ICVRV #295

Under the Movement of Head: Evaluating Visual Attention in Immersive Virtual Reality Environment

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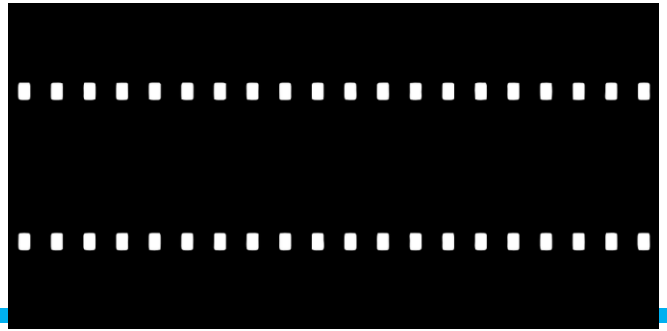
Main question

- In immersive VR, use natural interaction methods
  - which are much easier to utilize excessively
- May miss something are important for narrative
- So it is vital for VR film directors to be able to evaluate the user's attention



Immersive VR exploring features

- Participants will respond to a VR as if it were real
  - Place illusion (PI) and plausibility illusion (Psi) [1]
- In non-immersive VR scenes, it's harder to invoke the feeling of presence
  - Perceive information through the 2D monitor
  - Use unnatural interactive hardware to mingle

[1] M. Slater, "Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments," Philosophical Transactions of the Royal Society of London B: Biological Sciences, vol. 364, no. 1535, pp. 3549–3557, 2009.

Hypothesis

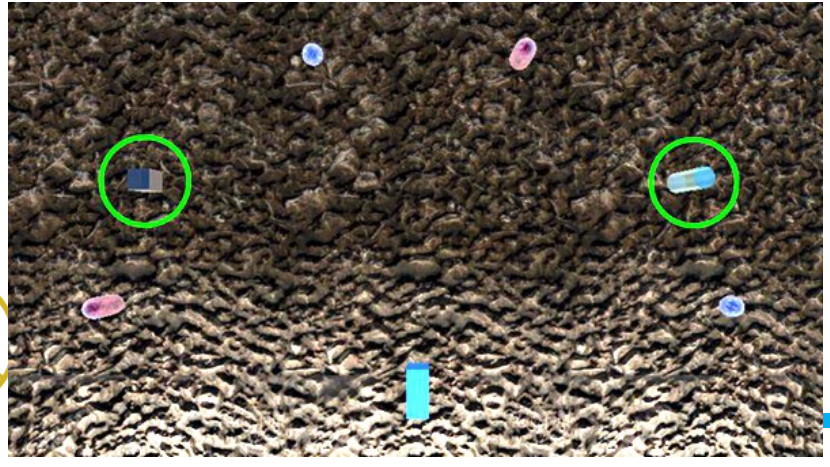
- In immersive VR, users tend to move their heads more often to perceive interested objects
  - As they do in real life
  - So the head movement can be used as gaze predictor
- In non-immersive VR, move their own eyes to gaze at objects that appear on the screen
  - Inconvenient to move the avatars' heads
  - Delayed response from computer

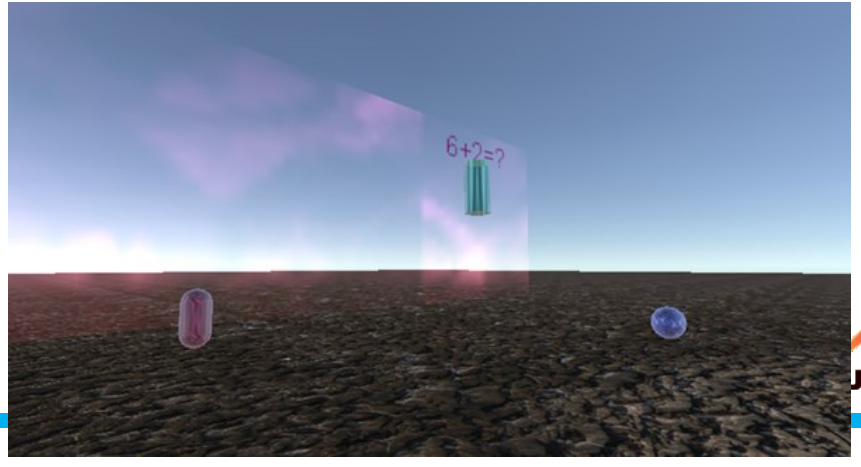
User study

- Use behavior analysis to verify our hypothesis
- Based on recorded particular interactions
- Better reflect the real-time exploration interests
- Better than questionnaires used in many others
  - Cannot remember everything that they just observed
  - Errors might be introduced in using a postprocess

User study configuration

- Task-related and background virtual objects
  - Math problems solving
- 5 user study scenes
  - Task-related objects number and moving trajectories



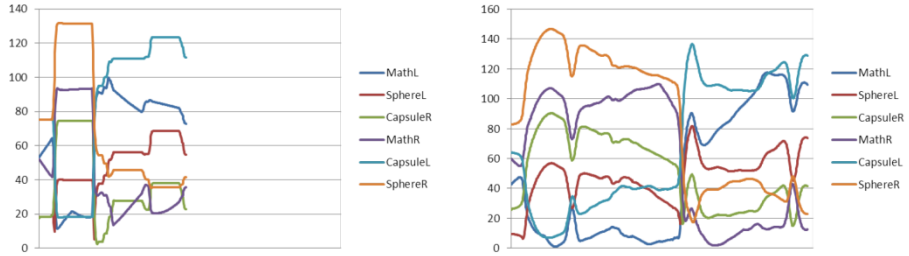


Main collected data

- Included angle between view direction and the vector from the camera to the object
  - It indicates how centered the object is in the camera
- Is a strong hint of the objects' visual attention degree from the participant

Result analysis

- 25 participants, backgrounds are diversified, all are familiar with how to navigate in desktop VR
- Only few have experienced HMD-based
- Play the scenes in both of the VR modes

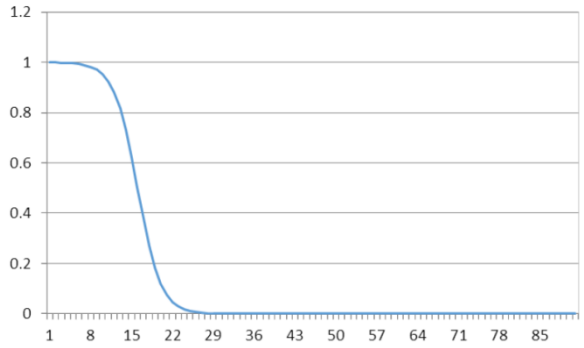


(a) non-immersive mode (b) immersive mode

Figure 2. Included angles of a participant with different objects in scene $2moveS$ use non-immersive (a) and immersive (b) methods respectively. X axis is time, and Y axis is included angles

Object-based attention quantitative equation

- A math model to give a higher value to the objects that have smaller included angles
  - which means they are being focused on
- Much lower values to larger included angles
  - which means the items are being mostly disregarded



Object-based attention quantitative equation

- A revised Logistic function

$$A(O) = \sum \frac{1}{1 + e^{k(deg-d)}} dt$$

where *k* denotes the steepness of the curve; here we use 0.5

deg denotes the included angle

d denotes the sigmoid curve's midpoint, the threshold of gazing included angles, we use 15°

The attention value is accumulated along with time *t*

Validate

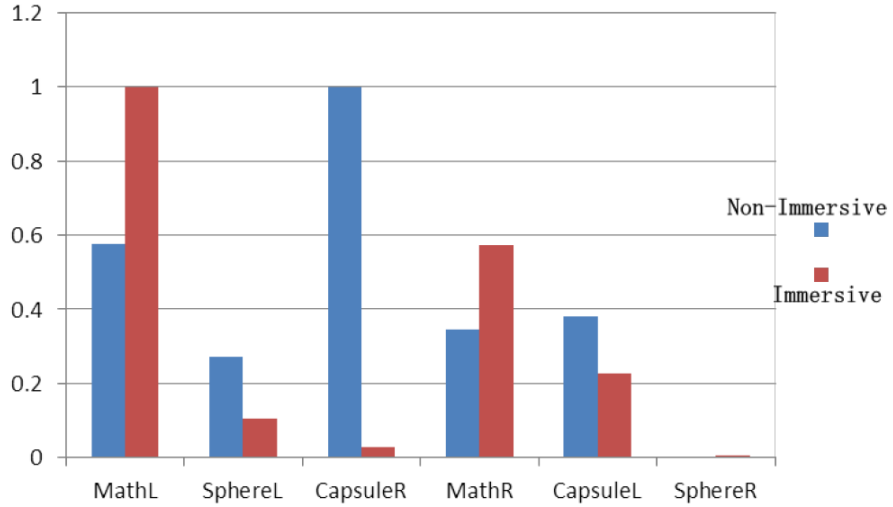


Figure 3. A user's normalized attention degree calculated by Equation1 in scene $2moveS$ using non-immersive and immersive modes respectively

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Application——personalized storyboard system in VR

- The attention equation is used as a criterion
- Key frame if an object received enough attention

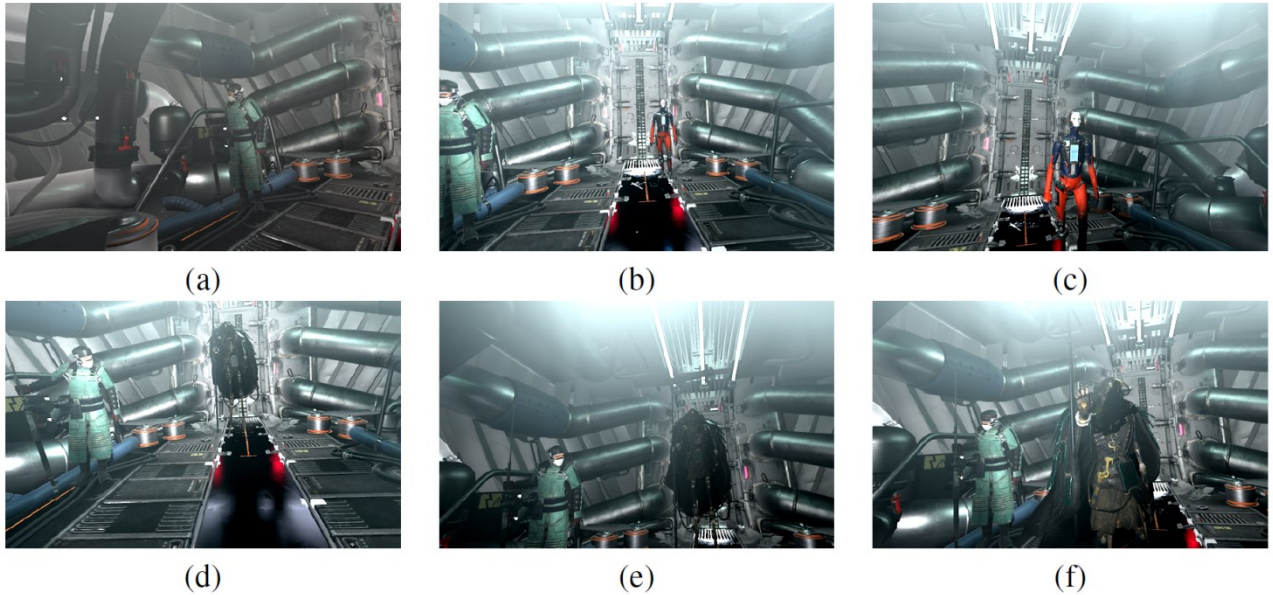

Figure 4. A participant's personalized experience storyboard captured by our system

Conclusion

- Verified hypothesis of head movement importance in immersive VR
  - Included angle is a strong hint for gazing
- Proposed a quantitative object-based attention evaluation method
  - Use the attention value to diagnose designed VR scene
- The equation is used to VR personalized storyboard system
  - Enrich user experience
  - An intuitive way for designers' review purposes.
- Can be easily embedded into current immersive VR applications
  - The eye tracking system is not necessary

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Thanks for watching
More results and the source code can be found @

Questions?