Experiment Plan

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# Environment

* NVIDIA Joint-Lab on Mixed Reality
* A space of 3.5\*3.5m

# Equipment

* HTC Vive Eye Pro
* Android smartphone

# Participants

* Age: 18+
* 2 (each group) \* 20 (groups) = 40 participants in total (or more)

# System features

* VR user
  + Situated in the virtual environment, using the VR headset and two hand-held controllers
  + Virtual avatar with the head and two hands (position + rotation)
  + Provided with six 3D virtual objects + one 2D image (a star chart), details listed in the objects section below
* AR user
  + Situated in the real environment, using the smartphone which recognizes the floor, on which the virtual room is augmented
  + Virtual avatar with the head (position + rotation)
  + Provided with six 3D virtual objects + one 2D image (a star chart), details listed in the objects section below
* Virtual avatar
  + Abstract representation of the head (position + rotation) and two hands (VR only)

A picture containing sitting

Description automatically generated

Figure 1. The AR user (green) and the VR user (blue), with their real-time position synchronized

# Objects

Table 1. Overview of seven virtual objects

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **#** | **Name** | **Picture** | **Size** | **Time Period** | **Museum** | **Interaction** |
| 1 | The Bronze Mask with Protruding Pupils |  | Height: 66cm  Width: 138cm | Shang  1600-1046 BC | Sanxingdui Museum | Medium  *Grabbable* |
| 2 | Bronze Music Instrument |  | Height: 63cm | Western Zhou  1046-771 BC | Tianjin Museum | High  *Grabbable;*  *Knock to trigger bell sound* |
| 3 | Xie Zhi (Pottery Unicorn) |  |  | Northern Wei  386-534 AD | Shaanxi History Museum | High  *Grabbable; poke to burst a balloon* |
| 4 | Tri-coloured camel |  | Height: 87cm | Tang  618-907 AD | Nanjing Museum | Medium  *Grabbable* |
| 5 | Pottery Figure of a standing Lady |  | Height: 138cm  Width: 26.6cm | Tang  618-907 AD | National Palace Museum, Taipei | Medium  *Grabbable* |
| 6 | Figure of an Assistant to the Judge of Hell |  | Height: 148cm  Width: 36cm  Depth: 20cm | Ming  1368-1644 AD | The British Museum | Low |
| 7 | Chinese Star Chart |  |  | Tang  ~700 AD | British Library | Low |

# Research questions

**RQ1.** Can user-generated contents enhance user engagement around virtual objects?

**RQ2.** How does presence influence user engagement around virtual objects?

# Hypotheses

**H1.** Users are more engaged in objects when user generated contents are presented, such as others’ comments.

* Within subject score (parametric or non-parametric)
* Justify the reason for using t-test/Wilcoxon test/others
* Reference for using t-test for established questionnaires
* Order effect (two-way ANOVA)

**H2.** Users are more engaged when they are aware of the presence of other users around virtual objects.

* Correlation between level of engagement and proximity (average/percentage of time with each object or each zone/…) to others.
* Real-time ones (TBD)

**H3.** Users are more engaged with objects of which greater interactivity are afforded.

* Script to record the time objects being hold/interacted with
* Types of interactions (with labels, etc.)
* When they do more, does it affect the engagement

# Independent variables

* Presentation of user-generated content (UGC)
  + User-generated content refers to media content created or produced by the general public rather than by paid professionals and primarily distributed on the Internet. (Daugherty et. al 2008)
* Proximity between virtual avatars (calculated using script logging)
* Interactivity afforded by virtual objects (the last column in Table 1) - Time

# Dependent variable

* Engagement

# Controlled groups

Each study includes two participants, who experience the same exhibition room twice

* Two users: VR + AR
* Two times: with/without user-generated content

# Experiment settings

* Setting I: hybrid VR and AR without user-generated content
* Setting II: hybrid VR and AR with user-generated content
* Each user will use the same technology twice in order to do within group comparison

# Timed experiment

## Hybrid VR and AR, with/without UGC

|  |  |
| --- | --- |
| Time | Events |
| 00:00 | Introduction to the experiment. Participants fill in the information sheet, consent form, and the ITC-SOPI background information |
| 00:05 | Introduction to the use of VR headsets and the controllers; show participants how to use the controllers / smartphone, and the EEG |
| 00:15 | Start experiment setting I |
| 00:25 | Fill in the ITC-SOPI Part A and B, and the UES-SF questionnaire |
| 00:30 | Start experiment setting II |
| 00:40 | Fill in the ITC-SOPI Part A and B, and the UES-SF questionnaire |
| 00:50 | Group interview |
| 00:60 | End of experiment |

# Measures

* ITC Sense of Presence Inventory (ITC-SOPI)
  + Spatial Presence, Engagement, Ecological Validity/ Naturalness, Negative Effects
  + Lessiter, J., Freeman, J., Keogh, E., & Davidoff, J. (2001). A Cross-Media Presence Questionnaire: The ITC-Sense of Presence Inventory. *Presence*, *10*(3), 282–297. https://doi.org/10.1162/105474601300343612
* User Engagement Scale (UES) – Cross validate with the engagement in ITC-SOPI
  + Attention, Perceived Usability, Aesthetics, Reward factor (Novelty, Felt Involvement, Endurability)
  + O’Brien, H. L., Cairns, P., & Hall, M. (2018). A practical approach to measuring user engagement with the refined user engagement scale (UES) and new UES short form. *International Journal of Human Computer Studies*. https://doi.org/10.1016/j.ijhcs.2018.01.004
* Physiological measure with Muse EEG

## ITC Sense of Presence Inventory (ITC-SOPI)











Check and validate the translation (5 people)

Tell me what this questionnaire means to you

### Scoring the ITC-SOPI

* Each completed questionnaire will result in 4 factor scores (each generated by calculating a mean of all completed items contributing to each factor) per media experience per participant.
* The factors, and items contributing to them are:
  + **Spatial Presence**

*mean of items* B4, B7, B9, B12, B13, B18, B19, B22, B23, B24, B25, B28, B29, B31, B33, B34, B35, B36, B38

* + **Engagement***mean of items* A1, A3, A4, A5, A6, B1, B2, B3, B8, B16, B17, B30, B32
  + **Ecological Validity/ Naturalness***mean of items* B5, B11, B15, B20, B27
  + **Negative Effects***mean of items* A2, B10, B14, B21, B26, B37
* Scores for each factor cannot currently be combined into one overall "media experience" score - results for each factor should be analysed individually.
* Missing data must be taken into account in calculating the means - but should be minimised through careful instruction in administering the questionnaire.
* When environments that do not contain characters are being evaluated with the ITC- SOPI, we recommend that item B23 be ignored when calculating the mean **Spatial Presence** factor score - as B23 refers specifically to characters in the environment.

## User Engagement Scale (UES)

﻿The following statements ask you to reflect on your experience of engaging with Application X or “this study ”. For each statement, please use the following scale to indicate what is most true for you.

﻿Strongly disagree 1

Disagree 2

Neither agree nor disagree 3

Agree 4

Strongly agree 5

### UES-LF items

**Focused Attention**

FA.1 I lost myself in this experience.

FA.2 I was so involved in this experience that I lost track of time.

FA.3 I blocked out things around me when I was using Application X .

FA.4 When I was using Application X , I lost track of the world around me.

FA.5 The time I spent using Application X just slipped away.

FA.6 I was absorbed in this experience.

FA.7 During this experience I let myself go.

**Perceived Usability**

PU.1 I felt frustrated while using this Application X .

PU.2 I found this Application X confusing to use.

PU.3 I felt annoyed while using Application X .

PU.4 I felt discouraged while using this Application X .

PU.5 Using this Application X was taxing

PU.6 This experience was demanding.

PU.7 I felt in control while using this Application X .

PU.8 I could not do some of the things I needed to do while using Application X .

**Aesthetics**

AE.1 This Application X was attractive

AE.2 This Application X was aesthestically appealing

AE.3 I liked the graphics and images of Application X .

AE.4 Application X appealed to be visual senses.

AE.5 The screen layout of Application X was visually pleasing.

**Reward factor**

RW.1 Using Application X was worthwhile

RW.2 I consider my experience a success.

RW.3 This experience did not work out the way I had planned.

RW.4 My experience was rewarding.

RW.5 I would recommend Application X to my family and friends

RW.6 I continued to use Application X out of curiosity.

RW.7 The content of Application X incited my curiosity.

RW.8 I was really drawn into this experience.

RW.9 I felt involved in this experience.

RW.10 This experience was fun.

### Scoring the UES-LF

1. ﻿Reverse code the following items: PU.1, PU.2, PU.3, PU.4, PU.5, PU.6, PU.8, and RW.3.
2. Scale scores are calculated for each participant by summing scores for the items in each of the four subscales and dividing by the number of items:
   1. Sum FA.1, FA.2, ... FA.7 and divide by seven.
   2. Sum PU.1, PU.2, ... PU.8 and divide by eight.
   3. Sum AE.1, AE.2, AE.3, AE.4, and AE.5 and divide by five.
   4. Sum RW.1, RW.2, ... RW.10 and divide by ten.
3. If participants have completed the UES more than once as part of the same experiment, calculate separate scores for each iteration. This will enable the researcher to compare engagement within participants and between tasks/iterations.
4. An overall engagement score can be calculated by adding the average of each subscale as per #2.

### UES-SF items

﻿FA-S.1 I lost myself in this experience.

FA-S.2 The time I spent using Application X just slipped away.

FA-S.3 I was absorbed in this experience.

PU-S.1 I felt frustrated while using this Application X.

PU-S.2 I found this Application X confusing to use.

PU-S.3 Using this Application X was taxing.

AE-S.1 This Application X was attractive.

AE-S.2 This Application X was aesthetically appealing.

AE-S.3 This Application X appealed to my senses.

RW-S.1 Using Application X was worthwhile.

RW-S.2 My experience was rewarding.

RW-S.3 I felt interested in this experience.

### Scoring the UES-SF

1. ﻿Reverse code the following items: PU-S1, PU-S2, PU-S3.
2. If participants have completed the UES more than once as part of the same experiment, calculate separate scores for each iteration. This will enable the researcher to compare engagement within participants and between tasks/iterations.
3. Scores for each of the four subscales can be calculated by adding the values of responses for the three items contained in each subscale and dividing by three. For example, “Aesthetic Appeal ”would be calculated by adding AE-S1, AE-S2, and AE-S3 and dividing by three.
4. An overall engagement score can be calculated by adding all of the items together and dividing by twelve.