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The implementation and evaluation of the field of view in 3D PC game

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ABSTRACT

This research developed a 3D third-person game, made open and closed scenes, through experiments to investigate the field of view suitable for different scenes. Playing 3D games can sometimes cause 3D discomfort or motion sickness. There are many people who have this kind of 3D discomfort. In the research on this issue, the authenticity of the game or the physiological impact of the observer was discussed in detail; however, the impact of the design of the game itself was less discussed. The field of view in the game scene is likely to cause motion sickness. This experimental method uses the adjustment method in psychophysics to test whether the player is comfortable with different scenes. According to the test of different scenarios, the average and standard deviation of the most comfortable visual field are obtained. The viewing angles of different scenes are significantly different, and the best viewing angle of a closed scene is larger than that of an open scene.

1. Introduction

The phenomenon that causes motion sickness in games could not be ignored (Stoffregen et al., 2008; Yildirim, 2019; Stanney et al., 2020). For a game that players want to play, but because of this symptom, they gradually lose enthusiasm for the game, which is quite a pity for the player. If the player plays for a long time, it will cause headaches, dizziness, nausea, excessive sweating, and excessive salivation. Therefore, it is necessary to understand related diseases and precautions to solve the problem of motion sickness caused by 3D games.

The symptoms of dizziness during playing games are caused by hardware equipment problems or physical conditions. Motion sickness is considered to be the problem of eyeball aggregation, eyeball muscles causing visual fatigue or excessive brain load on the human visual physiology level. In these statements, it is found that the problems mostly point to the player's own physical characteristics (eyes or brain), or the lack of technical aspects of the playback hardware equipment.

Virtual reality (VR) games focus on the research of the hardware device level in reducing motion sickness, including the adjustment of physiological activities and light stimulation to reduce motion sickness. In the virtual reality game, head movement was used to manipulate the vehicle (Saito et al., 2020), and it was found that the x-axis movement was the most reliable. It could reduce VR diseases while ensuring better usability and realistic movement. For the virtual reality display of the head-mounted display (HMD), the optical flow could be controlled to reduce dizziness (Farmani and Teather, 2020; Kim and Park, 2020). The weakening of visual input in the simulator could delay the onset of motion sickness or reduce the severity of symptoms in some cases (Ishak et al., 2018). In terms of the effect of speed changes in VR content on the comfort of play, a constant speed was not more comfortable than variable speed profiles (Widdowson et al., 2021), and in specially calculated paths, users were less troubled by VR sickness (Becerra et al., 2020).

Viewers watch movies or games through the screen, and the gap between the viewer's field of view and the camera's field of view has an effect on motion sickness. Draper et al. (2001) investigated the difference between the camera field of view (internal field of view iFOV) and the player's screen field of view (external field of view eFOV), found that using iFOV=eFOV in the head coupling virtual interface minimizes motion sickness. In the computer game environment, different iFOV and eFOV settings were used, and the opposite effect was found (Bos et al., 2010). It was speculated that the relatively large difference between the iFOV and

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eFOV used in this experiment caused the discrepancy. There were fewer discussions about the impact of scene settings on motion sickness in 3D games during game production.

Console video games had an obvious risk of motion sickness (Stoffregen et al., 2008). When playing with different postures, displaying distances and angles, the incidence of motion sickness was between 42% and 56%, and there was no difference in different situations. Video games could cause motion sickness in many adults, and could also induce motion sickness in children (Chang et al., 2012), and it also occurred when watching movies (Ujike et al., 2008).

The game camera can be set in the screen configuration options to adjust the field of view. But in some unsatisfactory situations, we must edit the configuration file in the game directory. There is no correct or wrong field of view setting, if the closer to the screen, the higher the field of view setting. Just like the TV or monitor is the window to the game world. The closer you are to the window; the more outside world you see. The brain tells us that we expect to do this, and if the view seen from the screen (virtual or otherwise) does not match your proximity to the window, it may cause physical symptoms. In this research, we investigate the setting of the camera field of view in 3D games to reduce the occurrence of motion sickness when the player is playing the game.

2. Motion sickness

The development of technology has changed the living habits of human beings. People living in a stressful environment can relieve stress by playing games. The visual enjoyment brought by 3D technology not only appears in games, but also in movies and animations, but it also causes dizziness during the process of playing 3D games. We investigated the possible causes of 3D dizziness and ways to relieve 3D dizziness.

2.1. Causes of motion sickness

Motion sickness is a kind of civilization disease that appears with the development of 3D technology and virtual reality. 3D vertigo is a type of "motion sickness", and its cause is like seasickness. Realistic 3D images disrupt the brain's ability to process visual and auditory signals, causing an imbalance between the senses in the middle ear, which governs balance, and vision, leading to dizziness. Most people have varying degrees of 3D vertigo. There are many situations that cause 3D vertigo. The most common ones are watching 3D movies, playing first-person shooters and 3D games with a high degree of immersion. Some mobile phones, such as the iPhone's 3D dynamic desktop launched from the iOS7 system, also some users feel uncomfortable. With the advancement of technology, the picture quality of electronic products has improved, and the dizziness symptoms that may be caused will only worsen (Liu, 2016; 2010; Chen, 2010).

2.2. Mitigation method

Because the 3D game screen is much more realistic than the normal game, it will make the brain judge wrong. So, players can try to reduce the quality of the game, not only can make the program run more smoothly, but also reduce the impact of the screen on the brain.

Some games try to increase the sense of realism by causing movement in the camera. In different games, it has different names, but it is usually found in the settings such as "camera shake" or "realistic camera". Although the effect will make the game action more realistic, it can also make many people feel uncomfortable. Watching this movement when you are still being is usually enough to make you feel sick.

3. Methods

In the research on the three-dimensional perception and comfort of 3D images, it was proposed that the field of view and distance are the most likely causes of motion sickness (Lin, 2014). This literature mainly discussed the phenomenon of 3D animation. In this study, we are investigating the prevention of motion sickness in games.

This research uses experiments to understand motion sickness. The experiments in this research have psychophysical tests in open and closed scenarios. In the experiment, the player determines the most comfortable field of view and distance. A 3D third-person survival game developed in the research. The art style is a low-poly style. The background is set in the ancient continent. For the young warriors of the tribe, the survival process is a test of whether they are mature and independent. The protagonist is ready to show off in the ancient land. The functions of this game include collection and store systems. Players can freely explore on the map and find resources to maintain their survival. Players will also encounter warmth retention issues when exploring, which increases the richness and challenge of the game. The questionnaire is used to collect the players' answers to the comfort of different scenes and the sense of distance.

4. Experimental method

The experimental method uses the method of adjustment in psychophysics to measure the results (Cunningham and Wallraven, 2019). The method of adjustment is one of the oldest and most basic psychophysical methods. The adjustment method is mainly used to measure the difference threshold, but it can also be used to measure the absolute threshold. When using the adjustment method to measure the absolute threshold, the subject was asked to start from a point that was significantly greater or less than the absolute threshold stimulus in each experiment until the comparative stimulus seemed to disappear or began to feel. The absolute threshold required is the average of these points. The test method of this research is as follows:

1. Setting the field of view at 30^0 to exaggerate our described effect to allow the player to experience a high field of view that allows the brain to rest (the field of view that is most likely to cause nausea) for one minute and let the brain take a break.
2. Setting the field of view to a suitable distance for the viewing angle of 110^0 for the player to experience. After the experience is over, let the brain rest.
3. Finally, letting the player decide the distance of the field of view by himself, and the field of view is adjusted to find the most comfortable field of view.
4. After the player adjusts the field of view and distance he likes, the value of the game will be displayed after the experiment is completed.

5. Participants

The target age of the game is between 16 and 35 years old. The purpose is to hope that these groups who are more hurried and tired can have a way to relax. The subjects of this study are voluntary participants recruited from a university in Taiwan. The experimental population is between 19 and 21 years old. There are 50 participants (39 males and 11 females), and 6 of them are prone to 3D dizziness. dizzy. This age group is chosen because it has the most gamers and plays the widest variety of games among all age groups.

6. Procedures

This research mainly explores what kind of game conditions can reduce the user's discomfort during the game experience. Using the game "A Hat in Time" on the market as a reference, we will create similar scenes for experimentation. The experimental item is to test the player's perception of different vision and viewing distances in the test scene.

The experiment process is mainly to collect experimental data and analyze the experimental results. Participants who participated in the experiment played the game, first conduct an open scene test and then collected experimental data, and then complete the experiment after conducting the closed scene test and collecting experimental data.

The experimental scenes in this research are made by Unity. The characters are made with 3D software (3D MAX) and the height is 15 cm in Unity. The objects in the scene are made with the unity asset store, and two different types of scenes are created:

1. Open scene-The open scene we created is a big world village, forest, lake, etc. The game has a very large area for players to explore and find in the game (Fig. 1). This can greatly increase the playability of the game. The map size is 5230 cm in length and 2600 cm in width.
2. Closed scene-The closed scene is a cave (Fig. 2). The game scene is quite a small map compared to the open one. Players can only explore along the route we have planned. Follow our planned route to the exit. The map size is 680 cm in length, 220 cm in width, and 130 cm in height.

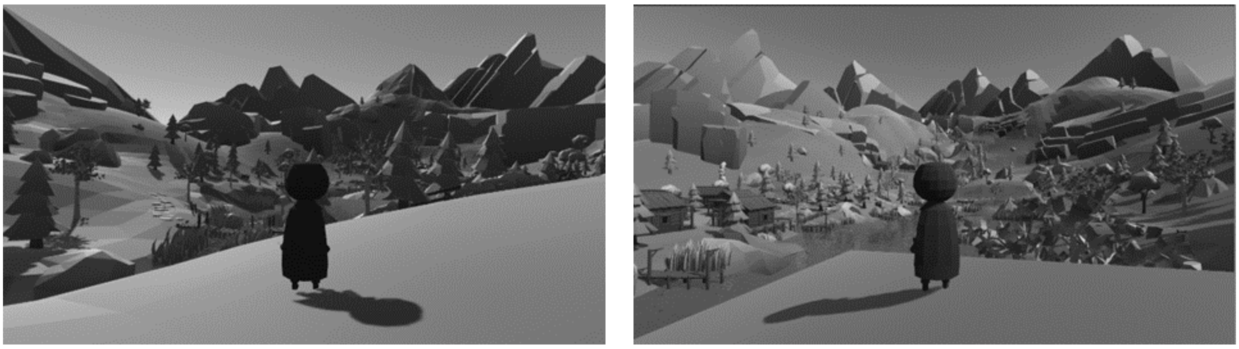

Fig. 1: Open scene

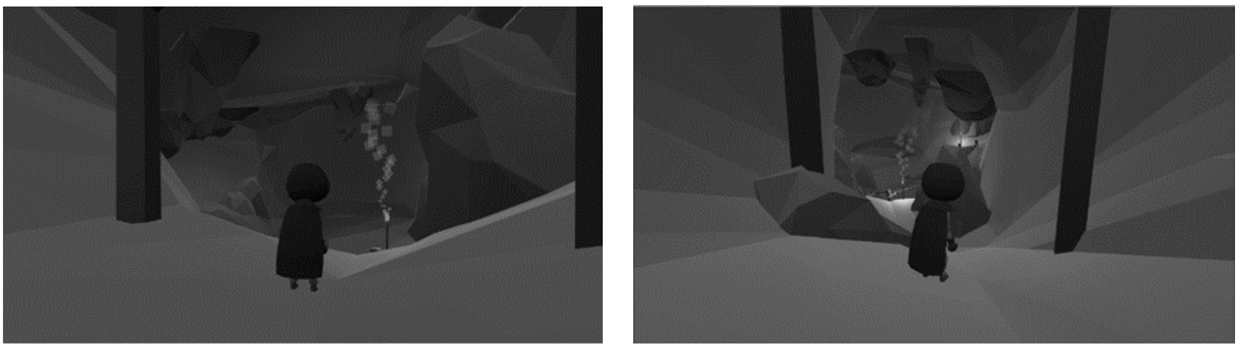

Fig. 2: Closed scene

7. Results

In the experiment, the comfortable view angles of open and closed scenes were obtained (Fig. 3). The best viewing angles of the 50 subjects who participated in the experiment showed that the average value of the open scene was 61.32^0 and the average value of the closed scene was 63.08^0. That is, closed scenes were suitable for larger viewing angles. From Fig. 3, we could see that the best viewing angle of the subjects was about 55-69 degrees. The average of the open and closed scene angles was 62.2^0 and the standard deviation was 5.7^0.

Perform correlated t-test on the viewing angle of the open and closed scenes. Investigate the impact of different scenes on the viewing angle, and the results ($t(100)=11.37$, $p<0.05$). Table 1 shows that there were significant differences in the best viewing angles of different scenes. Repeated measured ANOVA analysis ($F=2.02$, $p>0.05$) showed that there was no significant difference in variance.

Fig. 3: A scene with the comfortable viewing angle

Table 1: Results of the difference between best viewing angles of open and closed scenes

Viewing angle of open scene Mean (SD) (n=50)	Viewing angle of closed scene Mean (SD) (n=50)	t(p)
61.32(5.85)	63.08(6.52)	2.45(p<0.05)

The best visual effects in the game may be accompanied by motion sickness. Because the critical range of comfort is close to the best three-dimensional effect data, if you want to have the best effect, you will feel uncomfortable when you change the value. The best effect and the best comfort sometimes cannot be produced together. To avoid conflict between the two, it is necessary to balance the two in game production to achieve a reasonable balance.

Some special places of the game will be changed, for example: When you are in a negative state or when you pass through a narrow place on the map, you can adjust the distance and vision. Because these situations do not occur frequently, it will increase the game effect without causing discomfort.

8. Conclusion

Motion sickness caused by playing 3D games, the current explanations are mostly focused on the authenticity of the game or the differences in the physiological aspects of the viewer; however, the game itself is rarely discussed. It may be that there are problems in the design of 3D games that induce discomfort in human vision and the brain. There are many people who have this kind of 3D discomfort. It is a pity for the player to gradually lose enthusiasm for the game because of this symptom.

Through discussion and investigation, it is found that the field of view and distance are the causes of motion sickness. Open and closed scenes are made in the developed game, and experiments are carried out with adjustment methods in psychophysics. Let the player decide for himself the most comfortable field of view. According to different scenarios, the average value and standard deviation are obtained by testing.

The experimental results show that there is a significant difference between viewing angles of the open scene and the closed scene. The best viewing angle of the closed scene is larger than that of the open scene, while the standard deviation of the viewing angle of the closed scene is larger but there is no significant difference. Studying the effects of FOV on motion sickness in different environments will have completely different results (Draper et al., 2001; Bos, 2010), which shows that the causes of motion sickness are complicated. In this study, it is shown that the scene is also one of the factors affecting motion sickness, which also confirms that the FOV is an important factor affecting motion sickness.

The best viewing angle and distance of view obtained can be used to make scenes, so that the game can prevent motion sickness, and players can enjoy the game. The final result can provide anyone who needs the data, and allows producers who want to make games to find useful resources quickly and easily.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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