Development of a Virtual Reality Platform as a Training Tool Using Gaming Software

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Abstract—**Virtual Reality (VR) is a well-known technology that is applied in many areas including education, medical, manufacturing etc. In the engineering field, VR is commonly used as a toolkit to train humans to perform complex tasks such as aircraft piloting, chemical handling etc. However, the practicality of using gaming software as a VR platform for training purposes needs to be investigated. In this paper, the DarkBASIC Professional (DBPro) gaming software was applied as a VR platform to train humans' adaptability towards new environments. The design of the structure of the VR platform using DBPro is described together with the main elements including 3D modeling, mapping, lighting and sound effects, and player's control. A comparison between the real world and the VR platform was evaluated. Ten selected subjects conveyed positive feedback on the realism of the VR platform through the survey. The results show that the time taken to complete a task was reduced up to 60% after the subjects performed the VR training in advance. It is hoped that the VR platform will support VR training with low development costs and an open source concept.**

Index Terms—**Gaming Software; Tools; Virtual Reality; 3D Modelling.**

I. INTRODUCTION

Virtual Reality (VR) is defined as an alternate world filled with computer-generated images that respond to human movements [1]. The definition of VR makes reference to a particular technology that applied to the system. For instance, a VR system can include real-time animation, wired gloves and position trackers for control, head-mounted stereoscopic displays etc.

VR can be classified into three major systems; non-immersive, semi-immersive and fully immersive [2]. Non-immersive is the least developed form of VR system and only involves the use of a computer desktop with a keyboard, mouse or joystick. In some cases, a high-resolution monitor is used to improve the immersion. Semi-immersive includes high-performance graphic computing systems together with a large projector screen or multiple monitor projection systems. Fully immersive is the most advanced and is closer to the actual experience of virtual environment (VE). It may include wearing a head-mounted display (HMD) with several tracking and haptic feedback systems. In this project, a semi-immersive VR system was implemented where the VR environment was projected onto a large screen in order to increase the immersion.

VR technology has been applied as training tools in many areas including emergency drills, medical training, education etc. An emergency evacuation drill was developed by [3] to determine human behavior and evacuation time during an emergency situation. Participants were tested in the virtual environment (VE) with three different scenarios and the goal was to find the exit of the building. The researcher found that using the 'Second Life' game engine to simulate the virtual environment of a building for training purposes was credible and had high potential value for subsequent research. [4] also made use of VR to teach fire-safety skills to children. Students learned home fire hazards with a companion and then practiced exiting from a simulated fire in the virtual environment.

In medical training, [5] explored some examples of commercial simulators and concluded that there was a need to evaluate the speed and accuracy of the systems. Besides, certain aspects of gaming and playing should be examined with regards to learning. For example, goal-driven activities can be developed using VR since the progress towards the goal can be evaluated. At the same time, [6] also selected several game engines to simulate a virtual environment for surgery practices. The results showed that the game-based engine was suitable for applying simple simulations based on pre-recorded animations.

On the other hand, [7] used a VR tool to teach students to have better learning in scaffolding poetry lessons. Several learning modules were designed in VR form to facilitate the learning process. The researcher found that students were highly engaged with the VR learning environment compared to the conventional teaching method. [8] also organized an engineering drawing course in VR so as to improve the visualization and imagination skills of the student. This facilitated the student to add in or remove object in a three-dimensional way effortlessly in an unlimited space and safe environment [9], [10]. Therefore, it is significant to understand the effective instructional designs for a better integration of VR [11]. [12] had proved that about 90% to 95% teacher and student prefer a VR interactive environment in the school learning process.

The development of VR platform using gaming software is considered limited. Since the development program is considered low costs [14] and all related coding is open source, there is a need to explore the potential of gaming software as a VR platform. Gaming software known as DarkBASIC Professional (DBPro) is applied in this research. DBPro is based on the BASIC computing language that has been enhanced specifically to aid the creation of games programs [13]. The development programs can be redistributed or modified based on the specific project and it is publicly accessible. The objective of this research is to develop a VR platform using gaming software and to evaluate

the platform using real human test. The test was conducted in order to assess the human adaptability towards new environment using the newly developed VR platform. In this paper, the development process of the VR platform using DBPro and the experiment results are discussed.

II. METHODOLOGY

A. Develop the Virtual Reality (VR) Platform

In this research, the lecturer room at Faculty of Engineering, Universiti Malaysia Sarawak (UNIMAS) was selected as the case study area for the VR platform. The area consists of several rooms with two exit doors at different ends. The selected area was measured and a 2D map was drawn using computer-aided design software as shown in Figure 1. The exit doors are shown circled in red. The 2D map design was then converted into a 3D map in the DBPro software. The map in DBPro software consists of programming codes that include the mathematical equations, matrix functions and functions substitution. The program was split into several routines or subroutines rather than one set of continuous instructions. The overview of the subroutines in the software or known as structure diagram is shown in Figure 2.
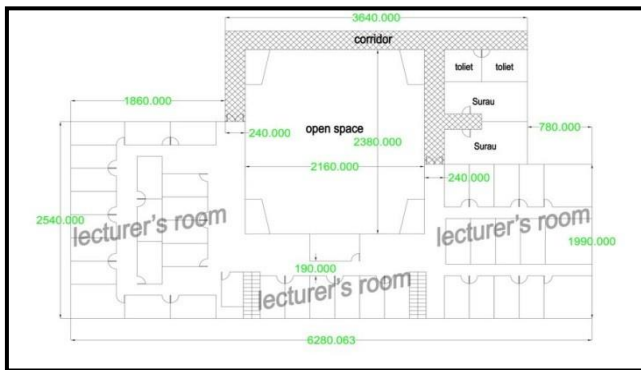

Figure 1: Map of lecturer room at Faculty of Engineering in Universiti Malaysia Sarawak (UNIMAS).

The developed VR platform or environment consists of special items, complicated objects, the map and lighting, sounds and control of the player. A special item is a created element that relates to the user or player such as player life, body, hand etc. Complicated objects refer to elements that are required in the 3D map such as room partitions, tables, chairs etc. Both special items and complicated objects were created using the DBPro command or drawn using computer-aided design software and loaded as 3D media in the DBPro command. Figure 3 shows an example of a door created using 3D Studio Max.

Maps and lighting refer to the arrangement of 3D media and lighting effects in the VR platform. The map and lighting are important in developing a VR environment comparable to the real world. In addition, sound was included in the VR platform in order to increase the realism. Lastly, control of player refers to the movement of cameras in the VR platform. This feature enhanced the feeling of movement in the VE.
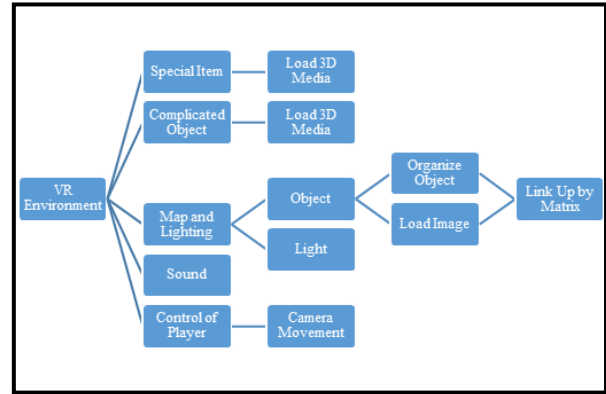
Figure 2: Structure design using DBPro software.
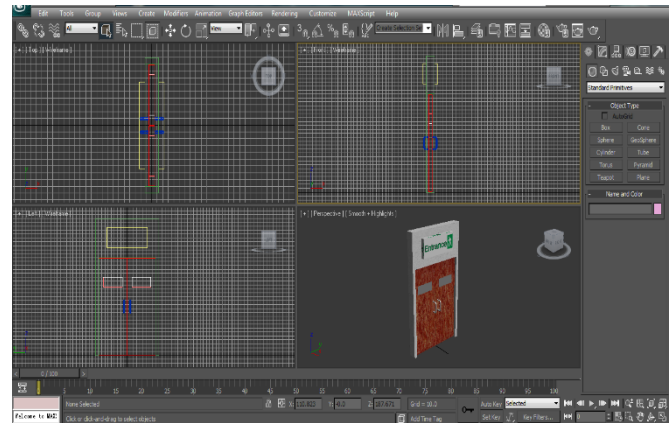
Figure 3: A door (complicated object) that was created as a 3D media.

B. Sample Experiment and Feedback

After the VR environment was developed, sample testing was conducted using two groups of subjects. Both groups consisted of 5 subjects who were totally unfamiliar with the lecturer room at the Faculty of Engineering. The first group was required to conduct Task 1 which is the real-world experiment without VR training. As shown in Figure 2, the subjects were located at Exit 1 (entrance door) and were asked to find Exit 2 (exit door). Figure 4 shows the real world and VR training.

On the other hand, subjects in the second group were asked to conduct Task 2 which was the real-world experiment with VR training. In Task 2, the subjects were asked to find the exit door (Exit 2) in the VR platform first before moving around in the real world. No assistance was given to the subject for either task. The times taken for both tasks were recorded and a simple questionnaire was given to the subjects after the experiment.

Figure 4: The real world and VR training

III. RESULTS AND DISCUSSION

The results and discussion focused on two areas which are the developed VR platform and the experiment conducted by voluntary subjects.

A. Virtual Reality (VR) Platform

The comparison between the real-world environment and developed VR platform is shown in Figure 5 and shows three different areas within the map. The figure indicates that the DBPro software managed to develop a VR platform similar to the real-world environment. A human hand and a phone were selected as the special items to assist movement in the VR platform.

The VR platform (the map) was developed from three important elements called objects, organized objects and a matrix as shown in Figure 6. Objects refer to the special items, complicated objects, 3D media etc. that were created to develop the VR platform including the door, wall, chair, grass etc. After an object was created and assigned as an image, the object needed to be organized into the structure. A name was given for every organized object so that it could be distinguished from others.

Figure 5: Comparison between the real world and developed VR platform.

Figure 6: Relationship between object, organized object and matrix.

In DBPro commands, an organized object is known as a 'mapid'. Each 'mapid' can be a single or multiple subroutines. In order to develop a complete map, each 'mapid' is linked together in a matrix. Figure 7 shows the

example of a completed 3D map that consists of three different 'mapids'; the wall, roof and floor. The 'mapids' were defined by the author. Figure 8 shows some examples of commands in DBPro. The command begins with the setting command such as 'sync on', and ends with the matrix link between each 'mapid' namely '00', '01', '18', '19', '20' and so on. The results of the command end up with 853 lines of coding.

Figure 7: Example of 3D map simulated using DBPro software.

Figure 8: Some example commands in DBPro

B. Real world and VR platform experiment

The results from experiments using Task 1 and 2 are presented in Table 1 and Figure 9. The results show that the subjects need an average of 90.6 seconds to complete Task 1 which was finding Exit 2 from Exit 1. On the other hand, other subjects (Task 2) only needed an average of 54.4 seconds to complete the task on the VR platform. After going through the VR training, the subjects in Task 2 were asked to perform the real-world task.

Table 1
Time taken for Task 1 and Task 2

Task 1 (Without VR Training)		Task 2 (With VR Training)		
Sample	Time (s) In Real-world	Sample	Time (s) In VR	In Real-world
A'	100	A	49	38
B'	71	B	50	32
C'	69	C	59	32
D'	100	D	67	38
E'	113	E	47	40
Average	90.6	Average	54.4	36.0
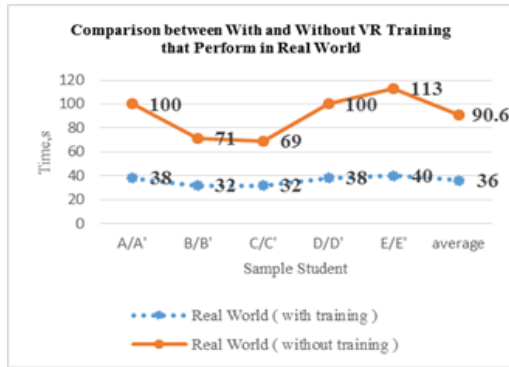
Figure 9: Comparison between with and without VR training performed in the real world

The results show that the time taken to perform the task was reduced to an average of 36.0 seconds. As shown in Figure 10, the time taken to complete the task was reduced by up to 60.3% after the subjects performed the VR training. The results indicated that a VR platform for training purposes plays an important role in improving performance efficiency. In this case, the subjects who were totally unfamiliar with the new environment performed the task much faster after undergoing VR training. The results show that the VR training platform affected the performance of the subjects in performing a task. The subjects with VR training in advance were shown to be quicker in decision making and had better adaptability to a new environment.

Feedbacks from all subjects were taken after the experiment as shown in Table 2. Most of the subjects agreed with the parameters provided in the VR platform. 80% of the subjects agreed that the VR platform was user-friendly and convenient to be handled. 70% of the subjects agreed with the effect of sound in the platform and agreed with the overall realism. 60% of the subjects agreed with the smoothness of the speed provided in the VR platform. Only 40% of the subjects agreed with the lighting effects and 50% of the subjects strongly agreed with the level of the task.
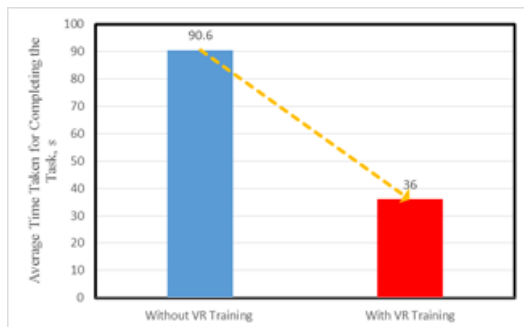

Figure 10: Average time taken between without VR training and with VR training

Table 2
Participant's feedback

Parameters	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Game Friendly	0	0	1	8	1
Sound Effect	0	1	2	7	0
Lighting Effect	0	0	4	4	2
Smoothness of Speed	0	0	3	6	1
Level of Task	0	0	2	3	5
Overall Realism	0	0	1	7	2

IV. CONCLUSION

This research discussed the development of a VR platform using DBPro gaming software for training purposes. Two different tasks were conducted in order to understand the effect of VR platform on human adaptability to deal with new environments. A lecturer room at Faculty Engineering, Universiti Malaysia Sarawak (UNIMAS) was selected as a case study. The experiment and feedback data shows promising results towards the usage of VR platform as a training platform. However, the software has limitations in handling the huge amounts of data since the developed area was based on the actual size of the selected case study. Besides, more subjects are needed to evaluate the VR platform.

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