Touching Holograms: A Preliminary Evaluation of Mixed Reality Gestures

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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.
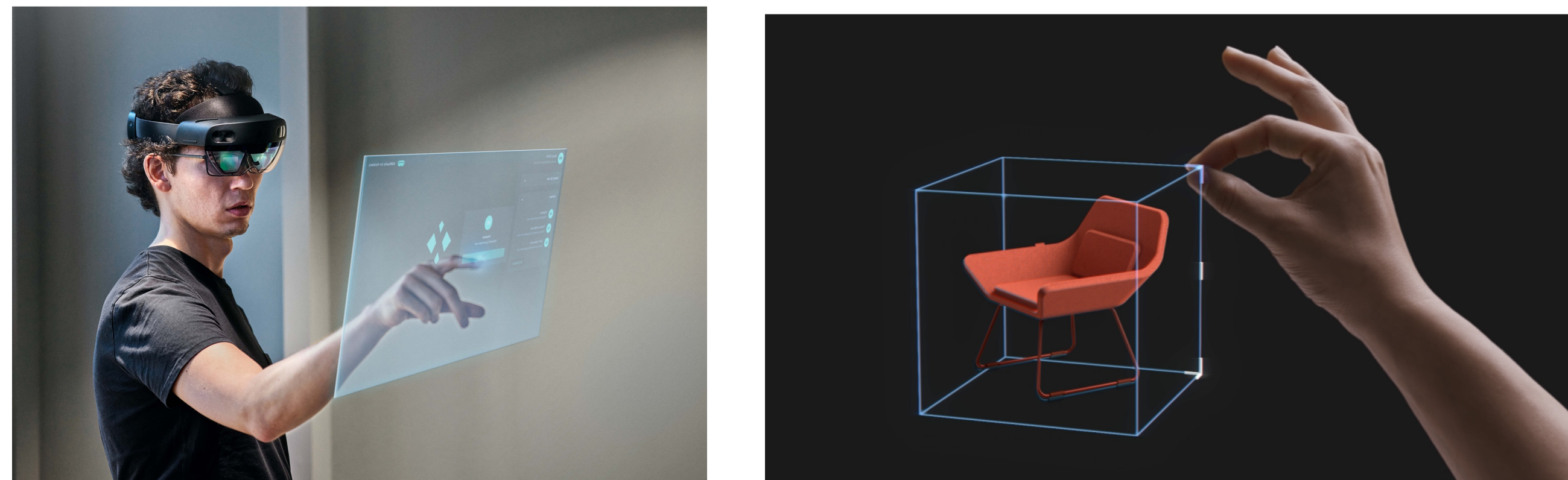- MR gestures must be easy for the users to remember and perform without having to learn a completely new language.

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)

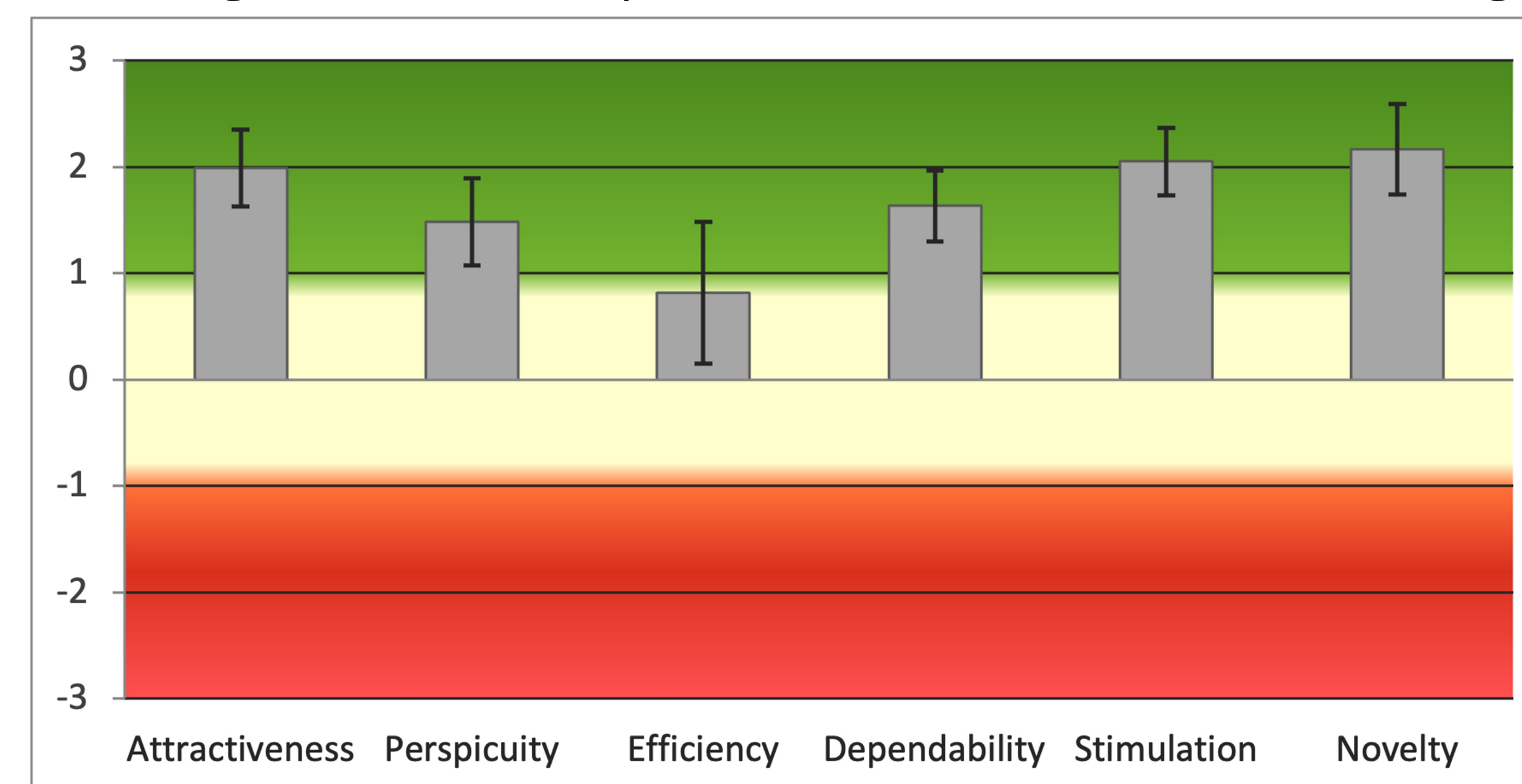- The average UEQ showed positive results in all dimensions (Figure 3)

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

References

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