Virtual Reality Approach in Treating Acrophobia: Simulating Height in Virtual Environment

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Abstract— Acrophobia is a scientific term used to describe the fear of height. To some people, this fear is manageable, but to others, the fear could pose danger to their life if it stars to interfere with their day to day activities. The conventional treatment for acrophobia is usually done through exposure therapy, where individuals suffering acrophobia will be gradually exposed (physically) to height. The disadvantage of conventional treatment is that it could put the sufferers in life threatening situation. Therefore, the goal of this study is to investigate whether it is possible to create the presence of height using a simple 3D virtual environment, which later could be used in exposure therapy for acrophobia. The system consists of a multimedia workstation, a Head Mounted Display (HMD) and a virtual scene of a busy city surrounded by tall buildings. The experiment consists of the user being gradually lifted up and down on an open elevator hanging outside one of the buildings. Set of questions were being asked to each participant after the experiment, and the results shown that with simple 3D virtual environment, the simulation of height is achievable.

Keywords— Virtual Reality, Acrophobia, 3D Environment, Virtool

I. INTRODUCTION

Acrophobia is characterized by marked anxiety upon exposure of heights, by avoidance of heights, and by interference in functioning as a result of this fear [1]. If left untreated, acrophobia could significantly reduce the quality of life of the sufferers. Current or traditional method of treating acrophobia is through method called graded exposure in-vivo, where the sufferers will be gradually expose to a hierarchy of feared stimuli, where the fear will first increase, and gradually diminished as the exposure being repeated [2]. Using the in-vivo treatment, the sufferers will be exposed to the real stimuli,

such as climbing on the stairs of 10 storey building.

Another approach is to conduct the in-vivo exposure using Virtual Reality (VR) where the sufferers will be exposed to the stimuli created by the virtual environment. VR lets people act within and upon computer-generated environments, making it ideal for exposure therapy [3].

Lots of research have been carried out to test the effectiveness of treating acrophobia using VR environment [4] – [6] including the experiment to compare the effectiveness between exposure using VR and in-vivo therapy [7].

Our main objective is to find out whether it is possible to create the presence of height using a simple 3D computer generated environment. The term simple here refers to a system consisting of a multimedia workstation, HMD and the 3D environment. The environment was created using Autodesk Maya (a 3D modeling tool) and the VR interaction was achieved using Virtools (a tool for creating highly interactive 3D applications). We presume that if the presence of height could be created, then the treatment would be feasible. The effectiveness of the treatment and how the treatment should be done are out of the scope of this project.

II. DATA GATHERING

The research started with data gathering where sets of questionnaire were distributed to 150 randomly selected participants (Malaysian public ranging from students to professionals). However, out of those 150 responses, only 136 responses were accepted while the rest (14 responses) were rejected. The responses were rejected due to incomplete answers given by the participants (there are some parts that the participant did not fill in) or the answers given are not consistent with each other.

The questionnaire was divided into three main categories: demographic information about the participants, types of phobia and a specific section specifically designed to be answered by acrophobia sufferers. This specific section was designed with the objective to obtain information on symptoms experienced by acrophobia sufferers when they are exposed to high altitude environment and the conditions that could make them feel safe being at high places.

Fig. 1 shows the types of phobias suffered by the participants. The participants were asked to select the phobia

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they are suffering and for each of the selected phobia, the participants were asked to rate the severity of their fear from 1(least severe) to 3 (most severe). Option 1(least severe) refers to situation where the participants, despite of experiencing all the symptoms, are still able to manage their fear of height.

telecommunication tower or construction site. This figure shows that having exposed to height could not assure that someone would be freed from acrophobia.
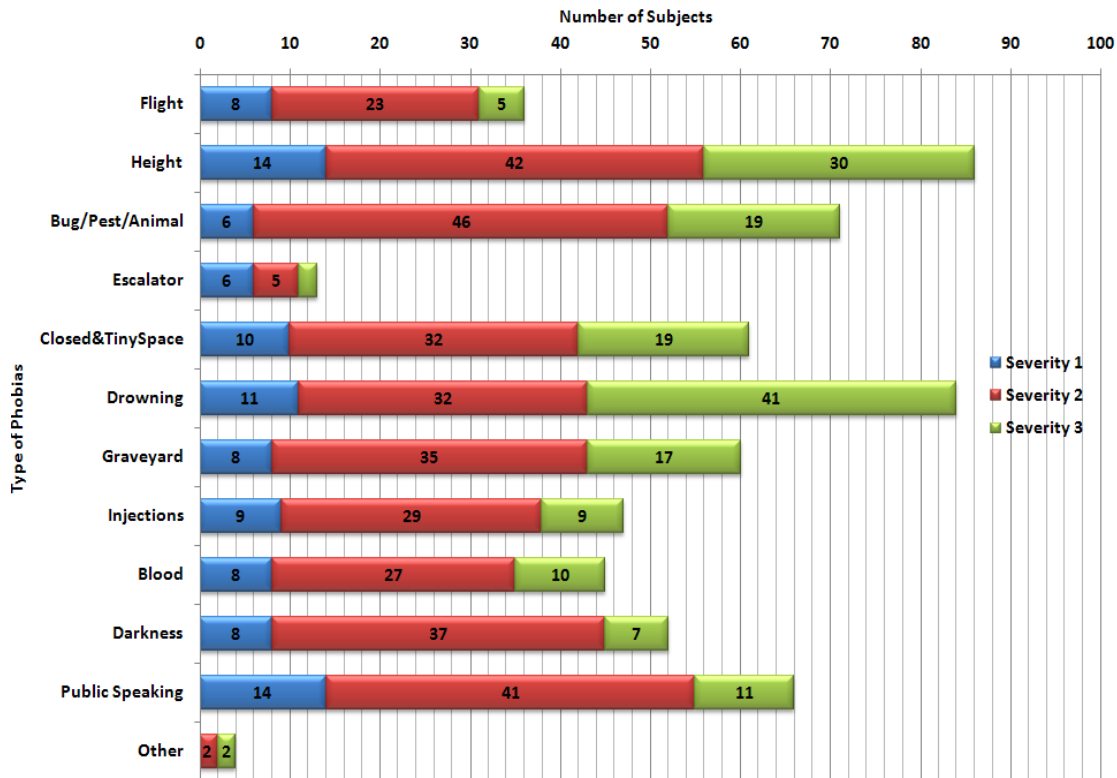

Fig. 1: Types of phobia suffered by Malaysian

This group of participants would still be able to go out to a balcony on the 10th floor even though to do so they need to hold tight to the railing. Option 3 refers to situation where the participants suffer fully-fledged panic attacks with all the associated disabling symptoms and start to avoid high places. Option 2 refers to participants whom while they may not starting to avoid high places and experiencing panic attack, they find it very difficult for them to manage their fear, to which extend that they need assistance.

Fig. 1 shows that 86 out of 136 participants reported having problems with height, with 30 of them experiencing severity level 3, which justify the need of research in treating acrophobia. From the result, it could be concluded that even with a small sample of randomly selected participants, acrophobia is one of the most commonly suffered phobia among the participants.

From 86 of people who suffered from acrophobia, surprisingly 12% of them have experience in working at high places. In this context, working in high places refers to people that perform work-related tasks at transmission or

Participants were also asked about their preferred methods to treat their phobias. Fig. 2 shows that 93 of participants choose to treat phobias by self-effort.

44 participants chose gradual exposure. Gradual exposure means the avoidance behavior is broken by exposing the participants to a hierarchy of feared stimuli (height level), whereby the fear will first increase, after which habituation will occur and the fear will gradually diminish [2]. The number suggests that there is demand for exposure treatment, and as virtual environment is able to evoke stimuli similar to the real phobic situation, it could deliver the equivalent of in-vivo exposure within the therapist's office.

Apart from gradual exposure, the other treatment methods chosen by the participants are reading relevant materials (15), joining the support group (18), making research through the Internet (16), going for counseling (14), going for hypnosis (3), taking medication (6) and using virtual reality (9). Quite a large number of participants chose not to receive any treatment. They made such choice because they felt that the phobia did not interfere with their day to day activities.
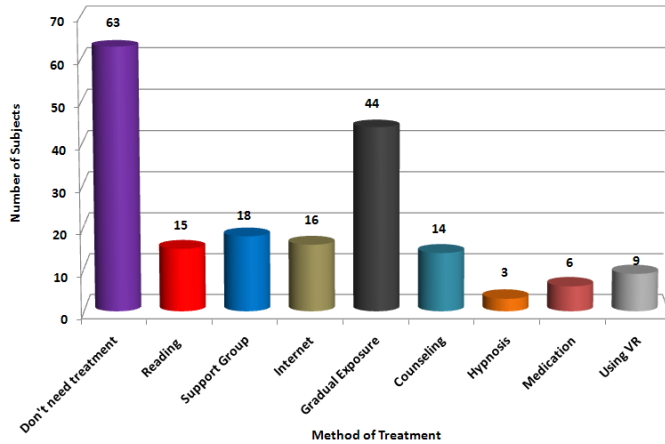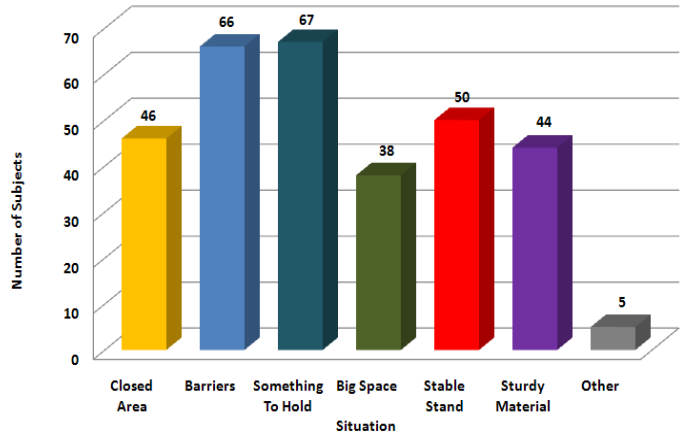
Fig. 2: Preferred Method of Treatment

This study has several additional purposes, one of which is to study the common symptoms felt by the sufferers when they placed at high altitude environment. The result shows that majority (68) of the sufferers experience fast heart beat rate, followed by hand/leg becomes weak (33), feeling dizzy (31) and sweating (30). Numbers of responses of other symptoms are shown in Fig. 3.
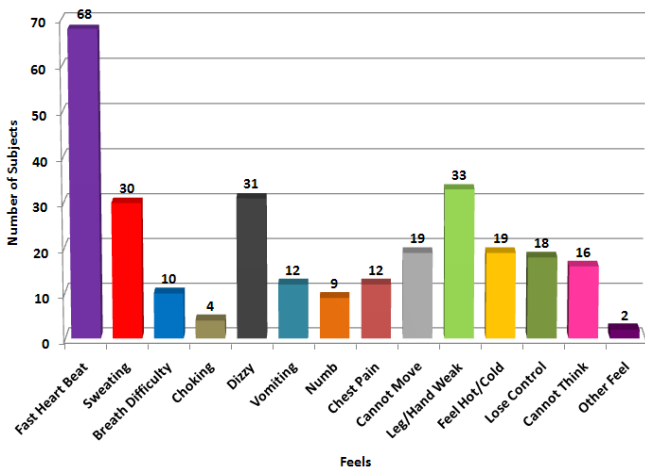

Fig. 3: Symptoms felt by acrophobia sufferers when placed at high altitude environment.

Another additional purpose of this study is to identify situations that could make the participants feels safe when they are placed at high places. Fig. 4 shows that most sufferers would feel safe if they have something to hold on to (67) and if there is a barrier around them (66). 50 sufferers also acknowledge that they would feel safe if they stand on a stable and sturdy surface.

Fig. 4: Condition that made the sufferers feel safe being at high places.

III. THE ENVIRONMENT PROTOTYPE

A prototype environment was developed to test the treatment approach for acrophobia. It was developed using a 3D authoring tool called Virtools. Detail implementation of the environment will be discussed in the following sections. The environment developed contains scenery of a small town with high building scattered around the surroundings. A number of high buildings were created to simulate the scenario of a sky scrapper city. A construction elevator was hanged at the highest building in the environment. Moving cars as well as helicopter were included to enhance the realism effect of the city. Stereotype sound of helicopter and cars moving around were included as well as the sound of wind. Stereotype sound was used so that the sound is projected dynamically rather than static. For example, when the helicopter moves to the left hand side of the user, the left speaker will be louder compared to the right speaker.

Fig. 5 shows a snapshot of the environment seen from the elevator at the 45th floor of the tallest (60 floor) building.
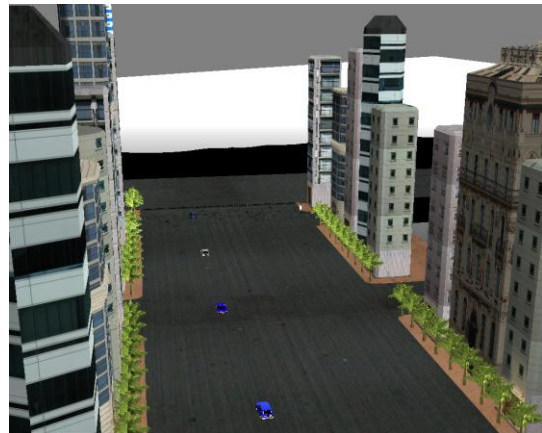

Fig. 5: View seen by the 45th floor of the main building.

A. Implementation Methodology

The implementation methodology of the system is shown in Fig. 6. The whole environment is modeled using MAYA. The environment consists of buildings, road, grass and trees. Additional objects include helicopter and cars to add-in the realism effect into the scene. The environments are then exported to Virtools. Virtools handles the interactivity. The detail process of each step of the modeling and interactivity set up will be described further in the next section. HMD is used as the output device.

Model the 3D virtual environment in MAYA

Export the model into Virtools

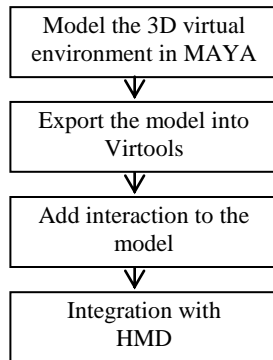Add interaction to the model

Integration with HMD

Fig. 6: The implementation methodology

We used Virtools as the authoring tool for the environment because it is easy to develop the interactivity with Virtools. The nature of Virtools, which is using modular based approach on the development of the environment, allows us to quickly change the setting and configuration of the environment to what we desired. Other than that, Virtools allows us to integrate our environment to the VR devices quickly. For example, we do not have to go through the programming troublesome to connect the environment to HMD.

B. Modeling the Environment

There are seven different types of building being created. The building which the construction elevator was hanged was created by extruding the polygon cube and applying the Lambert material with a transparency effect. It was also designed to be the tallest building in the environment. This it to ensure that the elevator can reach the highest point in the environment which will enable the user to see the roof of other buildings. Fig. 7 shows the shape of the building for the construction elevator.

Fig 7: The shape of the building where the construction elevator is hanged.

Next are all the other buildings that will fill up the rest of the environment. All the six buildings are created by using polygon and texture mapped. Fig. 8 shows some of the buildings created.

Fig. 8: Other Buildings.

The environment terrain was created by sculpting a plane to represent the pitch and slope of a terrain and texture mapped using the picture of grass. Fig. 9 shows the snapshot of the terrain.

Fig. 9: Terrain Modeling.

We also added in some trees in the environment. The trees were placed in every corner of the road and in front of the building. The trees were taken from the built-in models provided in Maya. The picture of the trees used in the environment is illustrated in Fig. 10.

Fig. 10: The Trees Model

In the effort of making the environment to be more realistic, we include the stereotype sound of each object in the environment such as the helicopter, the wind, the elevator and the car passing by. We attached each sound to related object. For example, the elevator sound was attached to the elevator; the car sound is attached to the car and the sound of helicopter to the helicopter itself.

By attaching the sound to the object, it was easier for us to simulate distance in the virtual environment. The further away the object to the character that we are controlling, the softer the sound will be. The nearer we are to the object, the louder the sound will be. However, the wind sound was not attached to any object but was set as background. We configured the sound of the wind so that it could only be heard when the elevator is raised to a certain height. The sound was disabled when the elevator is on the ground. Fig. 11 shows the snapshoot of the sound set up in Virtools.
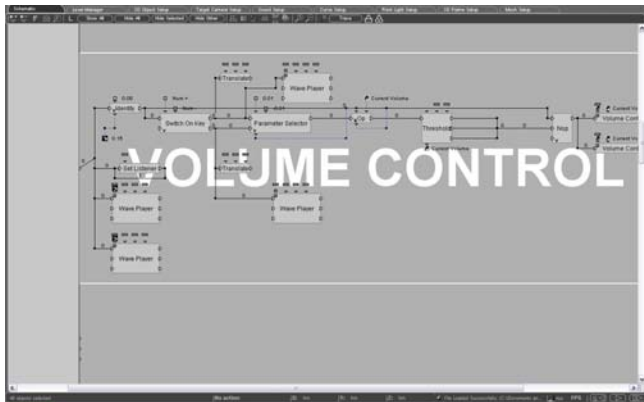

Fig. 11: Sound configuration in Virtools

C. Environment Interaction

To replicate the user movement in the environment, we created a character to represent the user in the virtual environment. To move around the environment, the user basically will need to control the virtual character. As the character move around it will automatically update what user see inside the virtual environment. The view that the user sees was attached to the character through the use of camera.

We applied collision detection in the environment to avoid the character from walk through the object inside the environment. The implementation of the constraint is applied using one of the Virtools building block or modules called *Object Slider.* The usage of object slider will allow us to simulate the collision detection. When the character controlled by the user collide with the object in the environment, the character will slides along the object surfaces.

Character Controller Building Block is used to add animations (e.g. move forward, backward, jump, and run) to the character. Each of the animation is assigned to the arrow key on the keyboard using *Keyboard MapperBbuilding Block*. The *Keyboard Mapper* allow us to create a controller for the user. The limitation of hardware possession forcing us to rely

on the keyboard as the interaction device in interacting with the environment. The *Character Keep-on-floor Building Block* is used to keep character in a user-defined floor which in our case is the road. Fig. 12 shows the detail set up of the *Character Controller* and *Keeps-on-floor* building block.
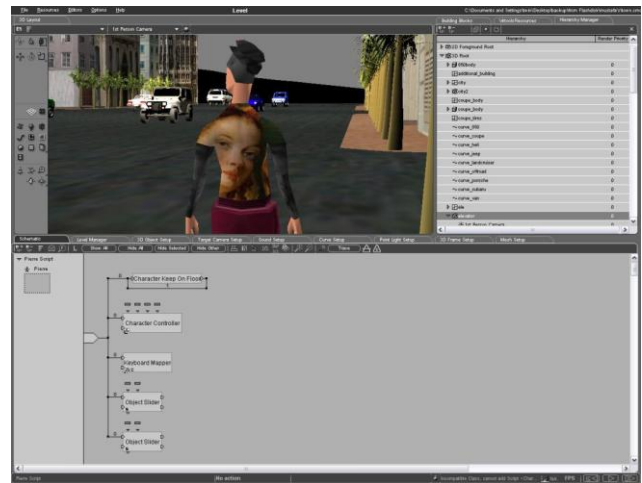

Fig. 12: Setup of character and object slider

Fig. 13 shows the snapshot of camera set up in Virtools which allows the users to see the environment through the virtual character.
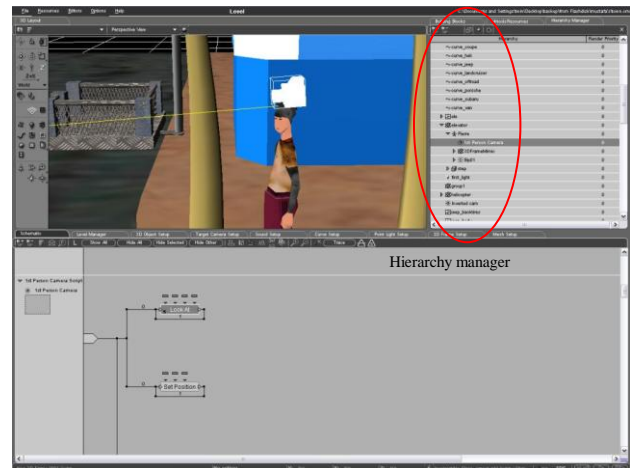

Fig. 13: The set up of camera in Virtools

D. Hardware Specification

We are using a stereoscopic 5DT Head Mounted Display with the following specification: 800-26 Resolution 800x600 per display, 26° Diagonal Field-of-View, LCOS Display Technology and Sennheiser HD25 (16Hz - 22kHz) Headphones .

The environment runs on Pentium 4 3GHz Graphic Workstation, 2 GB RAM using NVIDIA graphic card (Quadro FX1400, 128 MB).

IV. THE EXPERIMENTS

Around 50 participants took part in this experiment. The participants come from different backgrounds. 20 out of the 50 participants suffer from acrophobia. The participants were asked to put on the HMD and stand on the panel.

The participants will then being virtually lifted up to the highest level of the building and then quickly brought down to lower levels. During the experiment, the participants' gestures and reactions were carefully observed. The participants were asked to rate their anxiety level on a scale of 0 (they do not feel the fear at all) and 100 (they are frightened to death). This scale is called the Subjective Units of Distress Scale, or SUDS [8]. The participants were asked to provide SUDS ratings when they being raised at certain height.

Since there was no data tracker being used, the participants have no control over the movement of the elevator as well as the view (turning left and right) of the HMD. The movement of the elevator and viewing area were controlled by therapist.

For our case, we did not use any special tools to measure the anxiety level of the users as we believe that the users have the ability to evaluate the presence of height felt by them during the experiment.

Upon completing the experiment, each participant was asked the following questions:

- How real is the environment?
- Can the presence of height being felt in the environment?
- Any suggestions to improve the current mechanism.
- Any other comment on the system.

Fig. 14 shows the view seen by the participants when they are on the ground floor. Fig. 15 shows the view seen by the participants when they are at the highest level of the building.

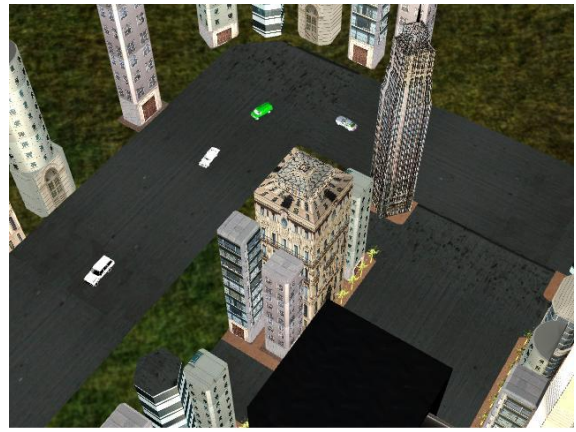Fig. 14: View seen by the participants on the ground floor.

Fig. 15: View seen by the participants on the highest level.

V. THE RESULTS

35 out of the 50 participants commented that the environment looked real. They could feel as if they are on a real elevator going up and down of a building. They commented that the vibration, the wind and the sound effects are vital elements in the experiment. It helps the participants to feel that the environment is real.

Out of these 35 participants, five of them are severe acrophobia sufferers. These five participants were observed to demonstrate the following behavior: clutching their hands, knee shaking, screaming as if they are going to fall from the elevator when they were lifted higher and lower suddenly. Two of them even asked to stop the simulation since they could not tolerate the fear that they were experiencing.

15 of these 35 participants were mild sufferers. They commented that they felt the presence of fear once they were on certain level. The rest of these 35 participants are non-sufferers. Even then, they commented that the presence of height could be experienced by them.

The remaining 15 out of 50 participants commented that they are unable to feel the presence of height since the environment does not seems to look real for them. There are many factors contributing to this matter, among them are:

- The buildings size is the same for all hence it does not mimic reality.
- They can feel the weight of HMD that makes them realize that the environment is not real.
- The set up of the experiment (the HMD, the floor panel and the fan) gives no suspense to participants.
- The size of the cars is not proportional to the environment.
- They cannot control the view. Since the system does not include data tracker, they will see the same view even if they turn their head to the left or to the right.

VI. CONCLUSION

As the conclusion, the study confirms that it is possible to create the presence of height even when using a simple 3D environment. It is noted that severe acrophobia sufferers would exhibit similar symptoms to the ones they experience when they are exposed to height in life situation.

From the observation during the experimentation, we realized that we need to choose the view carefully. Some views do not generate the presence of height. We noticed that in order to make the users be able to feel the presence of height in virtual environment, we need to focus on the view; which allow the users to see the changes resulted from the changing of the altitude. For example, a view where the users can see the car size is getting smaller and the road getting farther as they being lifted up.

The speed of virtually bringing the user up and down also plays an important role. We observed that the presence of height could be achieved if the users being lifted and brought down at a higher speed.

For future work, we will improve the environment based on the feedback given (mostly on graphics). Once the environment being created, we will proceed to examine the effectiveness of using virtual environment in treating acrophobia.

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