EARTHQUAKE SIMULATOR IN VIRTUAL REALITY

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Abstract: In Brazil, earthquakes are very rare because of their location, which is in the middle of a tectonic plate. Due to this issue, many Brazilians, especially the descendants of Japanese living in Brazil, are not aware of basic safety measures in earthquake situations. These Brazilians end up having difficulties when leaving Brazil and going to Japan, as it is a country with a great incidence of earthquakes, and these people are not properly prepared for situations of natural disaster. In spite of the various trainings given in Japan to prepare the population for natural disasters, these trainings usually require great human effort and a team prepared to offer these trainings. However, it is notorious that simulators are good approaches to learning and so this project comes through simulation in virtual reality, assisting unprepared people who are unaware of earthquake safety protocols. An earthquake-oriented education simulator was developed to assist people in learning safety measures in earthquake situations. Two free code software, Unreal 4 Engine and Blender, were used. Blender was used to model the 3d objects used in the scene, and the Unreal 4 Engine was used to develop the simulator and build the scenario with realistic graphics. The experiments were conducted inside college with students, teachers and technicians. Good results were obtained with the experiments performed. It was found in the tests that the simulator actually improved people's understanding of earthquakes, even though most of them already have a brief understanding of security measures. It was also confirmed, the relevance that this work has for Japanese descent, confirming the initial motivation.

Keywords: earthquake simulator. Virtual Reality. Disaster simulator VR.

1 – INTRODUCTION

Many Brazilians, of Japanese descent or not, go to Japan in search of new job or leisure opportunities (SASAKI, 2006). However, due to the rarity of earthquake occurrences in Brazil, many of these people have never had contact with the earthquake, which may leave them vulnerable to such situations. Although Japanese always send high volume sound messages with security protocols for these occasions, not all Brazilians who are there dominate the Japanese language, which can make the situation more tense and confusing for foreigners.

The earthquake is one of the most devastating natural disaster, that can result into tsunami, fire, leak of hazardous chemicals and radiation from nuclear power plants, flood, destruction of man-made buildings, injuries and death. Also, it can greatly harm the economy of the affected country hence the damage caused. Because of the given reasons, ways for defending the private propriety, the environment and

specially the life, efforts for better measures against the earthquake it is very important.

In some countries of the world, earthquakes are frequent natural phenomena. In Japan, for example, more than 600 earthquakes with a scale above 5 have been registered (TERRA). This type of event can cause gigantic catastrophes, so some types of contingencies are necessary. One way to avoid human losses is from training for possible earthquakes, so the individual will know how to properly act in case the event occurs.

The Virtual Reality technology has a large area of application, where its most evident element its the immersion provided to the user. Currently, this technology has become increasingly accessible and widespread, thanks to the technological advances of smartphones and virtual reality headsets such as Samsung Gear and Google Cardboard. It is possible, using VR, to take the user to different environments and to allow several experiences that are difficult to access.

This project proposes an earthquake simulator using Virtual Reality technology applied to smartphones. The main purpose of the simulator is that the individual can faithfully witness the situation of an earthquake, receiving information on how to proceed during the event. This would be a simple and inexpensive method for instructing people when an earthquake occurs and could be used as samples by individuals planning to travel to countries where such events may occur.

The simulator is still under development. The tools for creation are Blender a complete professional 3d development tool used for modeling elements of the scenario and Unreal Engine 4 a professional tool for developing games, used for the construction of the scene and the simulator.

The paper is divided as follows: The section 2 briefly explains the uses of Virtual Reality on simulations and its motivation; In the section 3 the methodology is explained; Section 4 is about the procedures on the making of the simulator; Section 5 provides information about the experiments; Section 6 gives an overview about our results and discussion; At last, section 6 provides information about the conclusion and future works.

2 – MOTIVATION

In Brazil, earthquakes are very rare events. Therefore, a large share of the Brazilian population has no real earthquake experience. Besides that, training for learning the safety procedures for earthquake situations its practically nonexistent in Brazil. considering this fact, and with a view to the large immigration of Brazilians

to Japan (FUSCO, 2016), many Brazilians go to Japan without having basic notions of safety procedures in situations of risk such as earthquakes and tsunamis. In addition, it is worth mentioning as the Olympics next year, which will take place in Tokyo, thus increasing the number of Brazilian tourists.

Japan, as a country located at a high earthquake risk site on the world, have a vast countermeasure plans against disasters using methods like early warning (FUJINAWA et al., 2008) and using strategical evacuation plans with self-defense forces (YUN; HAMADA, 2012). But, besides the technology and procedures taken by authorities, citizen man-power can greatly mitigate the damage caused. A previously minimally prepared population can make the difference at disastrous situations for reducing the damage caused by the earthquake, assisting other people in need and working as volunteers (ALDRICH, 2011). Hence the training of citizens with the purpose of learning general safe procedures.

Simulations is an effective way for training the citizens that lives where the earthquake occurrence is frequent. For instance, Japanese students are instructed to do an earthquake drill periodically (ASSESSMENT). Therefore, the people is prepared long before for any kind of natural disaster hazard since early.

However, earthquake drills require a great effort by the need for a team prepared to conduct the training. Besides that, foreigners that never experienced an earthquake can still have difficulties if not exposed to real situations. That being said, virtual reality is a great tool, providing great immersion to the user. Several applications in the clinical area have had good results through training using VR (GRANTCHAROV et al., 2004; AGGARWAL et al., 2006; BRUPPACHER et al., 2010). considering the good performance in this area of high complexity, we believe that VR can help in training people for risk situations

3 – METHODOLOGY

Firstly, we researched for methods in implementing the simulator. As stated in the article (MÓL; JORGE; COUTO, 2008), when making a simulator, the developer must carefully model the real world into a virtual reality as close to reality as possible. Fortunately, game engines can meet VR simulator requirements, which has implemented Real-world features like gravity, collision, light, etc. That being said, we used Unreal Engine 4 as game engine for developing the simulator, with the help of blender, as a modeling tool for creating the assets.

The simulator was developed from the idea of recreating an earthquake event. The proposal of this work is to use head-mounted devices of Virtual Reality with smartphones, making the simulator more portable and without the need of a computer with a great computational power as in the case of Rift Glasses. This project proposes an educational oriented environment for the learning of basic safety measures in earthquake situations with low cost and high usability.

In the simulator, the user is placed in the interior of a room. When the earthquake occurs, it is shown to the user how the event impacts the room, moving objects and making the user's movement more difficult. The user must be careful not to collide with the objects while finding a way to get safe. To assist the user with further information, it is explained along the simulation about general safe procedures. Upon receiving those guidance provided by the application, the user should act accordingly to get safe without harm.

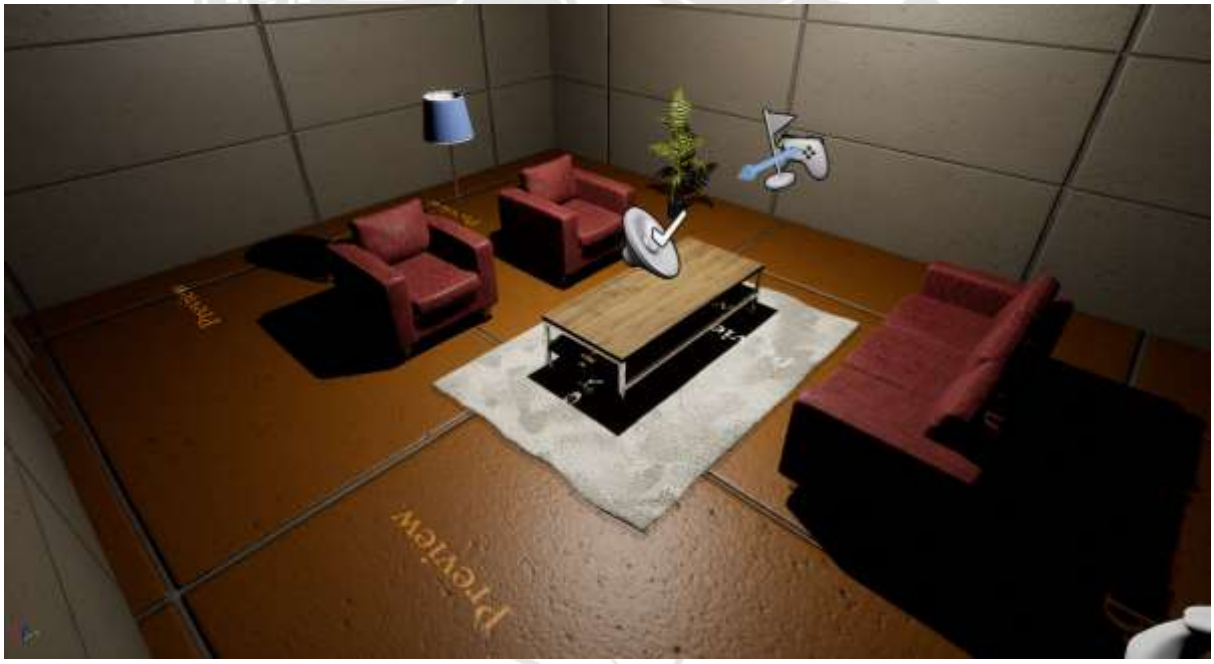

Figure 1: The room

Figure 2: After the earthquake

4 – IMPLEMENTATION

In this Section, we describe the softwares we used for making the simulator. The game was developed using two softwares: Unreal Engine 4 and Blender. The choice of software was based on the great power of these tools, as well as being free.

Unreal could be described in a short way as a system that organizes your "assets", your characters, artworks, props, weapons, music, sound effects, voiceovers, etc, into a visually stunning interactive environment (BUSBY; PARRISH; WILSON, 2009). Using Unreal Engine 4 it is possible to create realistic environments making the Virtual Reality experience even more immersive. It is also has support for developing on the most common equipment of Virtual Reality and allows you to work in conjunction with Visual Studio making the Unreal Engine even more versatile.

Blender is a free and open source 3D creation suite. It supports the 3D pipeline modeling, rigging, animation, simulation, rendering, compositing and motion tracking. Considering it is functionalities, tools and fast learning curves, Blender proved to be an excellent choice for the project. The Blender has been used to texturize objects, test 3 different materials and apply physics on objects.

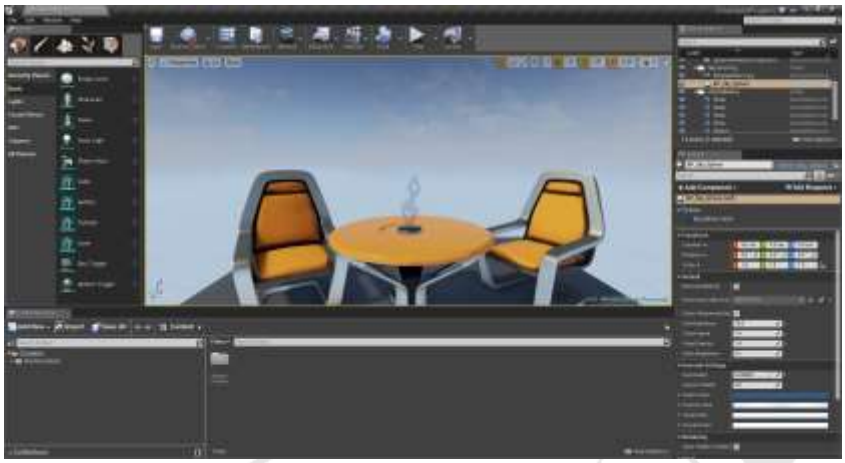

Figura 3: Unreal 4 Engine

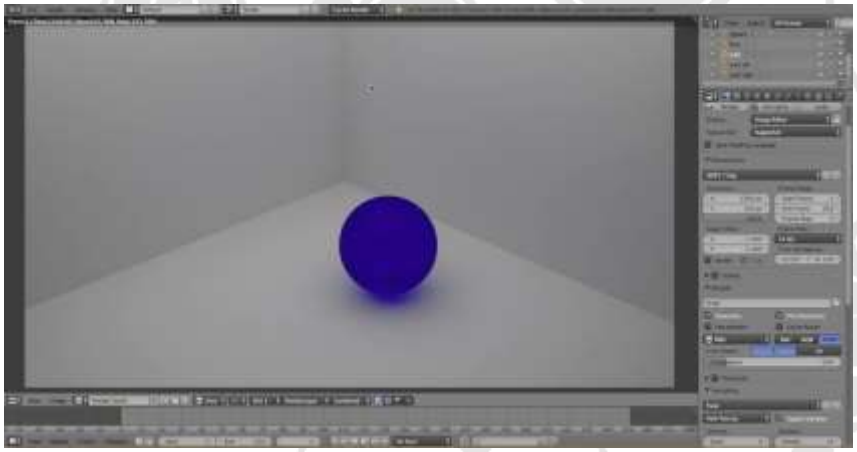

Figura 4: Blender modelling tool

5 – EXPERIMENT

The simulation lasted for 5 minutes with the person sitting in a chair. Before the simulation, a question will be asked to understand what the person would do in an earthquake situation. After the simulation, a form with 2 questions was given. Firstly, we want to measure if the simulator is realistic enough to make people know how an earthquake affects the environment, and give the user a perspective of someone that lives with earthquakes. The questions of the form is as follows:

• O que você faria nessa situação?

In this question, we seek to understand the basic notions of security that the person possesses. With the information from this question, we can better understand the concept of this person already about earthquakes. So we can know later if there have been any changes of concepts regarding earthquakes is safety procedures.

• A simulação ajudou você a entender melhor como proceder durante um terremoto?

Here we try to understand if the simulator contributed to the person's knowledge about earthquakes. This information is important because we will know that the simulator really made the person feel in the middle of a risk situation. Thus, if the simulation proved to be realistic enough, this provided to user a better understanding of the situation.

• Você acredita que esse simulador contribuiria com a população brasileira?

Finally, with this question we seek to understand if the simulator would have any impact on Brazilian society. We sought to know if this acquired knowledge is important for the Brazilian population. This last question is intended for when the simulator is entirely complete without graphics flaws.

With these information, we seek feedback from the project, to understand its faults and its positives in general. All tests were performed with a Samsung Galaxy S6 smartphone, due to its good computational power, enabling simulation with better graphics. The glasses used was Google Cardboard, as we would like to use a cheap and affordable device for ordinary people.

6 – RESULTS AND DISCUSSION

The tests are ongoing along with the project. Due to the lack of some components in the simulator, partial tests were conducted within UFMS college initially to obtain information on the first two questions on the form. The experiment were conduct with students, technicians and professors. With these results, we got feedback about how the simulator was realistic and if it contributed with the knowledge of the student about earthquakes.

There was acceptance by people regarding the test. It was observed that most people, even though they had never experienced an earthquake, correctly knew some sort of safety procedures like protecting the head. In the second question, it was observed that although the simulation was not realistic enough to provide an immersive experience, they were able to better understand a scenario during an earthquake.

Most of the answers to question 3 involved a lot of the Japanese people, who could eventually go to Japan. According to the tests, the simulator could help these people, but it would not have much relevance for the Brazilian population that does not travel abroad with frequency.

It is worth mentioning that the results may have been influenced by Google Cardboard, as it is a very simple device, which can lead to a lower graphic quality. The smartphones, however, had a great performance in the tests, in which it presented graphical problems.

7 – CONCLUSION

This project proposes an education-oriented earthquake simulator to assist people who will or will not go to countries at risk of earthquakes. The tests were conducted initially within college and we sought to understand what people think about such an approach to learning about earthquakes and safety procedures. With the results obtained, we can conclude great acceptance by the people. The simulator proved to have social relevance, mainly for people traveling to countries at risk of earthquake. This is very important, since it reinforces the motivation to carry out this simulator and that, although Brazil is a safe country in relation to earthquakes, knowledge of basic safety concepts can be of great help to Brazilians who think about traveling abroad. As future works, we intend to improve the simulator so as to make it more sophisticated in terms of realism, in addition to adding other areas, such as in cities or parks, because each place has a different security measure from the other. Other research with relevance would be tests with other virtual reality headsets. Some other models can provide greater immersion in exchange for the high cost.

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