# Comparison of input methods and button sizes in augmented reality devices

Sunyoung Park[1], Yuryeon Lee[2], Hwaseung Jeon[2], Hyun K.Kim[2*], Muhammad Hussain[3], Jaehyun Park[3]

[1]School of Software, Kwangwoon University (Republic of Korea)
[2]School of Information Convergence, Kwangwoon University (Republic of Korea)
[3]Department of. Ndustrial and Management Enginnering, Inchon National University (Republic of Korea)

Presenter : Sunyoung Park
School of Software, Kwangwoon University
Contact email : tjsdud9151@gmail.com

# Sunyoung Park

Sunyoung Park is a student at Kwangwoon University in Republic of Korea. Her major is Application Software. After graduating from university in 2021, she plan to go on to graduate school. She is very interested in UX and artificial intelligence. She participated in the development project for image quality improvement media player applying deep learning, which is an industry-academic cooperation project in cooperation with Pixtree, and wrote related research papers("A compartive analysis of Super-Resolution algorithms for media player"). She is currently working on kiosk-related research and papers.

# Motivation

## Augmented-Reality (AR)

- AR refers to a computer interface technology that enables users to perceive mixed images by combining a virtual world composed of computer graphics into the real world as a form of virtual reality and interacts with computers while manipulating them as virtual object by their actions in real time.
- AR has already been applied to many areas and applications but there is still a lack of research on appropriate interface considering the usability of AR devices.
- Users wear HoloLens and perform target selection works, measure the task completion time, user satisfaction score and error rate to check the effects of input methods, button sizes, and distances. This study can be used for future AR user experience and interface design.

# Participants & Apparatus

## Participants

- 12 male and 12 female participants
- Average age: 21.21 years old and Standard deviation: 1.26
- Who had no experience in using augmented reality except smartphone-based augmented reality
- Had no physical or visual problems
- 22 of them is Right-handed and 2 of them is Left-handed.

## Apparatus

- The experimental device used the HoloLens Development Edition.
- The prototype Application runs on HoloLens and is implemented using Unity and C#.

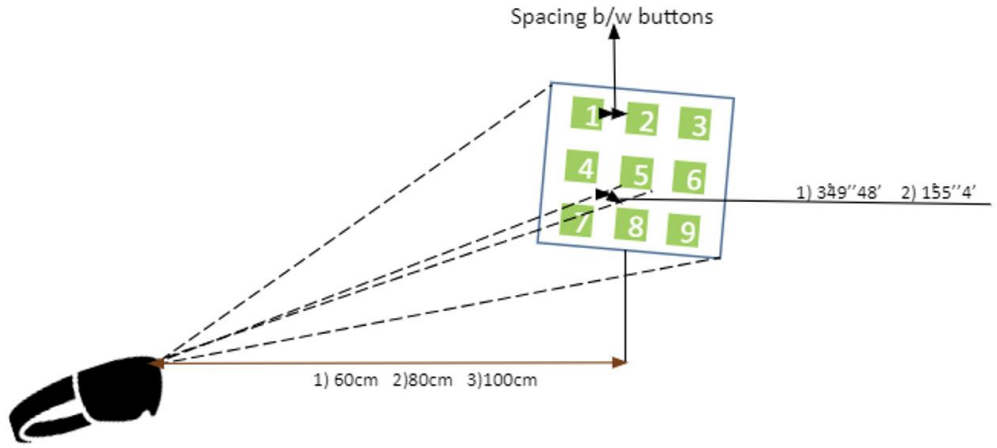
# Tasks

## FOV (Field Of View)

| FOV | Distance | Size of Button |
|---|---|---|
| 3° 49′ 48″ | 60cm<br>80cm<br>100cm | 3.68cm<br>4.90cm<br>6.14cm |
| 1° 55′ 4″ | 60cm<br>80cm<br>100cm | 2.00cm<br>2.68cm<br>3.35cm |

- For small buttons is set 1° 55′ 4″ based on the long side of the 3 x 4 keyboard of a smartphone and feature phone.
- For large buttons is set to double the small buttons, and the field of view as 3° 49′ 48″.

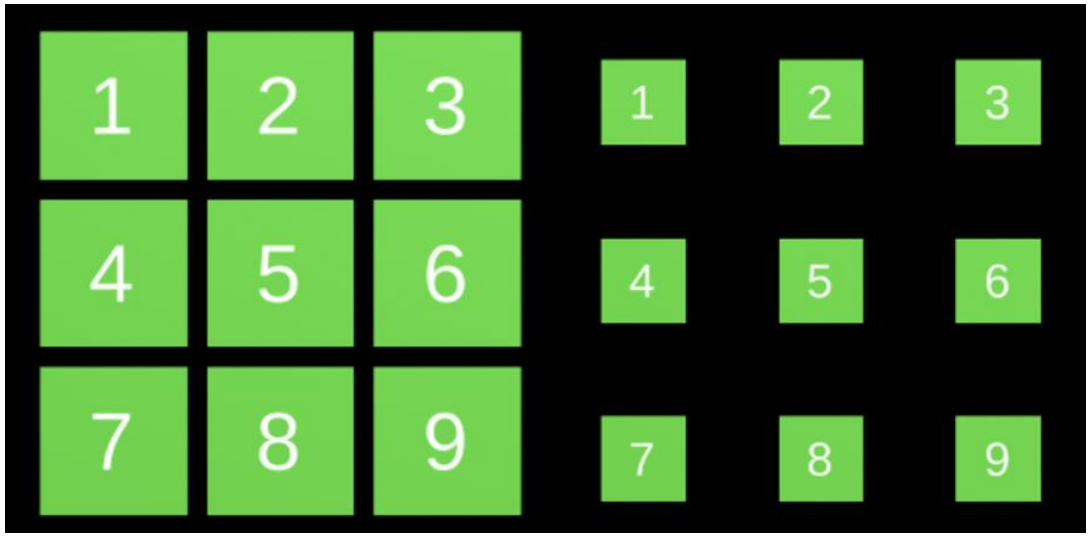
## Distance

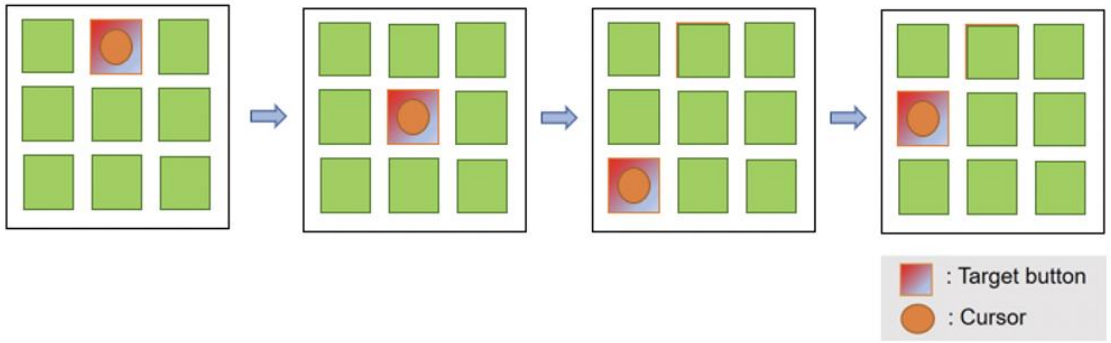



- For HoloLens, it is recommended against ever presenting holograms closer than 40cm.
- The distance was set at 1.5 times, 2 times, and 2.5 times of 40cm.

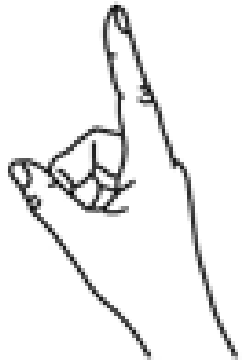
# Tasks

## Example of target buttons




## Input Method



# Procedure

## Before the Task

- All participants listened to the explanation about experiment and how to use HoloLens.
- Sufficient practice time was given before the button selection operation.

## Latin square Design

- The experiment was conducted with Latin square design to prevent learning effects.

## Treatment Condition

- This experiment consists of a total of 12 treatment conditions (2 Button size x 3 Distance x 2 Input method).
- Each treatment condition repeats 5 sets of four button selection tasks.

## Five-point Likert scale

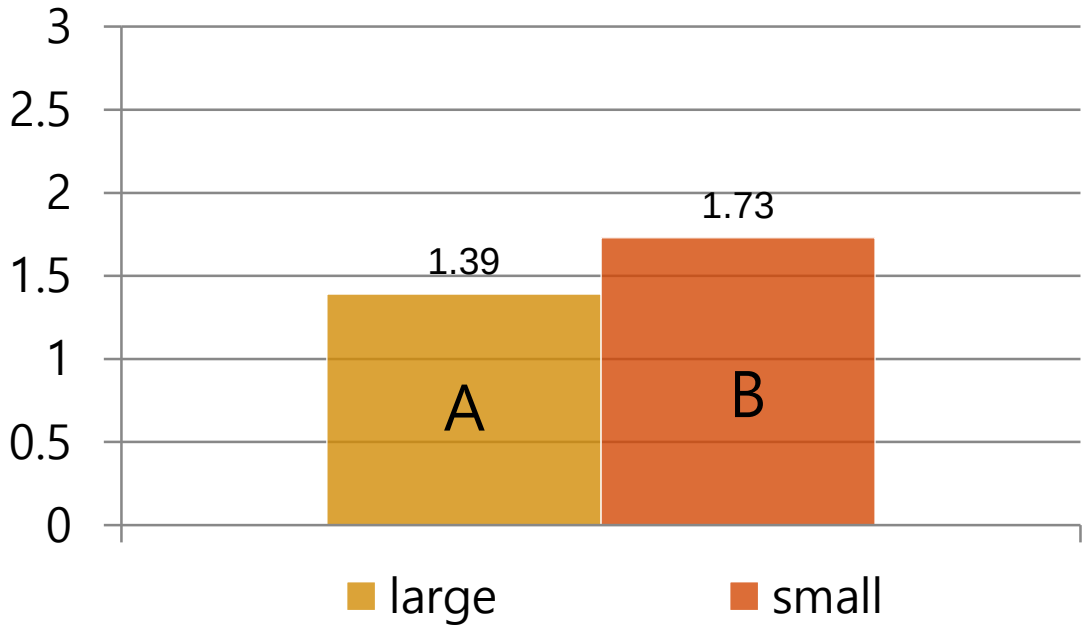
- Evaluate user satisfaction for each test conditions (1-Strongly disagree, 2-Disagree, 3-Neither agree nor disagree, 4 Agree, 5-Strongly agree).

# Results

## Result of ANOVA

| | Task Completion time | | User Satisfaction | | Error Rate | |
|---|---|---|---|---|---|---|
| | F | p | F | p | F | p |
| **Button Size(A)** | 334.13 | 0.00 | 29.10 | 0.00 | 5.95 | 0.02 |
| **Distance(B)** | 51.92 | 0.00 | 10.08 | 0.00 | 0.85 | 0.36 |
| **Input Method(C)** | 402.86 | 0.00 | 33.81 | 0.00 | 1.73 | 0.19 |
| **A X B** | 20.63 | 0.00 | 3.89 | 0.05 | 0.00 | 1.00 |
| **A X C** | 9.34 | 0.00 | 0.59 | 0.44 | 1.73 | 0.19 |
| **B X C** | 15.80 | 0.00 | 0.18 | 0.67 | 0.21 | 0.65 |
| **A X B X C** | 12.89 | 0.00 | 0.01 | 0.93 | 1.90 | 0.17 |

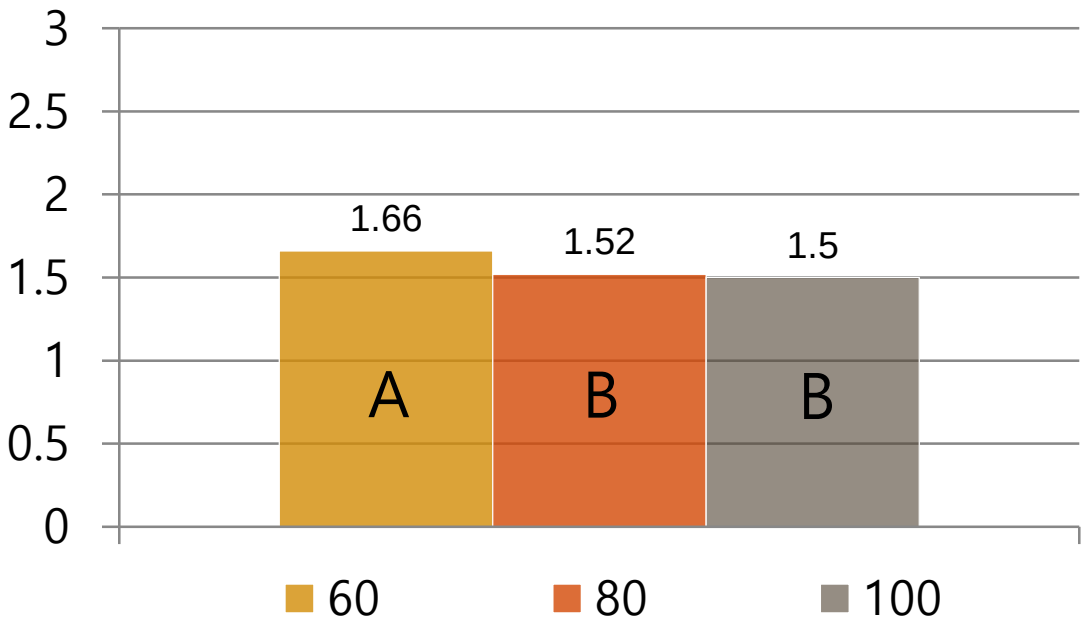
## Task completion time(s) - Button size




- The task completion time was faster for large buttons than for the small buttons ($p<0.000$, $\alpha=0.05$).

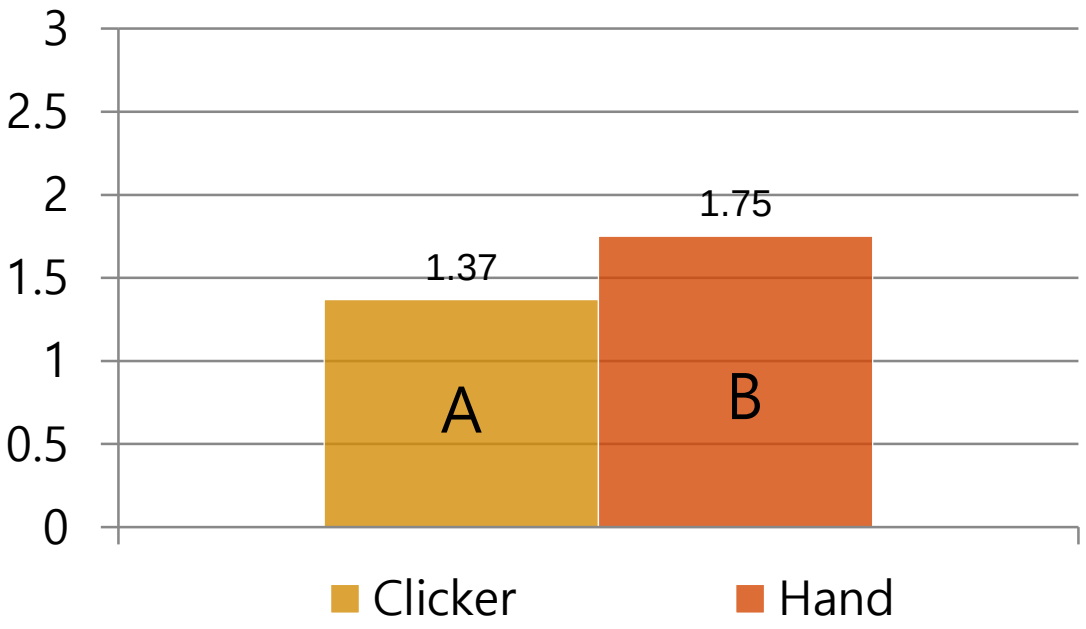
# Results

## Task completion time(s) - Distance




- The task completion time was faster for 60cm than for 80cm, 100cm ($p<0.000$, $\alpha=0.05$).

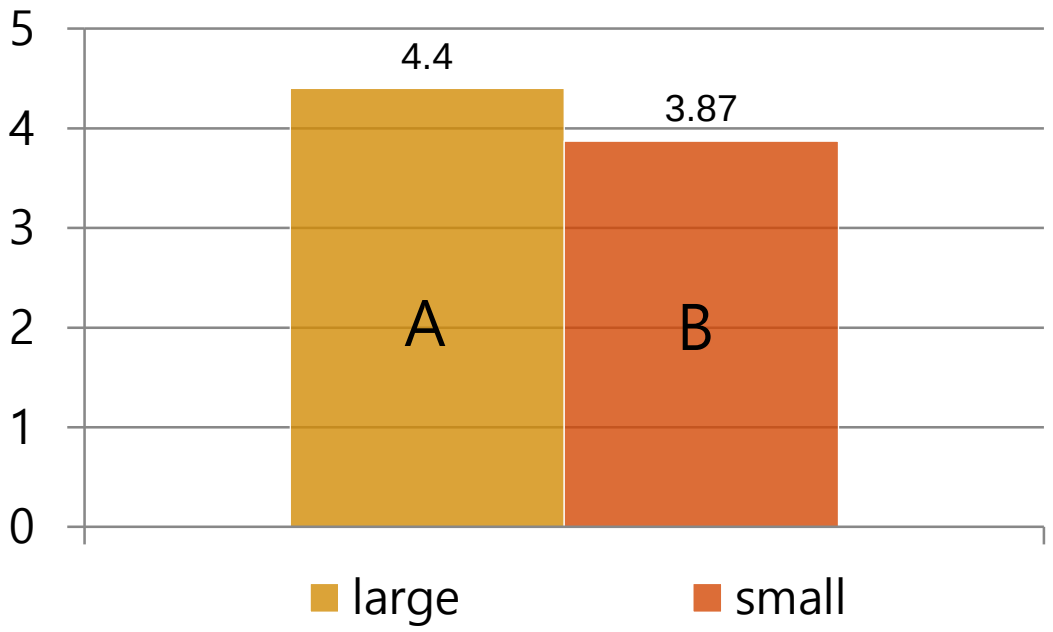
## Task completion time(s) - Input method




- The task completion time was faster for when using clicker than hand ($p<0.000$, $\alpha=0.05$).

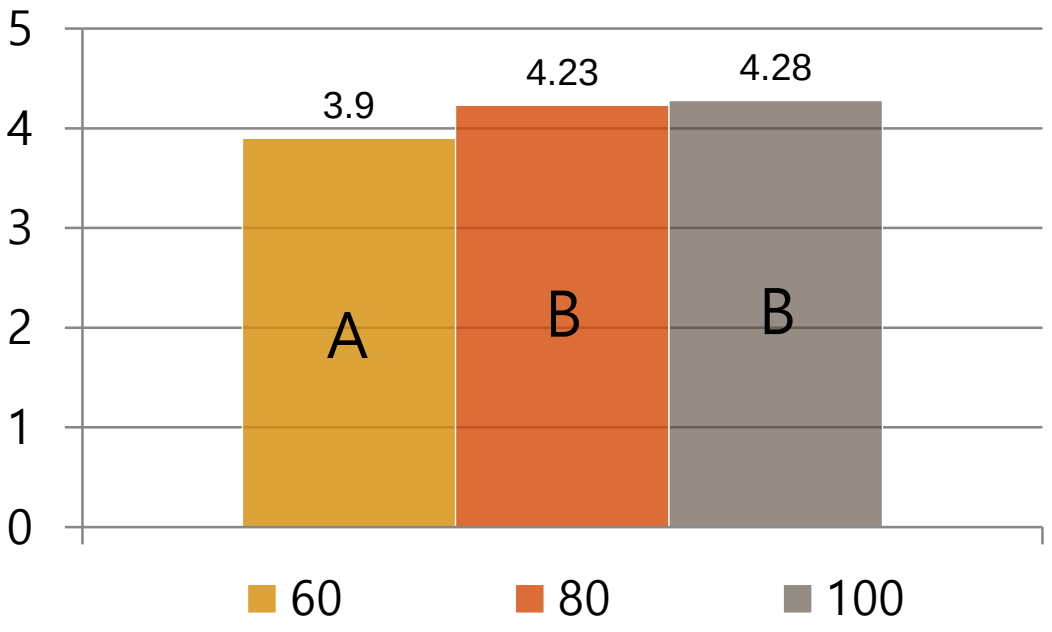
# Results

## User Satisfaction - Button size




- User satisfaction was higher for the large buttons than for the small buttons ($p<0.000$, $\alpha=0.05$).

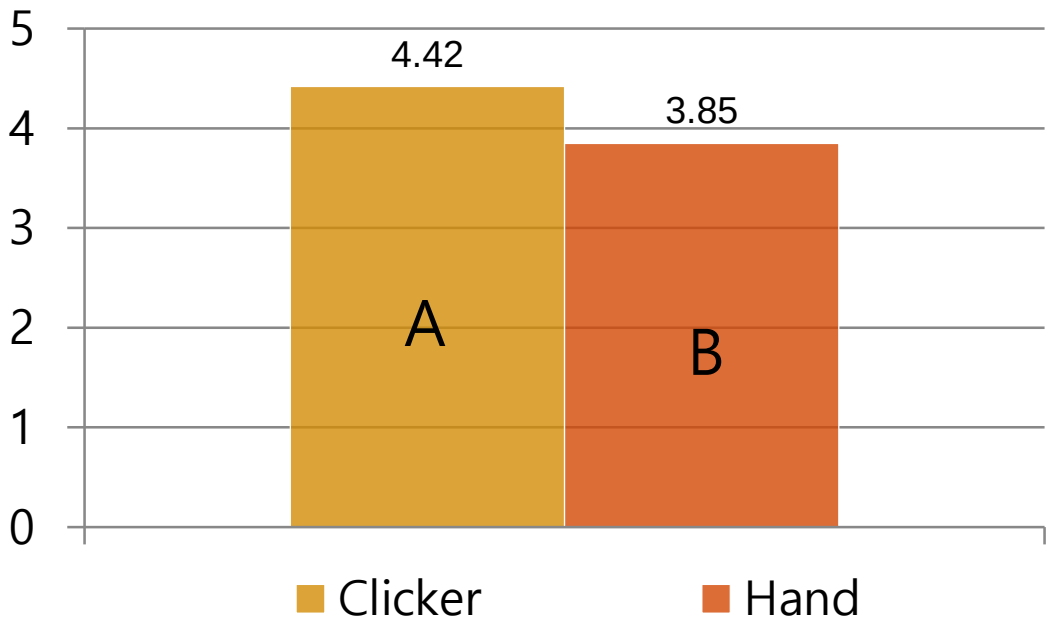
## User Satisfaction - Distance




- User satisfaction was higher for the 60cm than for the 80cm, 100cm ($p<0.05$, $\alpha=0.05$).

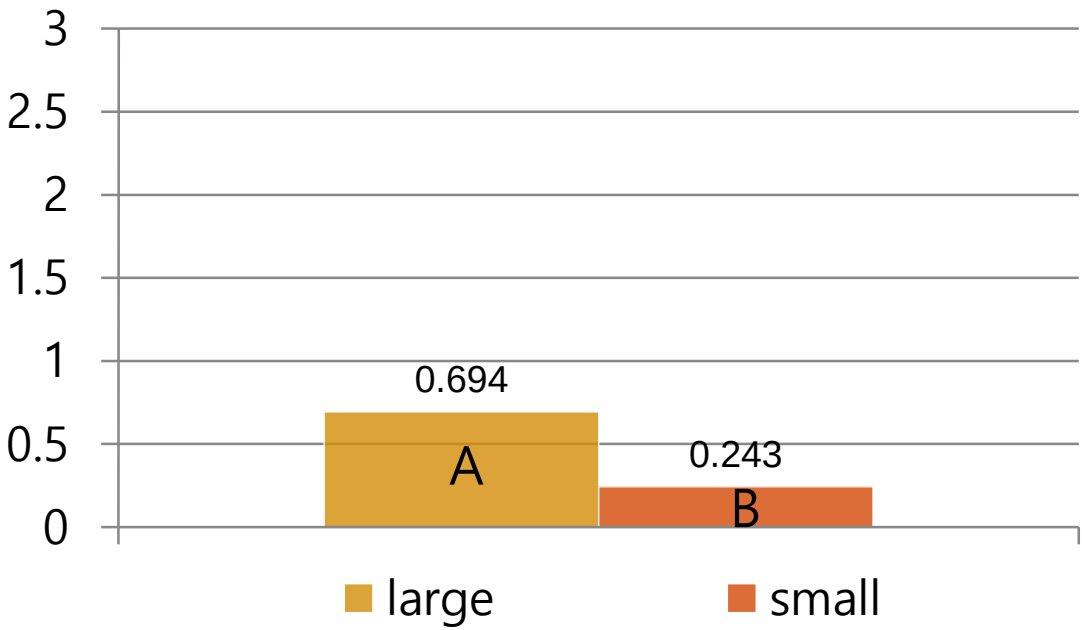
# Results

## User Satisfaction - Input method




- User satisfaction was higher for when using clicker than hand ($p<0.000$, $\alpha=0.05$).

## Error rate(%) - Button Size




- The error rate was higher for the large buttons than for the small buttons ($p<0.05$, $\alpha=0.05$).

# Conclusions

- We compared the performance changes of three factors ( task completion time, user satisfaction score, error rate) with input methods, button size, distance on HoloLens.
- Task completion time and user satisfaction was better in large buttons than small buttons, clicker than the hand, 80cm, 100cm than 60cm, and the error rate was higher in large buttons than small buttons.
- This study are thought to help determine the appropriate target distance, size, and input method for AR devices.

# Future work

- Considering more variances and conducting research on participants of various age groups

- Conduct experiments to perform complex tasks (The current experiment is a simple task of target selection works)

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# Thank you! Questions?

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