Final Year Project

Topic: Exploring viewers' eye movement patterns in virtual reality

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Motivation

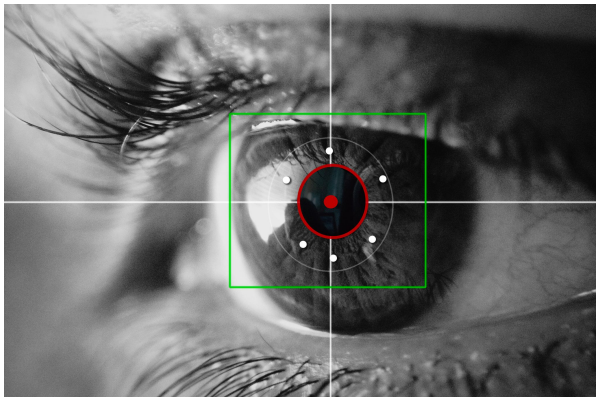
Background

- Nowadays, the digital age → Virtual Reality (VR)
- Computer technology → immersive virtual environment (Carrozzino & Bergamasco, 2010).
- Visit inaccessible locations (Freina & Ott, 2015).
- Education nowadays → cultural heritages (Hu et al., 2019).

↳ Rebuild different cultural heritage → Present it to the audiences

Why Our Research is Significant ?

- Cultural heritage and VR
- How people view different conditions → VR environments → not widely studied
- Analysis of viewers' eye movement → VR environments→ rare
- Our research findings can apply in global



Research Question

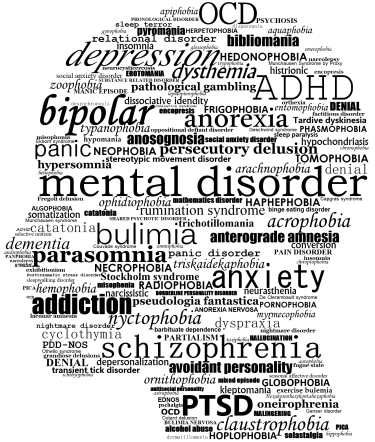
Is there any difference in

eye movement patterns in different conditions?

What will be the potential impact of our project?

- Educators could probably benefit from the research findings
  - New way to attract people's attention
  - Boost the effectiveness of teaching.

- Blend into metaverse



Method

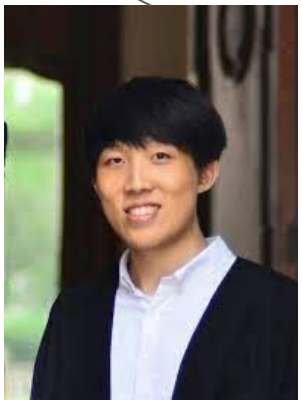
Data Source

- From Dr. Hu's research team (Ng et al., 2020)
- For each participant
  - Eye fixation data in every condition
    - Fixation: A period where the eyes are locked towards an object
  - Questionnaire with audio recording
  - In-experiment survey
  - Pre-and-post survey

Dr Hu

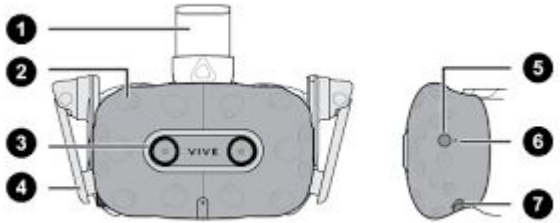
Ying

Jeremy



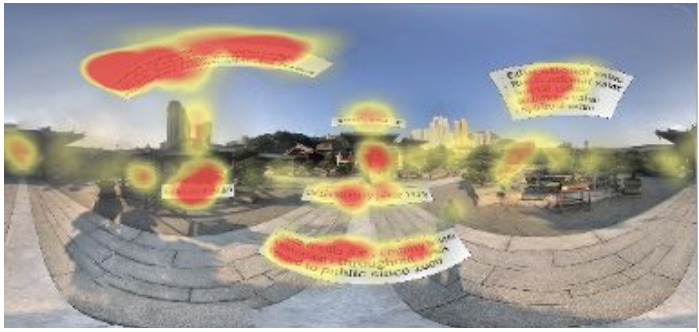
Procedure

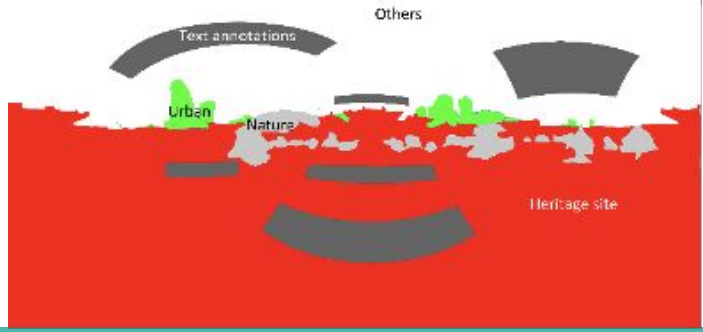
- 8 volunteers
  - 4 Males 4 Females
- 30 minutes for each individually
- HTC Vive Pro Eye goggles were used
  - built-in Tobii eye-tracking software
- A short oral questionnaire



Data Collection

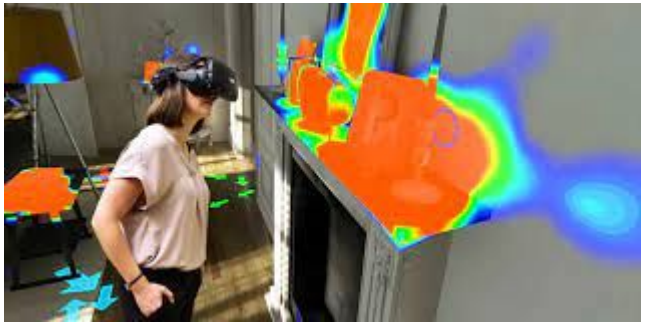
- Scores of each cultural heritage
  - The ratings: 1 (Strongly Disagree) to 7 (Strongly Agree).
- Eye fixations under conditions
  - Baseline (A)
  - Audio (C)
  - Text (B)
  - Text + Audio (D)
- "Regions of interest" (ROI)
  - Cultural Heritage
  - Text
  - Urban
  - Nature

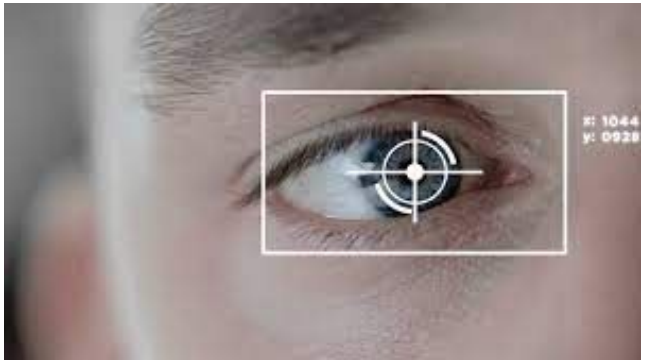




Data Analysis

- Baseline(A) vs Audio(C)
- Text(B) vs Text + Audio(D)
- Saccade Analysis
  - Saccade: Eye movements between fixations
  - How eyes travel between fixations
- Sequence Analysis
  - Probability of one ROI to another



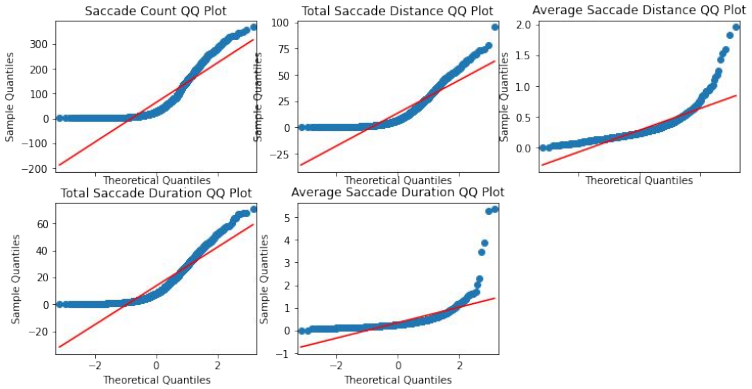


Data Analysis (Saccade Analysis)

- Aggregated each participant's fixation into an intermediate table
- Calculated 5 variables for determining differences
  - Saccade Count
  - Total Saccade Distance
  - Average Saccade Distance
  - Total Saccade Duration
  - Average Saccade Duration
- Only **Intra-ROI** saccade was used
  - a saccade happens within the same ROI category (ROI 1-> ROI 1)
    - Inter-ROI saccade
    - a saccade happens between different ROIs (ROI 1-> ROI 2)

Data Analysis (Saccade Analysis)

- Performed normality test deciding the choice of comparison test
  - Kolmogorov-Smirnov test
  - Anderson-Darling test
  - Shapiro-Wilk test
- Used Mann-Whitney U-tests
- p-values would be adjusted
  - Benjamini-Hochberg procedure
  - Avoid Type-I error
  - False discovery rate = 0.25



Data Analysis (Sequence Analysis)

- Lag Sequence Analysis
- Examine sequential dependency
- Each sequence -> normalised to Z-score
- Z-score = probability of occurrence of sequence
- Z-score matrix

	Culturual Heritage	Nature	Others	Tamed nature	Urban
Culturual Heritage	128.49722	17.940140	72.706863	43.814959	55.2631523
Nature	17.78924	93.385275	6.586941	5.346120	7.3547534
Others	72.80224	7.155770	122.546082	20.790507	13.4508691
Tamed nature	43.89267	4.766795	20.741685	94.358291	0.8556212
Urban	55.10811	7.007998	14.181425	1.391328	103.9327579

Result

Result (Saccade Analysis)

- **(A vs C)** [other]

: **Look more surrendings** to gather information to understand the cultural heritage

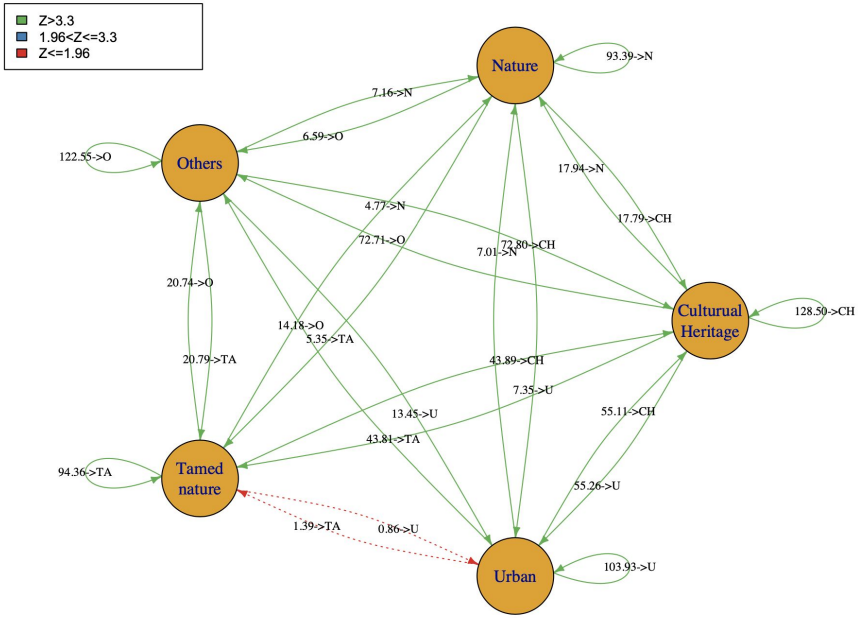
: Narrator in the audio could **already provide enough facts**, so I spend more time to admire the heritage

- **(B vs D)** [text]
- A longer saccade distance -> lower difficulty of understanding the current texts (Rayner et al., 2006).
    - Perceived the texts might became easier in the text+audio condition (D).

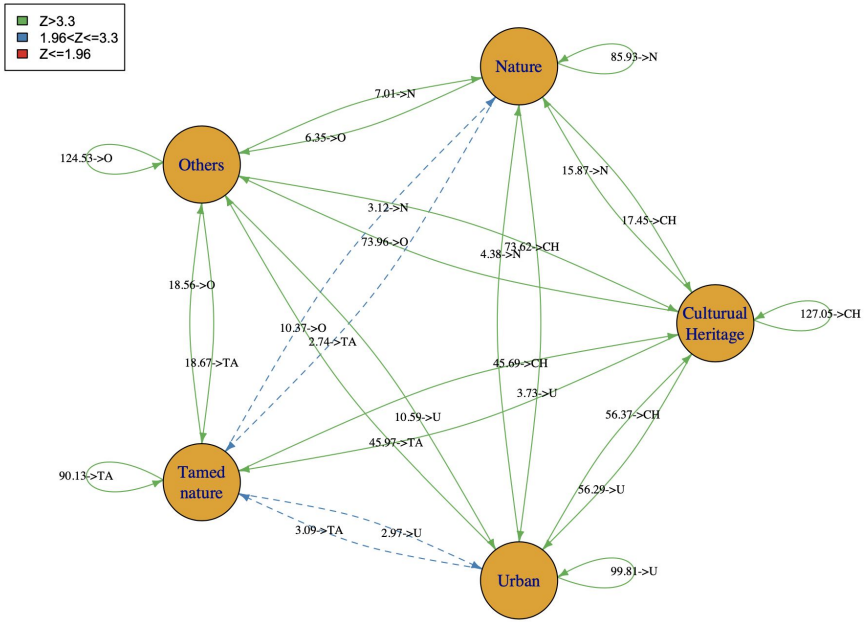
ROI	Saccade Count	Total Saccade Distance	Average Saccade Distance	Total Saccade Duration	Average Saccade Duration
A vs C:	0.53	0.2875	0.15	0.2875	0.175
Cultural Heritage	0.6167	0.6167	0.8125	0.91	0.6167
Urban	0.55	0.55	0.55	0.55	0.55
Nature	0.66	0.6375	0.6375	0.6375	0.6375
Tamed nature	0.88	0.8375	0.3	0.8375	0.3
Others	0.45	0.175	0.2167	0.175	0.45
B vs D:	0.9	0.9	0.9	0.9	0.9
Cultural Heritage	0.93	0.93	0.93	0.93	0.93
Urban	0.583	0.7875	0.45	0.99	0.45
Nature	0.8	0.8	0.8	0.8	0.8
Tamed nature	0.92	0.92	0.6	0.92	0.92
Text	0.4	0.98	0.1	0.8125	0.25
Others	0.98	0.98	0.98	0.98	0.98

Results (Sequence Analysis)

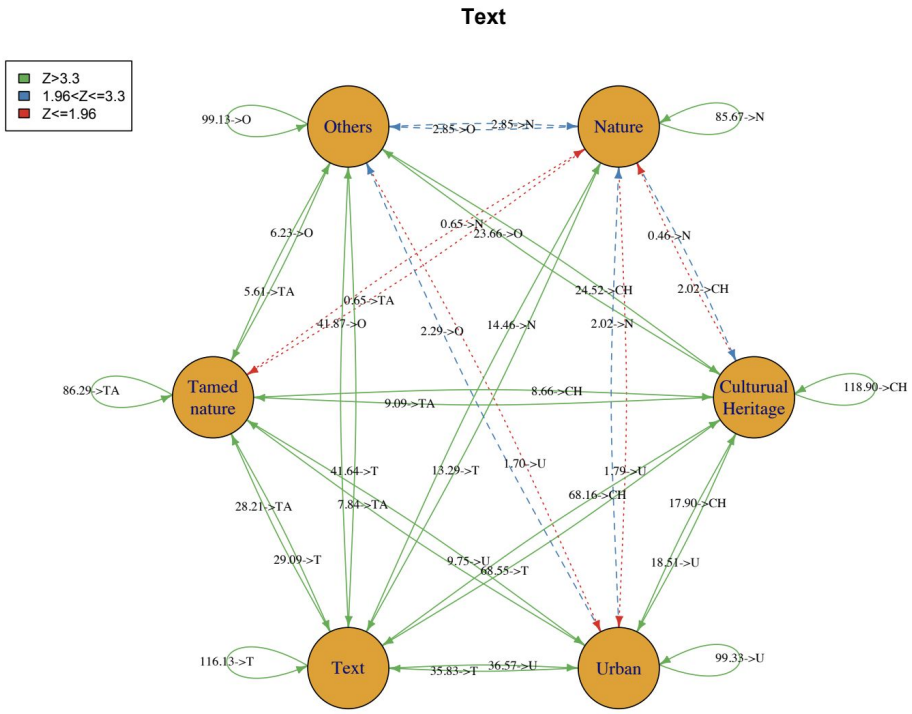
Baseline

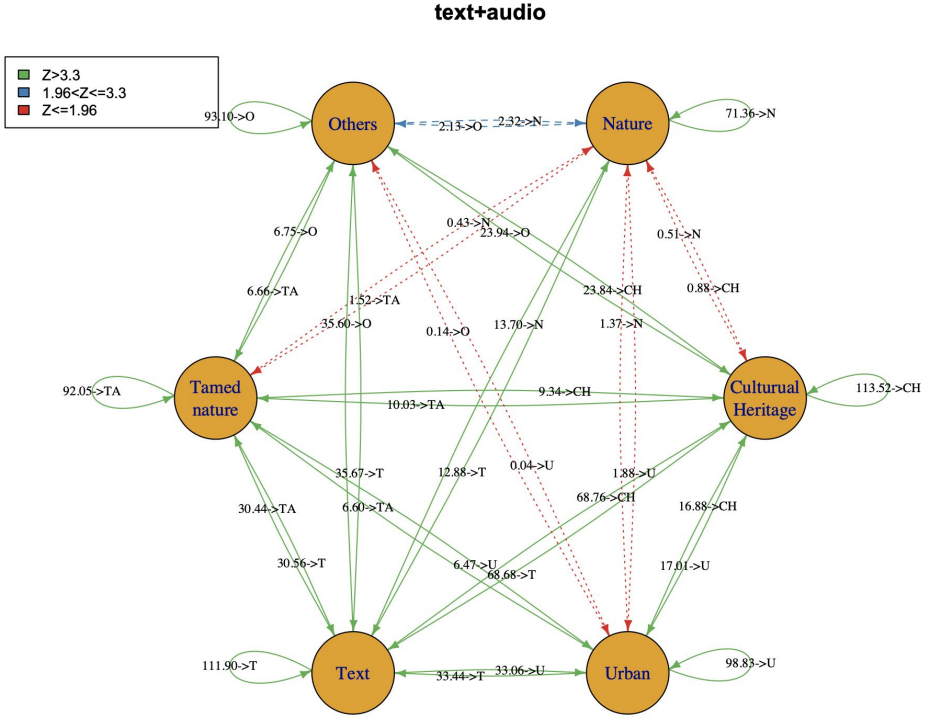


Audio



Results (Sequence Analysis)





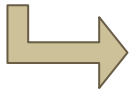
Conclusions

Baseline(A) vs Audio(C)

- Baseline condition had more immersiveness as tending to look around
- Higher possibility of switching to other ROIs

Text(B) vs Text+Audio(D)

- Participants paid less attention to cultural heritage



text annotation

Limitations

Data quality

- Sample size is small - not representative of all the people

Bias

- Sample selection

Data Analysis

- Human Error

Suggestions

- Improve the quality of the image of the scenes in VR
- Add inter-ROI saccade analysis
- Increase the sample size
- Find two programmers

Reference

Carrozzino, M., & Bergamasco, M. (2010). Beyond virtual museums: Experiencing immersive virtual reality in real museums.

Freina, L., & Ott, M. (2015). A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives.

Hu, X., Ng, J., & Lee, J. H. (2019). VR creation experience in Cultural Heritage Education: A preliminary exploration. *Proceedings of the Association for Information Science and Technology*, *56*(1), 422–426. https://doi.org/10.1002/pra2.42

Ng, J. T. dong, Liu, W., Hu, X., & Jung, T. P. (2020). Evaluation of Low - end Virtual Reality Content of Cultural Heritage : A Preliminary Study with Eye Movement.

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Q&A !!!!