Touching Holograms: A Preliminary Evaluation of Mixed Reality Gestures

Weerachet Sinlapanuntakul, Jenna Korentsides, Aaron M. Collard, Katlyn S. Skilton, & Barbara S. Chaparro
Department of Human Factors and Behavioral Neurobiology

EMBRY-RIDDLE Aeronautical University

Introduction

- The Microsoft HoloLens 2 is a mixed reality (MR) headset that overlays visual information over a real-world environment.
- Gestures are tracked and translated as system input used to manipulate and interact with 3D digital objects in the MR space.
- MR gestures must be easy for the users to remember and perform without having to learn a completely new language.


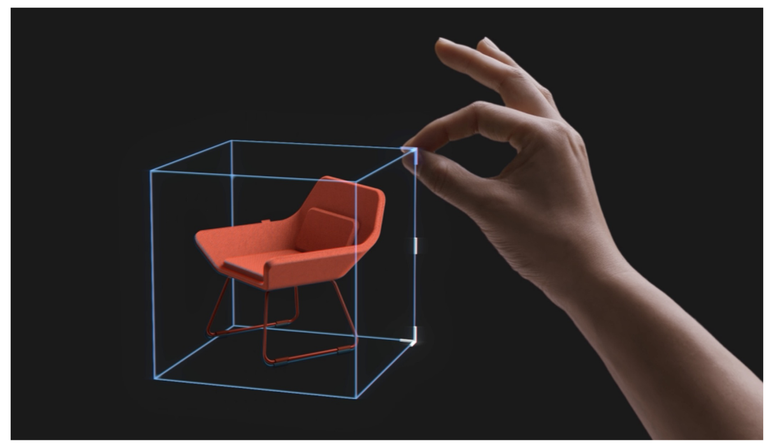

Figure 1 and 2. Direct Touch Gesture on the HoloLens 2 (left). Resizing a 3D Object (right).

Current Study

- This study evaluates the user experience, intuitiveness, and user perceptions of MR gestures as they apply to a potential future of work.

Methods

Participants

- *N* = 15 (9 males, 6 females), ages 18-28 (*M* = 21.80, *SD* = 3.17)
- 80% reported prior experience with VR, AR, or MR device, ranged from 0-25 hours (*Mdn* = 4, *IQR* = 9)

Procedure

1. HoloLens 2 fitting with eye calibrations and tutorial for gestures
2. Participants completed a series of 16 scenario-based, student-centered tasks (Table 1).
3. After each task, participants were asked to rate their perceived difficulty of the task on a scale of 1 to 10.
4. Upon completion of the tasks, participants completed the:
   - Demographic questionnaire
   - System Usability Scale (SUS)
   - User Experience Questionnaire (UEQ)
   - Simulator Sickness Questionnaire (SSQ)
   - NASA Task Load Index (NASA-TLX-R)
5. Participants answered open-ended questions on their perceptions of gestures towards a potential work environment of the future in MR.

Results

Task Difficulty

Table 1. Summary list of the tasks. *Note.* * $p < .05$ for pairwise comparison with tasks 4 & 12

Task Number	Gesture Use	Perceived Difficulty (1 = very difficult, 10 = very easy)
Task 1	Opening Menu and Apps	7.67 (1.59) *
Task 2	Selecting	8.00 (1.65)
Task 3.1	Scrolling	6.73 (2.34) *
Task 3.2	Placing 3D Objects	8.93 (1.39)
Task 4	Resizing 3D Objects	9.53 (0.64)
Task 5	Typing	7.73 (1.91)
Task 6	Dictating Text	7.47 (2.23)
Task 7	Rearranging MR Space	8.33 (2.06)
Task 8	Width Resizing	9.67 (0.90)
Task 9	Height Resizing	9.00 (1.41)
Task 10	Corner Resizing	9.60 (0.74)
Task 11	Replying to a Chat	8.53 (1.55)
Task 12	Interacting with a Game	9.93 (0.26)
Task 13	Rotating a 3D Object	9.40 (0.83)
Task 14	Moving a 3D Object	9.60 (0.83)
Task 15	Closing Windows	9.73 (0.59)

Perceived Usability (SUS)

- The average SUS score of virtual space (*M* = 78.00, *SD* = 12.44) was considered a "good" subjective score.

Subjective User Experience (UEQ)

- The average UEQ showed positive results in all dimensions (Figure 3)

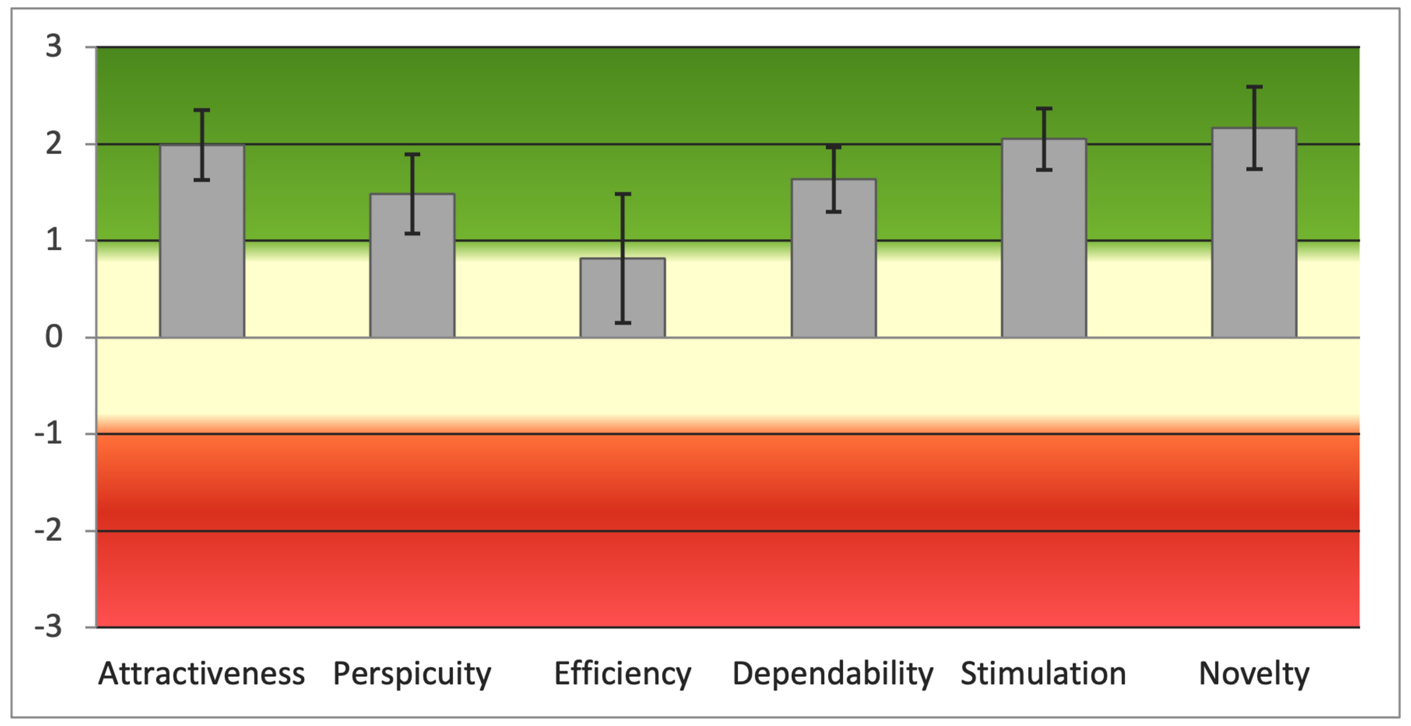

Figure 3. Preliminary User Experience Scores. *Note.* 3 = more positive, -3 = more negative

Simulator Sickness (SSQ)

- The use of the Microsoft HoloLens 2 associated with the overall "concerning" simulator sickness symptoms (*M* = 19.20, *SD* – 17.98):
  - Nausea is considered "significant" (*M* = 11.45, *SD* = 13.59)
  - Oculomotor Discomfort is considered "bad" (*M* = 26.28, *SD* = 23.43)
  - Disorientation is considered "bad" (*M* = 28.77, *SD* = 40.23)

Results (cont.)

Perceived Workload (NASA-TLX-R)

- Pairwise comparison with a Bonferroni adjustment revealed that mental demand (*M* = 9.00, *SD* = 4.91) was significantly higher than physical demand (*M* = 4.00, *SD* = 2.24), *p* = .002, temporal demand (*M* = 3.73, *SD* = 3.43), *p* = .014, performance (*M* = 4.80, *SD* = 3.21), *p* = .015, and frustration (*M* = 4.47, *SD* = 3.31, *p* = .004. No significant difference between mental demand and effort (*M* = 7.20, *SD* = 5.10).

Discussion

- Overall, participants had positive experience with MR but would only use it for simple tasks as it strained their eyes after a while.
- Resizing width, height, and corner (Table 1) with the HoloLens 2 is easier than the HoloLens 1's post-test in Benedict et al. (2019) study, indicating improvement.
- Participants reported that gestures were easy to learn as they resembled natural movements, with direct touch being the easiest to perform and provided the most feedback.
- Scrolling was the most confusing as participants associated MR gestures with a mouse cursor, instead of gestures used with tablets, due to the ability to bring up multiple windows.
- Other challenges included grabbing a window and using air tap to aim/select as they required high accuracy.
- User suggestions included adding scrolling and typing/dictating to the interactive tutorial, implementing haptic feedback, and improving the gesture sensitivity systems to make gesture interactions more intuitive and more natural to the users.

Acknowledgements

This research was partially supported by the Internal Research Grant from the Office of Undergraduate Research, ERAU. The authors would like to thank Matthew Bivens for assistance in running the study.

References

Benedict, J. D., Guliuzo, J. D., & Chaparro, B. S. (2019). The intuitiveness of gesture control with a mixed reality device. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 63*(1), 1435-1439.

Cision News. (2021, Nov 24). *XMReality now on HoloLens 2*. https://news.cision.com/xmreality/r/xmreality-now-on-hololens-2,c3458975

Lee, L. H., Braud, T., Hosio, S., & Hui, P. (2021). Towards augmented reality driven human-city interaction: Current research on mobile headsets and future challenges. *ACM Computing Surveys (CSUR), 54*(8), 1-38.

Microsoft. (2022). *HoloLens 2*. https://www.microsoft.com/en-us/hololens

Milman, N. B. (2018). Defining and conceptualizing mixed reality, augmented reality, and virtual reality. *Distance Learning*. *15*(2), 55-58.