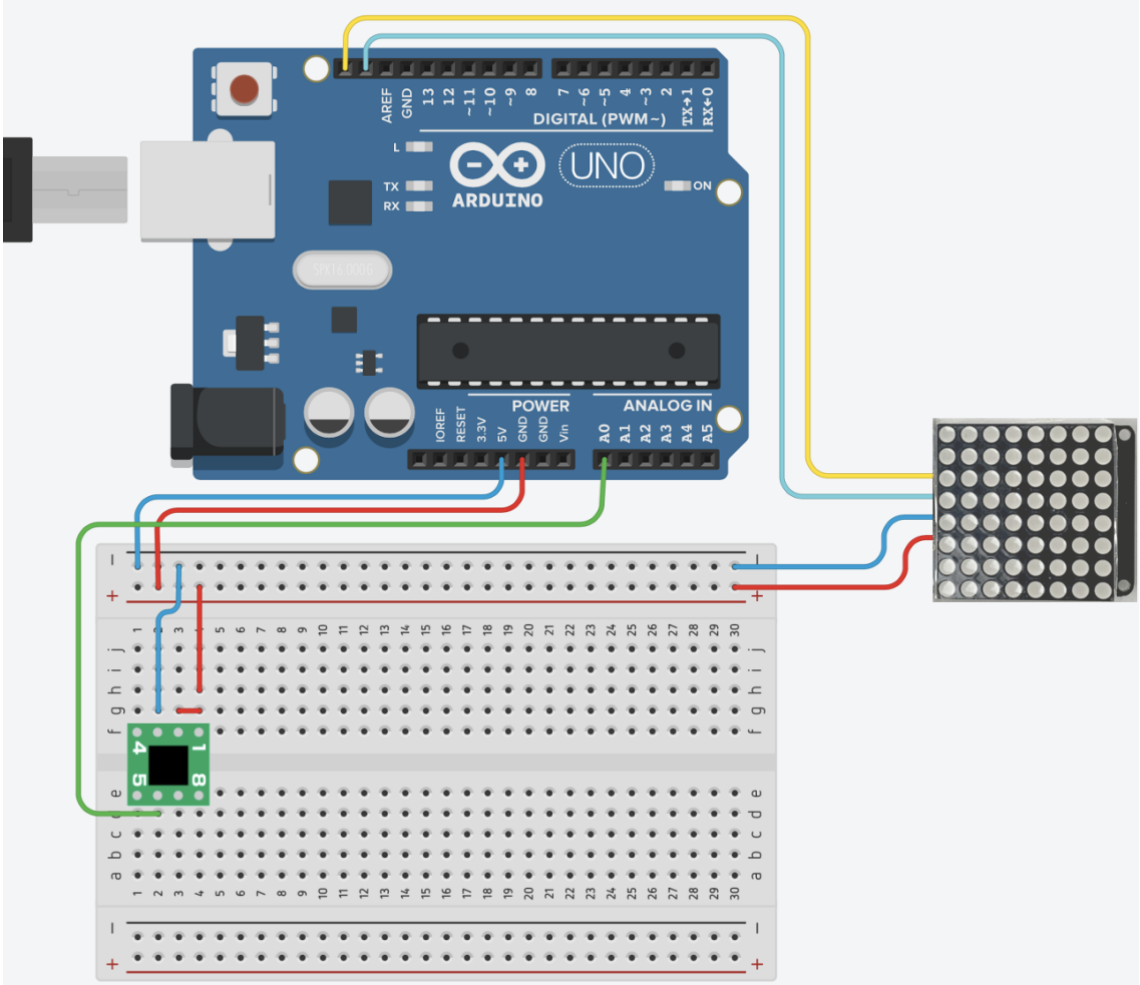

Fig. 5: Circuit of an LED matrix

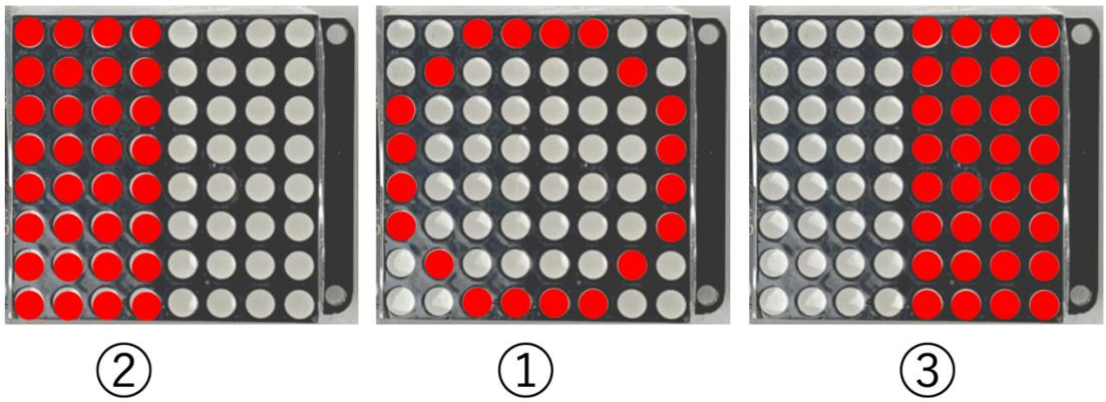

Fig. 6: LED Patterns

- 4th step – To Work Servo Motor.

I made a circuit to work a servo motor like Fig. 7. I can get a user's acceleration via A0 and display the user's movement on the LED matrix, then work a servo motor through 10 (Digital (PWM -)). Specifically, when a user moves forward, the servo motor move clockwise. Whereas, the servo motor moves counterclockwise, when the user moves backward. Then, the servo motor provides a small skateboard some power to move it.

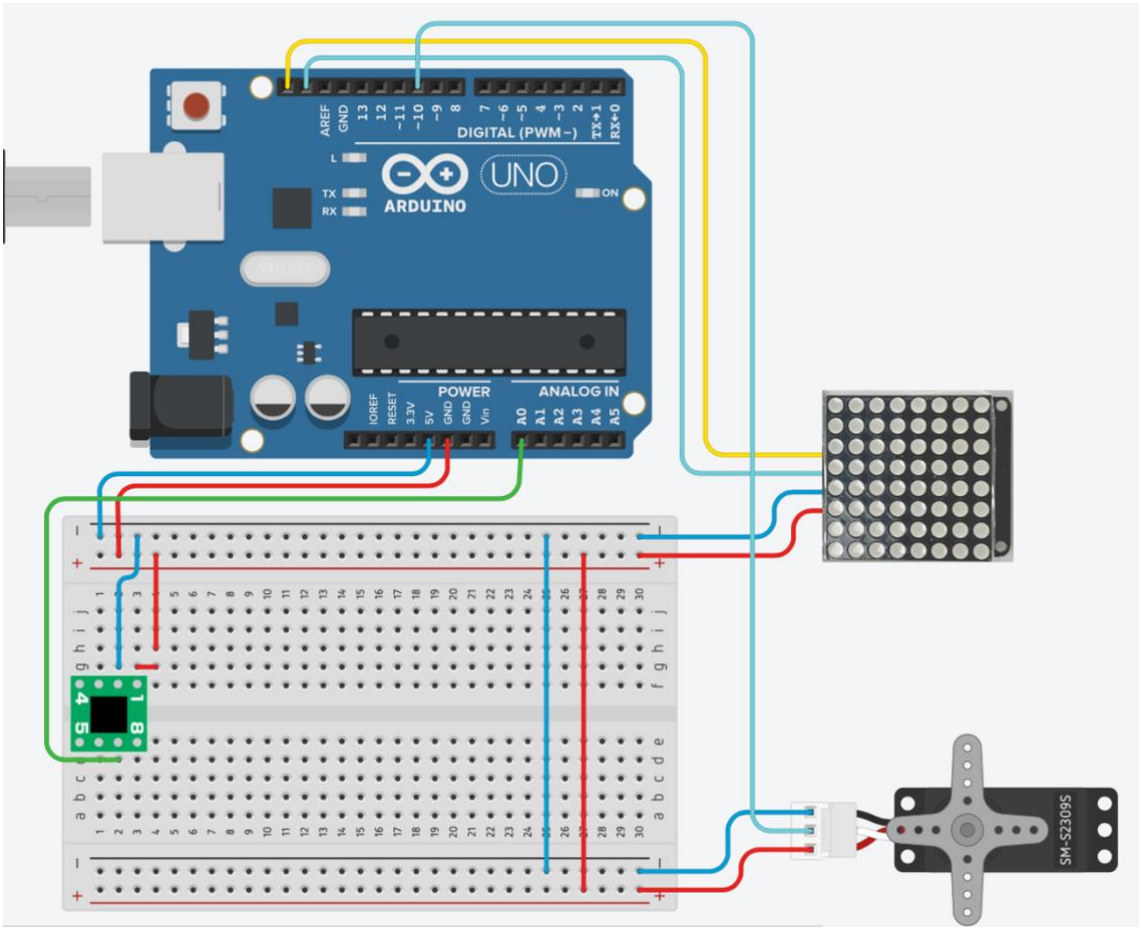

Fig. 7: Circuit of Servo Motor

- 5th step – To move Skateboard.

In order to move the small skateboard, I attached the servo motor to the small skateboard that was in my house. So, the servo motor can give the small skateboard the power to move. I also put some thought into the servo motor. That is the speed of movement of the servo motor. When the user moves forward, the servo motor moves clockwise quickly. However, the servo motor should be back to the initial position slowly because the movement of the servo motor works the small skateboard. So, the servo motor moves 90 degrees steadily, but when the servo motor is back to the initial position, I move it -9 degrees per 100ms to the

initial position (Arduino Code).

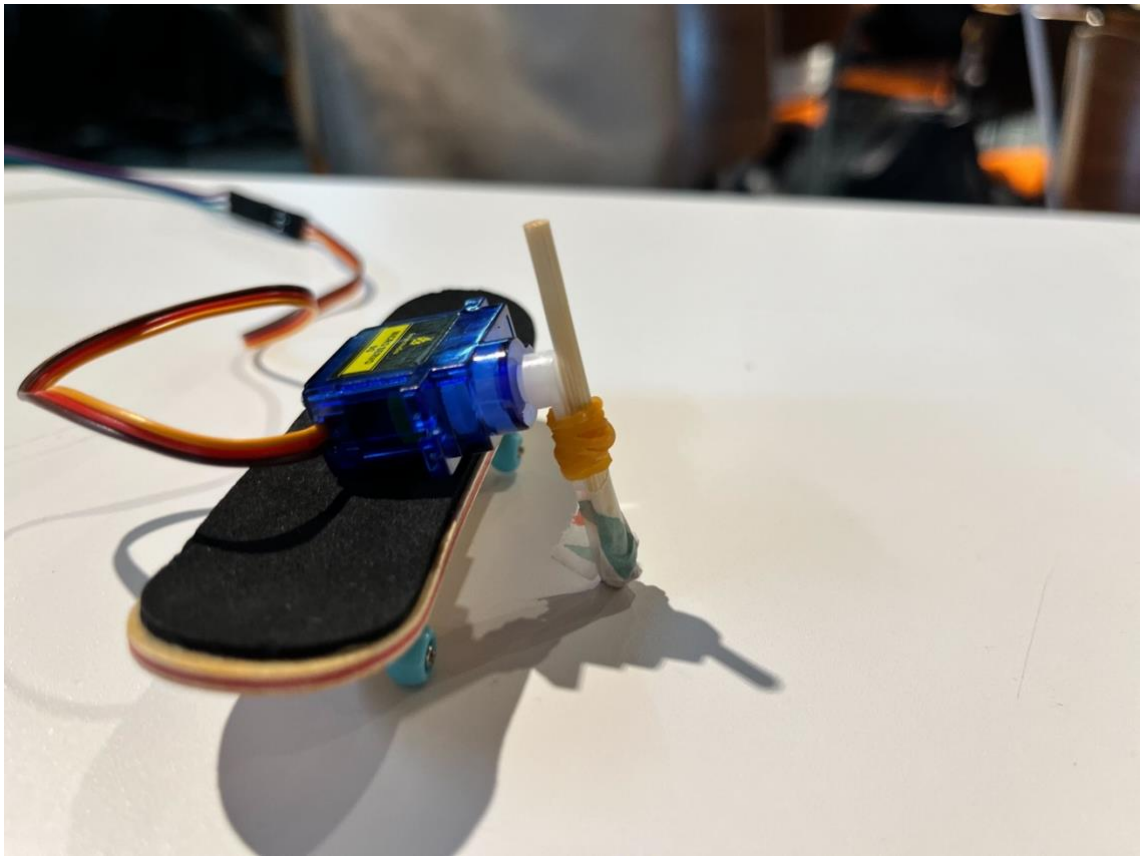

Fig. 8: The small skateboarding

So far, I made the prototype that the movement of the user reflects the small skateboard. However, the acceleration detector has a lot of jumper wires and a few modules. So, I need the prototype to be compact to put on the detector and use it easily.

- 6th step – To attach a detector to a user's body.

I made a box that concludes Arduino Uno and a few modules like Fig. 9. Users can check their movement through the LED matrix on the hole of the top surface. Moreover, the hole in the face in front is used to provide the prototype power. This box just fits in Arduino Uno and a Breadboard. So, the accelerometer can just detect users' acceleration. As further details, the extra element of another face in front is used when I attach it to the user. The users can put it on their belts easily because users should avoid accidents. So, this function leads users that their hands are free. Users can use this prototype easily and safely.

I made this box precisely, but I used MakerBot Replicator which prints the box badly. So, the box has support materials. You could see the raw cad data (CAD box **(Fusion):**).

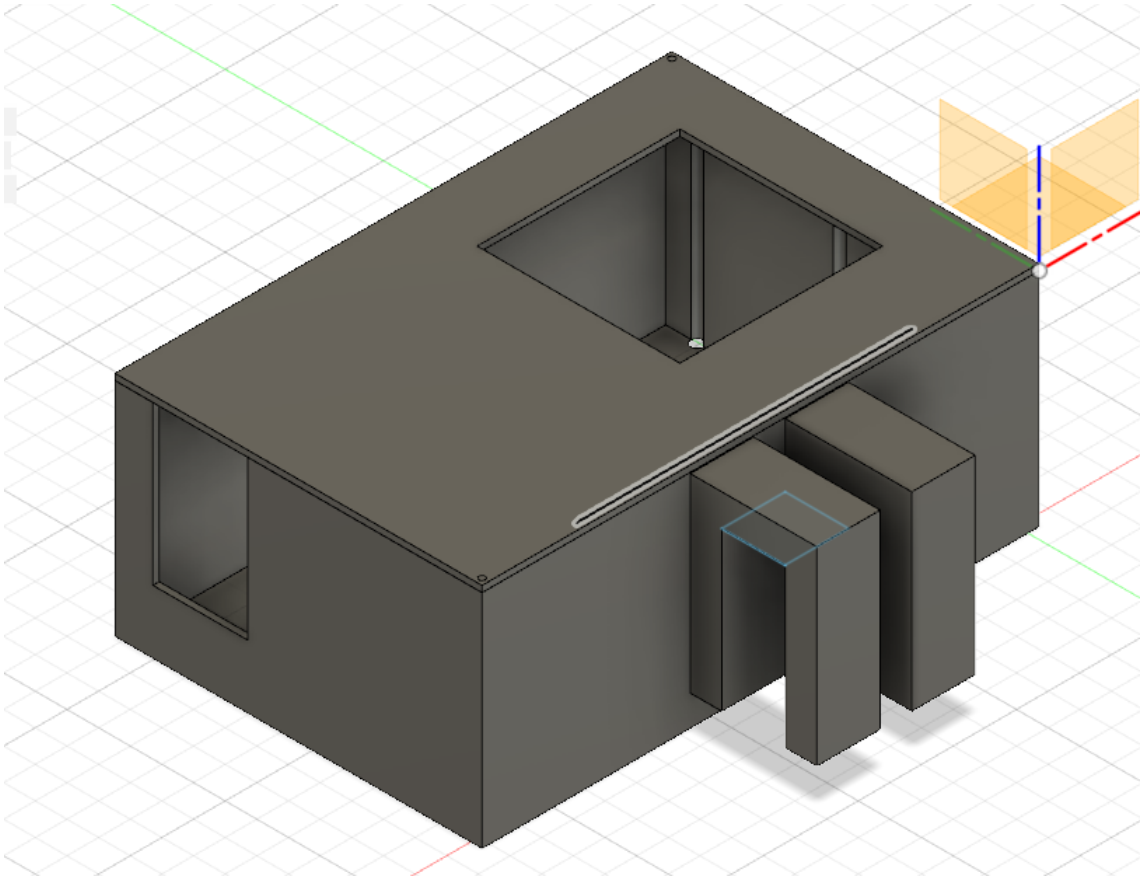

Fig. 9: Prototype Box

Future Work

In this prototype, users cannot do tricks, so firstly I need to incorporate the Z-value and Y-value of the acceleration of users. Moreover, now the prototype moves forward or backward evenly. So, I should utilize the strength of the acceleration to reflect it to the small skateboard. As I heard from skateboarders, they focus on the strength of the acceleration. So, this issue is most important.

However, this prototype leads users to experience a little skateboard. So, this prototype is enough good to use as a prototype.

Producer and date of production

OSAKI Yutaka

27th of July ~ 3rd of August in 2023

Appendix

Presentation Materials:

https://drive.google.com/file/d/1lIAyr8Vxp0SoqcueE1FSuxc9oyX5qhO8/view?usp=sharing

CAD box (Fusion):

https://drive.google.com/file/d/11AeDyPzVHKrgCOOeWxLr8ituLNvYbK7p/view?usp=sharing

Arduino Code:

https://github.com/YutakaOsaki/for-classes/blob/main/sketch_jul28a.ino