The Benefit of a Regression in VR Game

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Abstract. Nowadays, the Virtual reality advances in a startling speed. More and more game company start to make VR games. There are five types of VR game: Non-immersive Virtual Reality, Fully Immersive Virtual Reality, Semi-Immersive Virtual Reality, Augmented Reality, Collaborative VR. However, this article only talks about semi-immersive virtual reality. Semi-immersive virtual reality which provides a three-dimensional space by headsets is the combination of non-immersive and fully-immersive virtual reality. This article will explore the relationship between Degree of Freedom and semi-Virtually Reality Game. Even though most of the people believe higher the Degree of Freedom is greater the game itself is, this work believes even in Virtual Reality Games, high or low Degree of Freedom server certain purposes but never defines a game's quality. This paper made two versions of a VR game called In the Castle: one version is low Degree of Freedom, the other is high Degree of Freedom, and organized several experiments to explore the benefits of the low degree of freedom. The result of the experiments shows that the low degree of freedom in VR game can help players concentrate on the game and simplify the preparation.

Keywords: VR Game; Semi-immersive; In the Castle; Benefit.

1. Introduction

People always divide a concept they found into different parts or levels. For instance, the concept of dimensionality is separated into 10 levels. Human beings are living in a three-dimensional world now. Though people cannot even imagine what will the higher levels of dimensionality be like, they predict those levels are existed. This happens in Virtual Reality too. Some scientists and researchers divide virtual reality into ten levels. However, all the VR apparatuses people using today are at the same lever, no matter the most cutting-edge technology or one [1-2]. This is because the distance between different VR levels is too big to cross over by human beings just like that between three dimensions and four dimensions. Since the levels of VR are nearly impossible to change, the scientists choose to use degree of freedom (DoF) to refer nowadays VR development. Most of the VR apparatus companies are trying to update their VR equipment to higher DoF. Simultaneously, VR game companies also find the higher DoF is more appealing to players, so they develop their games based of higher DoF [3].

It is worthwhile to emphasize the concept of DoF, even though most of the people already know it. The terms degrees of freedom are used to describe in the final calculation of a statistic the number of values that are free to vary (Degrees of freedom, 2008). Translational and rotational movement both are three degrees of freedom movement(3DoF), since in a three-dimensional world, there are three directions of translational and three rotational movements [4]. However, 3DoF in VR is not referring to translational movement but rotational movement. Scientists gave the definition that 3DoF VR apparatus allow a user to look up or down, rotate left or right, or pivot left or right [5-6]. This is very easy to understand that why 3DoF VR is not allow translational movement but rotational. The VR's biggest advantage is the 360 degrees of view, so if 3DoF VR only offers translational movements, this advantage will be refrain. On the other hand, if 3DoF VR only allows users to rotate their view, they can still enjoy the impressive scene in VR. Six degrees of freedom (6DoF) VR is easier to understand. It is the combination of two kind of 3DoF which allows users to do all the translational and rotational movements.

Most of the VR games company already made their games into 6DoF VR games, but this work is exploring the advantages of 3DoF VR games compare with 6DoF VR games. What benefits can this regression bring?

2. Relate Works

Limitations on players movement seem to be a disadvantage of a video game, since the players have less choices, so called freedom, for their decisions. However, this is a misunderstanding on games' mechanics: mechanics' purposes are letting players make appropriate decisions. Here is a good example of phone side game called Rusty Lake Roots that limit players ability for moving. Rusty Lake Roots is a popular 2D puzzle solving game by Rusty Lake [7]. However, it has a merit that different from people's common impression of 2D puzzle solving games. Most of the 2D puzzle solving games allow player to move their view inside a two-dimensional space for clues by stroking the screen, whereas Rusty Lake Roots does not allow players to move their view instead putting all the information in one fixed picture (Figure 1).



Fig 1. Rusty Lake Roots

This means that the characters in common puzzle solving games have two degrees of freedom since they can move up ward or down ward, where as the characters in Rusty Lake Roots have no degree of freedom [8-9]. It seems like the Rusty Lake Roots is inferior than common puzzle solving games. However, the players in Rusty Lake Roots spend more time for collecting information and solving puzzles comparing with other puzzle solving games players who need to keep adjusting their view for having the situation well in mind. This is what the game producers want. They do not want the player be disturbed by the ability of view-moving or even miss some clues when players cannot see the whole picture of scenes. In fact, this mechanics really works. Players of Rusty Lake Roots love it, since it is such a pure puzzle solving game where players do not need to make any meaningless action.

Form the example of Rusty Lake Roots, it can see the potential benefits of limitations on players movements. Here is a opposite example that will tell us the consequence of no limitations on players movements. Hitman: Codename 47, released in the US. on November 19th, 2000 for PC through Eidos Interactive, is a third-person stealth game developed by IO Interactive (Hitman: Codename 47 Track Listing) [10]. In this game, the players have exactly six degrees of liberty that characters in it can move all directions. This seems to be a very interesting and appealing game. However, the players' ability for moving all directions bring many problems to this game. Since the players in this game can move around and look all directions, they may spend too much time to look for the items that are required for missions. In addition, the players' freedom of actions can really destroy the plots and characters' setting. For example, the Codename 47 should not jump on the table when his boss is telling him the missions, but the players can do this by simply press their keyboards [11].

From these two examples, it can know that high degree of freedom is not a good term but a neutral term that can bring both advantages and disadvantages. Since this work want to explore the advantages of low degree of freedom VR games, this paper developed a simple puzzling solving VR game called In the Castle. The biggest feature of this game is that this game does not provide any method for players to move around. In other worlds, players can only change their view through

rotating their head. This work hopes this feature can help players focus more on the puzzle solving just like that in Rusty Lake Roots.

Apart from the forementioned advantage of low degree of freedom, this work also expect that the limitation on players' moving ability can avoid to miss information or hints. This is very important in VR game, more important than in two-dimensional game like Rusty Lake Roots. To clarify, since in VR game, players have 360-degree view, resulting that players can only see a very small proportion of the scene, they may easily overlook some details.

3. Method

3.1 Game Outline

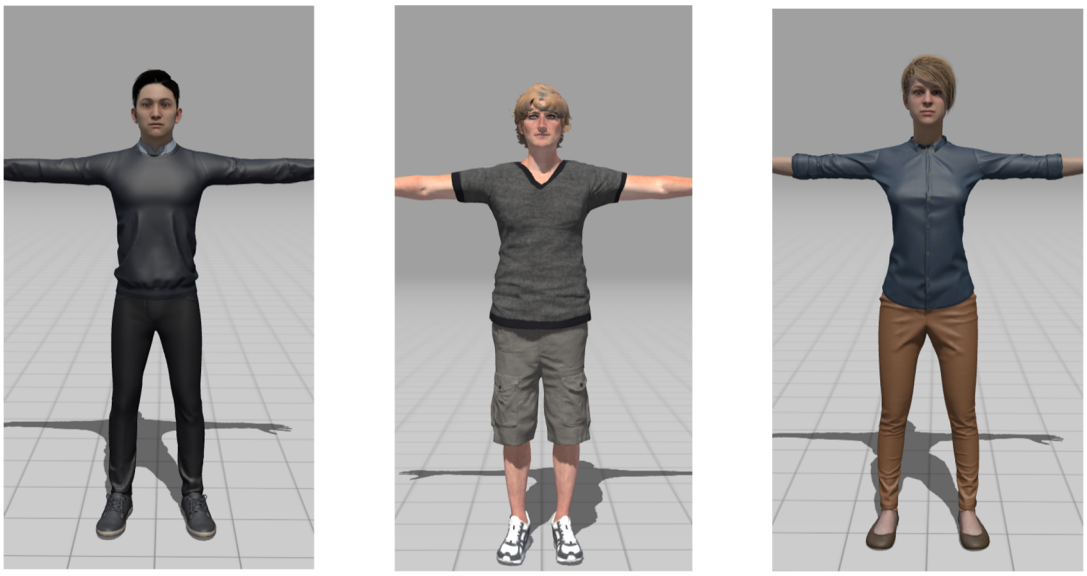
An introduction for the game is necessary. The game's background is in medieval Europe. The game's story is based on a crime and the process of the game is following the detection of the crime. The protagonist of the game is Alger.

3.2 Characters

Alger is a medieval detective in his mind world. In the game, the players will play the role of Alger to solve a homicide case in Alger's mind world. In the case, Andrew and Nicklaus are the victims. However, the Alger is not the detective but actually the killer in this case who killed Andrew and Nicklaus. Furthermore, the Alger is a killer who has Irritability disease of a modern crime, in the real world. When Alger received the mental treatment, the psychology doctor asked Alger's motives. Thus, Alger built a mind world for looking his motives. The final goal for the players is to realize and summary the whole story happens in this game (Figure 2).

Nicklaus is a virtual character in Alger's mind. In the story, Nicklaus is the boss of Alger who treated Alger haughtily. When Nicklaus was dealing with Andrew, they had some conflicts and dissensions. The Nicklaus ordered the Alger to kill Andrew for his benefits. However, he never thought that after Alger killed Andrew, the Alger will use the axe to kill him. Then the Nicklaus became the second victim.

Andrew is a business man who wanted to cooperate with Nicklaus, but she could not accept Nicklaus's request. Thus, she teared the protocol. Next day, she saw that the Alger stood in front of her room with an axe. The Andrew became the first victim.



(a) Alger (b) Nicklaus (c) Andrew

Fig 2. The characters in the game

3.3 Scenes

Based on the example of Rusty Lake Roots, the limitation on players' ability of moving should help them focus on puzzle solving. To further eliminate the meaningless factors which disturb players, this paper tried to make scenes in the game as simple and essential as possible. Thus, in the game scene, only important items are interactive. The tables and bookracks which are irrelevant to game progression only have the collision volume. About the sound effect of the game, this paper tried different types of background music, but eventually this paper only applies interactive sound. This is because that this paper wants the game progress in a relatively quite environment which will not disturb players. The scenes still need to match the story of the game. Thus, some decorations and settings are necessary.

In the first room, the vases, books, and cases are interactive. The players need to find a way to open one of the cases and use the key inside the case to open the door which connects the second room. Two methods are available. First, they can use the blunderbuss on the floor of the room. The second way is that players can use the books on the table to figure out the code of the case. Then, players can move to next room (Fig. 3).

In the second room, there is no puzzles. Instead, the story progress in this scene. The players need to determine who is the killer among Alger, Andrew, and Nicklaus. Then after determine who is killer, the Alger will wake up from his mind world to the third room in real world (Fig. 4).

In the third room, the players need to realize, from the conservation with the psychological doctor, the character they consider detective is actually a killer. When player figure out this, the game ends (Fig. 5).



Fig 3. The First Room



Fig 4. The Second Room



Fig 5. The Third Room

4. Results

From the description of the game's process, it is easy to notice that this game does not provide any real puzzles like that in Rusty Lake Roots. Since the purpose of this game is to explore weather the limitation on players movement will affect players' progression, this paper does not want the player progress by playing several individual puzzles. Instead of this, this paper hopes the player looking for details and hints inside a big scene. By doing this, it can really test the limitation's effect on players' abilities of looking for details.

4.1 The Effect of Low Degrees of Freedom on the Player's Puzzle Solving Efficiency

To test that weather the limitation on players' moving ability can let players more focus on puzzle solving, this paper designed an experiment. To achieve the purpose of our experiment, our programmer changed the code of the game in order to cancel the limitation on players' moving ability. Then, this paper had two exactly same game except that one game allow players to move their characters by walking around and the other do not allow. After that, this work gathered ten persons, and divided them in to two groups. A group would play the original game, and B group would play the changed game. This paper measured the time that each player spent on completing the game.

The table 1 records how many people spend certain time to complete the game.

Table 1. People spend certain time to complete the game

Time	Group A	Group B
Less than 10 minutes	1	0
10~20 minutes	3	3
29~30 minutes	1	2

The figure 6 represents the average time that A and B group's member spend to sol the puzzles.

In group A, one person spent less than ten minutes to finish the puzzles in the game, three persons spent more than ten minutes and less than twenty minutes, and one person spent more than twenty minutes and less than thirty minutes. By contrast, no one finishes the puzzles less than ten minutes, three persons finished the puzzles within the range ten minutes to twenty minutes, and two persons finished the puzzles within the range twenty minutes to thirty minutes. The group A players spent average 15.9 minutes to solve the puzzles, while group B spent average 23.5 minutes to solve the puzzles. The result shows that the players in group A spent relatively low time to finish the puzzles in the game. This is strong evidence suggesting that the original game which has limitations on players moving ability can help players focus on puzzle solving.

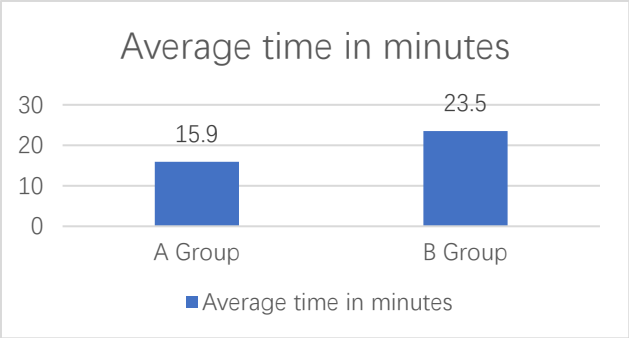


Fig 6. Average time in minutes

4.2 Other Benefits of Low Degree of Freedom in VR Games

After analyzing the data, this work also asked the players that is there any factors causing them spent more time on solving problems than they expected. The table 2 records the comments of players in different groups.

Table 2. The comments of players in different groups

Comments	Group A	Group B
Nothing disturbed	2	1
The game's immature mechanics	2	1
The movement of the character is distracting	0	1
Cannot find the keys and hints in the game	1	2

Despite the immature mechanics of our game, the data shows that the players in B group are more likely to complain the movement of the character is distracting and the hints are difficult to find. Even though this data is very rough, it can see the effect of the limitations on players ability of moving in VR puzzle solving games.

Beside of this, it also asked the total impression for this game. Surprisingly, some of the players in A group state that the preparation for this game is easy. This work never considers about the preparation for the game. However, this is fairly easy to understand, because the A group played version with limitation on moving ability. Since the players are not allowed to move, they do not need to find a space in reality for this game.

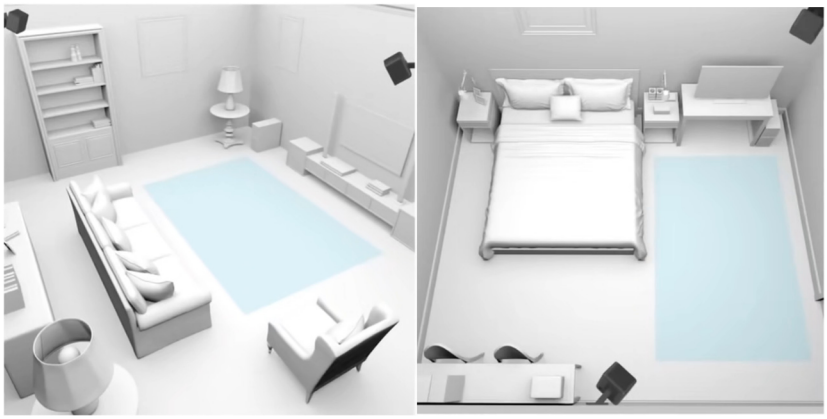


Fig 7. The official space requirement for VR games

These two pictures (Figure 7) are adopted from index valve's offical website which show the space that require for the VR games. Not only the questions of space, the apparatuses of VR games are also difficult to apply. All these will let the preparation for VR games become more difficult. However,

the games that do not need the movement of players to control the displacements of protagonist do not need all those complex preparations.

For instance, the Index Valve (a VR apparatus brand) has Index Base Stations to scan players' body movements. It is a very sophisticated device, but its setup is very difficult. If a user of Index Valve wants to use Index Base Stations, he/she needs to use screws to fix the device on the wall. Further more, the distance between two stations and the angle are both important for the base stations. On the other hand, if the player does not need to trace the displacements, he/she does not need to apply these devices.

5. Conclusion

In this article, this work used VR game In the Castle illustrate that the low degree of freedom can also bring benefits, and organized several experiments to clarify this. From the forementioned experiments, it can see that low degree of freedom cannot only help players focus more on puzzle solving games, but also let players avoid overlooking the clues. Furthermore, low degree of freedom games requires less space. Thus, the players can use more time to enjoy the game instead of finding space for games or setting devices for games. In other words, the preparation for low degree of freedom VR games is easier than that of high degree of freedom VR games. The advanced technology such as high degree of freedom in VR is necessary for human society's progression. However, this never means that the advancing technology is better than the old technology.

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