

# Thumble: One-Handed 3D Object Manipulation Using a Thimble-Shaped Wearable Device in Virtual Reality



Changsung Lim  
cslim@kaist.ac.kr



Jina Kim  
jina1190@kaist.ac.kr



Myung Jin Kim  
dkmj@kaist.ac.kr

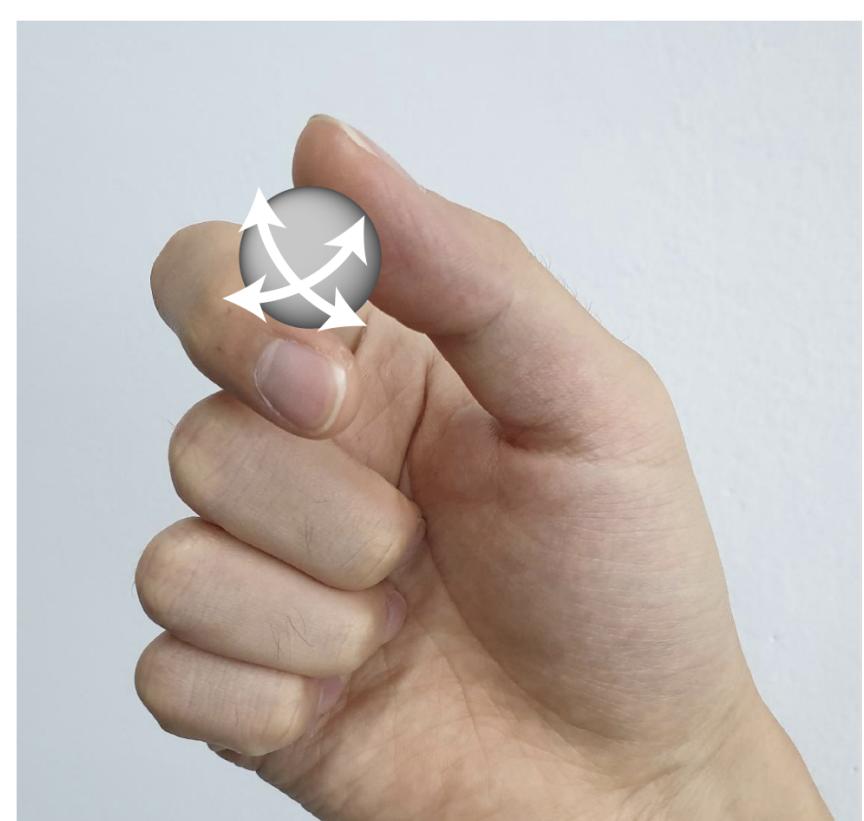
## Background and Problem

- Conventional controllers or hand-tracking interactions in VR cause **hand fatigue** while manipulating 3D objects because **repetitive wrist rotation and hand movements** are often required.
- Ball controller can intuitively manipulate objects according to the movement of the ball. However, it **limits the freedom** of the hand in use, and there is a **risk of dropping it**.

## Our approach

- Interaction design

**Key metaphor:**

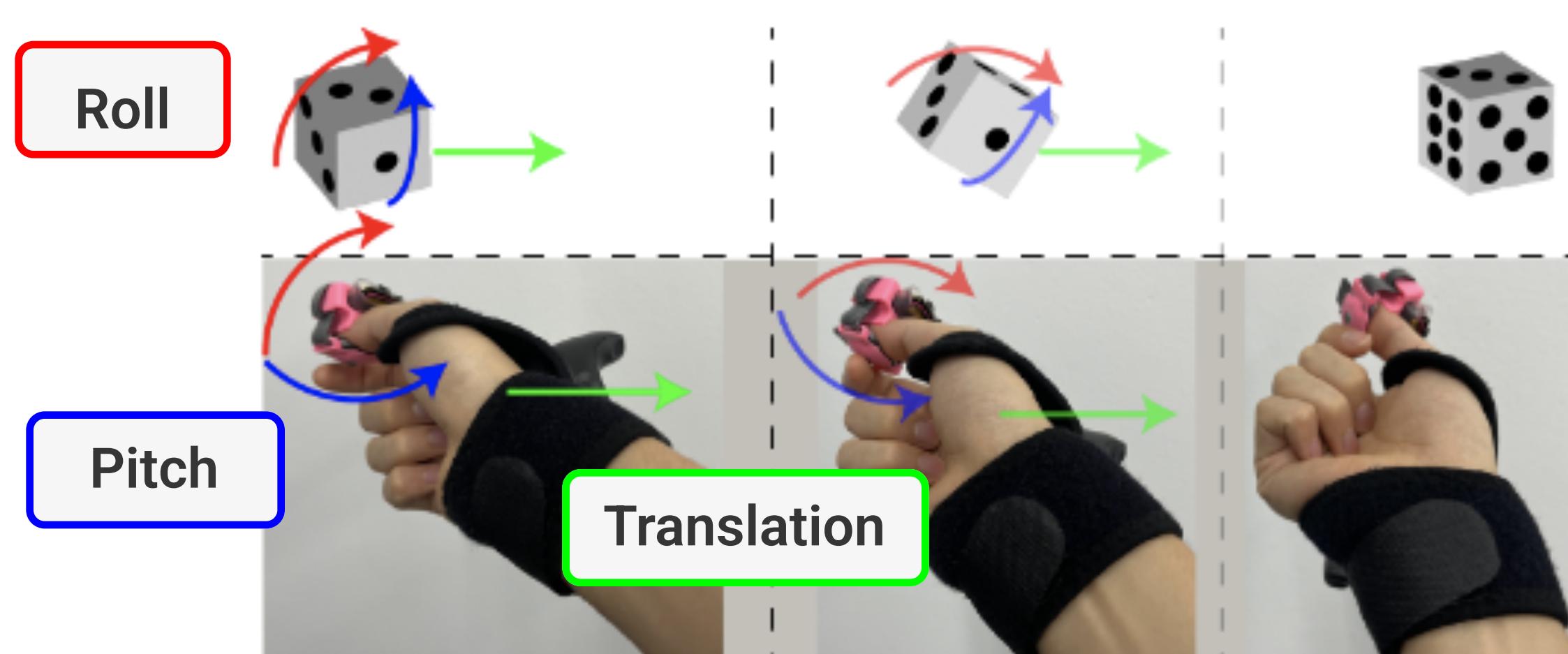


holding and rotating  
a tiny object  
**under the thumb**

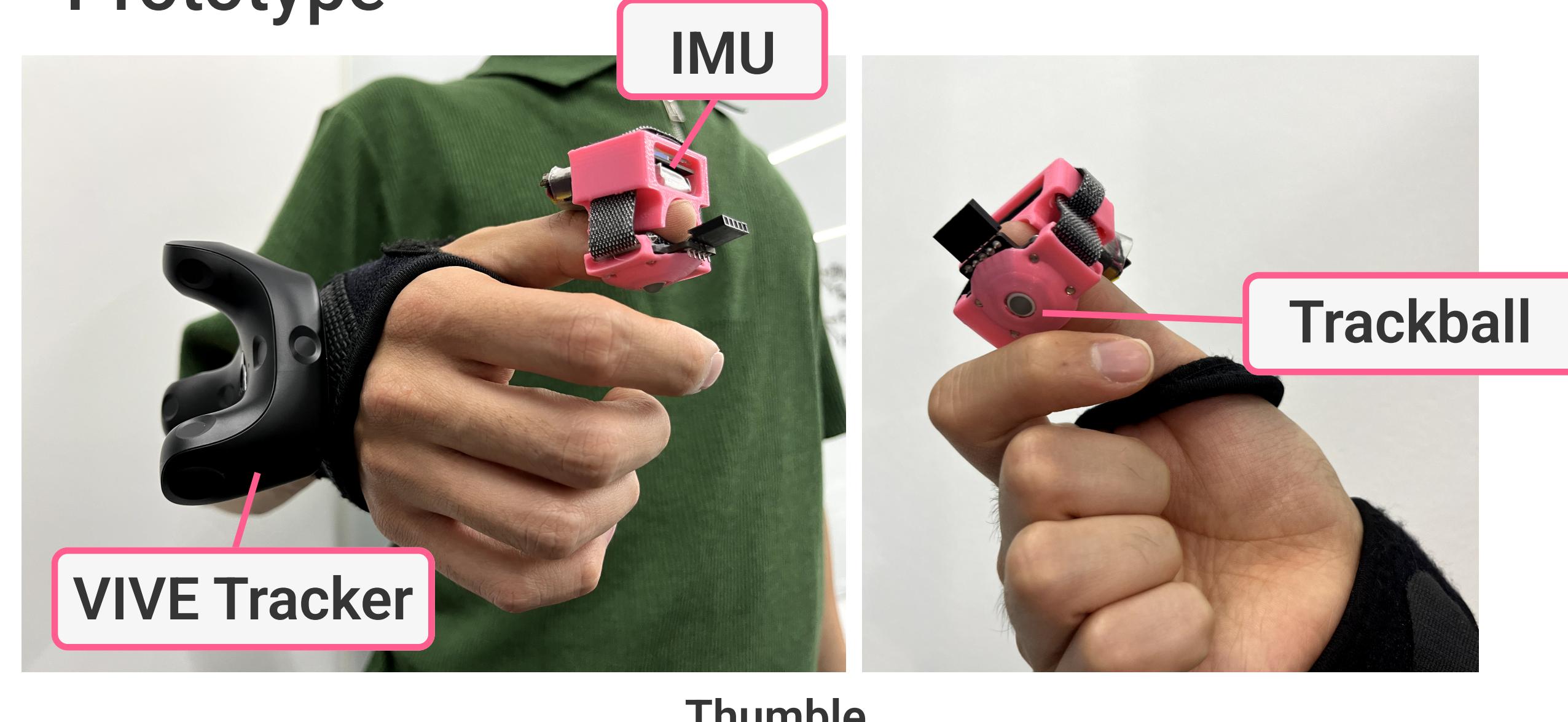
User can rotate the object

(1) by moving the index finger on the 2D surface under the thumbpad. Therefore, the user can rotate the object with **little hand movement**. We selected the trackball because it has the most **compact size and provides tactile feedback** that feels like it rotates.

(2) by rotating the thumb itself. We attached the IMU over the thumb. The object rotates in an **one-to-one mapping according to the orientation of the thumb**. Therefore, it can supplement the **2DOF** of the first interaction and **change the rotational axes of the 2D input**.



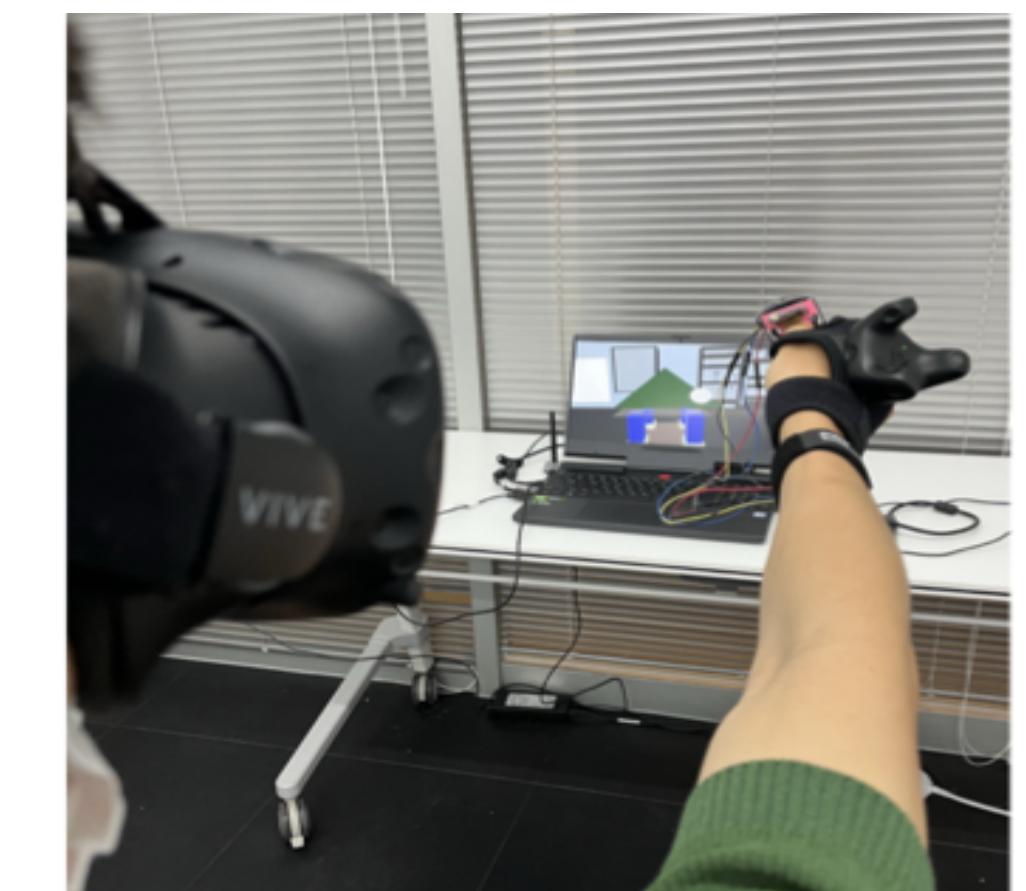
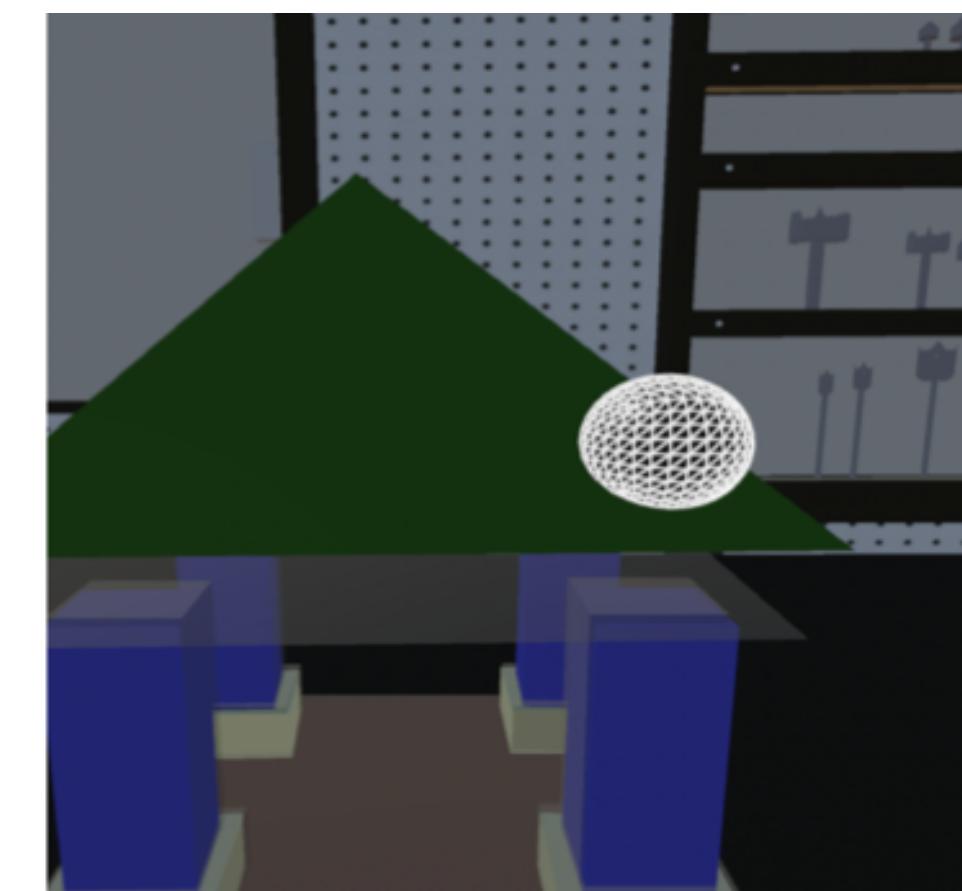
## Prototype



Thumble

## Experiment

Informal user study to collect **subjective feedback** and figure out the **effectiveness** of Thumble (HTC VIVE Controller was selected for a baseline device)



3D block stacking application

## Subjective feedback

"If I get used to it, I think I can move objects with **minimal movement**. It seems to be possible to control the object simply move in the x, y, and z axes without turning the wrist like a VR controller. It will be able to rotate the object by moving **only fingers with minimal wrist movement**", P1

"It seems it was a little difficult to know which I was pointing at, and to be sure which direction I am choosing", P2

"It will be **useful** when it is difficult to move the body a lot or the hand up and down", P3

## Conclusion

We found that thumble has **less movement** than the interaction provided by the conventional VR controller. In the further study, we will conduct **formal study such as performance measurement with the training session and improve the precision of the prototype comparable to the off-the-shelf VR controller**.