Enhancing the Experience, Decreasing the Cybersickness on Performance Video Watching for Virtual Reality Content Users

Introduction

A new performance watching paradigm has been introduced in the form of Virtual Reality (VR) where not by watching directly on the scene or by two-dimensional computer screen but by three-dimensional virtual scenes, which liberates people from travelling a long distance to the spot while present true-to-life, interactive circumstances. By wearing Head Mounted Displays (HMDs), people can get a sense of presence or immersion in the virtual environment. (Bangay & Preston, 1998)

However, a higher immersiveness can generate higher cybersickness. (Bangay & Preston, 1998; Lin, 2004), which will decrease the user’s enjoyment and experience. At least 60% of VR users report to have cybersickness in VR contents. (Rosa, Morais, Gamito, Oliveira & Saraiva) Cybersickness is not merely caused by technology factors but also by individual factors. (Jerome & Witmer, 2002) In previous studies, factors affecting motion sickness were exposure time, VR display type, degree of head movement, amount of screen movement in virtual environment, display lag phenomenon. (Lo & So, 2001)

Some of these factors has already been improved by modern HMDs, but even with good hardware implementation, improperly design content will cause unpleasant experience. (Porcino, Clua, Vasconcelos, Trevisan & Valente, 2016) There are rare research focusing on VR performance contents before, while the field does lie big problems. People feel dizzy after 5-10 minutes of VR using. (Kennedy, Stanney & Dunlap, 2000) The problem is most of the performance content takes more than 5-10 minutes. It is necessary to eliminate negative factor related to cybersickness in VR contents.

Hence, our goal is to investigate whether the speed, the duration, the genre and the color of VR contents have correlation with cybersickness, and provide guidelines for VR performance contents design.

Business Canvas

According to Goldman Sachs’s report (2016) [8], VR software market size will arrive at $35 billion in 2025. However, the market share of VR game is high, at $11.6
bn, while the market share of VR video entertainment is far lower than that, at only $3.2 bn.

![Figure 1. 2025 base case VR/AR software assumptions by use case [8]](image)

The reason, on one hand, is the paucity of VR performance contents production, on the other hand, is due to cybersickness, which is an obstacle in comfortable user experience. If the problem has been well solved, the VR performance can become a new art form with wide application prospect. Taking the following scenarios as examples:

**Scenario 1.** Korean pop star VR concert is going to enter Indonesia market, while the penetration of VR devices is low in Indonesia, many Indonesians have no VR experience before. It is likely to generate cybersickness among VR first-time users. If they feel cybersickness, they may refuse to use it anymore with fear. Vice versa, less cybersickness VR performance can make Indonesian users feel immersive and enjoyable, as well as can save travelling expenses to Korea.

**Scenario 2.** Top pop star’s concert tickets are usually been sold out within 30 minutes. People who haven’t got a ticket can choose a VIP seat of the concert just by wearing HMD at home.

**Scenario 3.** The handicapped who is inconvenient to move can watch favorite performance at home using HMD.

There are more possibilities in business model and forms of VR performance. Table 1 shows the business canvas of VR performance and Table 2 lists more possible forms of VR performance in the future.

**Table 1. The business model canvas of VR performance**
Key Partners
- Previous content provider
- Government
- Network resource provider

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<thead>
<tr>
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<th>Value Propositions</th>
<th>Customer Relationships</th>
<th>Customer Segments</th>
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<td>Local</td>
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Key Resources
- VR app service ecosystem
- Pools of good contents

Channels
- VOD
- Streaming
- Cable TV

Value Propositions
- Public service
- New experience
- Travelling expense reduction

Customer Relationships
- Customer pay for cheap and high-quality contents

Customer Segments
- Local
- Handicapped people
- People in foreign countries

Cost Structure
- Network fee
- Cost of installing wide-spreading pipe lines
- VR VOD market maintenance fee

Revenue Streams
- Customers get emotion fulfilling
- Pay for high-cost ticket
- By credit card

Table 2. The possible forms of VR performance in the future

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<th>Virtual</th>
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<td>Audience using HMD at home to watch real people performance</td>
</tr>
<tr>
<td>Virtual</td>
<td>Audience on the scene to watch virtual character performance or the avatar of real people performance</td>
<td>Audience using HMD at home to watch virtual avatar performance</td>
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</table>

Hence, the practical significance of this research is:

- To make it possible for users to watch VR performance which lasts for a long time.
- To alleviate cybersickness for VR first-time users and users with motion sickness before.
- To provide good VR performance contents helping open up more overseas markets and facilitate its popularization.

Previous Study of Cybersickness

Cybersickness is a kind of motion sickness based in virtual environment. A typical theory that explains the cause of cybersickness is the sense conflict theory. Sense conflict theory assumes that the two senses associated with motion induction conveyed by the two senses differ from the expectations based on previous experience, resulting in sensor conflicts, thus resulting in motion sickness. (Reason & Brand, 1975) Another theory is vestibular over stimulation theory, which claims excessive stimulation in virtual environment will cause controversy over otoliths or the
semicircular canals. (Regan, 1995) Users using HMD to watch VR contents can experience discomfort, nausea, dizziness or vertigo, disorientation, pallor, sweating headache or vomiting. (Kennedy, Lane, Berbaum & Lilienthal, 1993)

According to current literature, numerous factors in VR contents can contribute to generate cybersickness. And corresponding method has been proposed.

1. **Adjustment of visual acceleration.** High acceleration generates high vection sensation and sickness symptoms. (So, Lo & ho, 2001) The way to reduce cybersickness is to slow down the acceleration and stop it slowly to reduce the divergence between the two sensations. (Kim, 2016)

2. **Maximize degree of control.** Compared to passive viewing, direct manipulation of the virtual environment contributes to the implementation of the anatomical structure and helps the participants to maintain a clear reference frame during the interaction. (Jang, Vitale, Jyung & Black, 2017)

3. **Decrease exposure duration.** When the exposure duration increased, the total sickness will also increased. (Kennedy, Stanney & Dunlap, 2000)

4. **Decrease Field of View (FOV).** A high FOV will generate high degree of cybersickness, high degree of presence, and decline enjoyment. (Lin, 2004)

5. **Minimize latency.** A time delay experiment found that participants well notice the large latency, and make comments about the system sluggishness and unpleasant movement. (Draper, Viirre, Furness & Gawron, 2001)

6. **Simplify complexity in a scene.** Kim (2016) divided VR scene into center, back, left, right 4 parts, and found that putting the main character in central area and simplifying the other 3 area will reduce cybersickness.

7. **Minimize visual rotation.** Camera roll can cause severe motion sickness by generate a disparity between two senses that receive visual information and vestibular information. (Kim, 2016) Therefore, eliminating or minimizing camera rotation is a way to prevent cybersickness from happening.

8. **Appropriate cut transition.** If a person at right side is given an angle change with people at left side by cut editing, the VR viewer will feel that the whole environment rotates several times in a short time, which will cause cybersickness. To prevent this problem, using a full shot and a fixed camera can allow audience see the subjects at a glance. (Kim, 2016)

9. **Give motion cues.** Unreported motion cues can alleviate cybersickness in VR environment. (Lin, Parker, Laha & Furness, 2005) Therefore, put a visual hint that acts like a fixed frame in VR can reduce cybersickness. (Kim, 2016)

**Related experiments**

Concerning which factor show a dependence on the degree of immersion, Bungay and Preston (1988) designed tests to evaluate whether anticipatory excitement, comfort of the environment and impression of control affect immersiveness. It contained tasks to watch virtual roller coaster which has rapid orientation changes in the view point. The
evaluation had 143 participants watching virtual roller coasters, but they reported minimal cybersickness due to the lower degree of immersion. Bungay and Preston concluded that cybersickness shows a dependence on degree of immersion.

So, Lo and Ho (2001) focus on the effect of navigation speed on the level of motion sickness using VR4 LCD HMD, and finish an Simulator Sickness Questionnaire (SSQ) before and after the experiment. The evaluation compared eight different navigation speeds. So, Lo and Ho reported that vection sensation and sickness symptoms increased with increasing navigation speed from 3m/s to 10m/s RMS.

The work by Jeong (2016) is closely related to our work, both aims at finding the factors of cybersickness in VR contents. More specifically, the independent variables are point of view, direction of movements. They tested 21 participants with Oculus Rift Dk2, and requested them to fill the SSQ before and after the experiment. As a result, he concluded that first person viewpoint and rotation of Yaw axis in the direction of movements will cause more cybersickness.

However, to reach a convincing conclusion their participants are not enough, at only 20 people. Secondly, the SSQ only has scales described as “slightly uncomfortable” and “normally uncomfortable”, whose definition varies from person to person, which may cause deviation. Thirdly, in evaluating the direction of movements, participants cannot manipulate the direction of movement by themselves but being controlled, which will not actually happen in a common VR experience.

Table 3 lists the difference between our experiment and Jeong’s work.

<table>
<thead>
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<th>Table 3. Comparison of Jeong’s experiment and ours</th>
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<tr>
<td><strong>Jeong’s experiment</strong></td>
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<tr>
<td>Measurement</td>
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<td>Participants</td>
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<td>Independent variables</td>
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The innovativeness of this research is:

- Proposed specific index corresponding to 5 scale of SSQ.
- Used qualitative interview to acquire detailed user perception.
- Considered the speed, the duration, the genre and the color of VR contents as independent variables.
• Enlarge participants scales, ranges from Korean to Chinese, and focusing on 20s, who is the most active VR users.

References


