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Virtual Campus: A Case Study of Development Using Open Sources Software

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***Abstract*:** *Over the last decade Virtual World Technology, implemented in a role-playing games have attracted many young learners. The current setting of education, aside from the normal face-to-face lecture includes many channels and paths available to learners and Virtual World is starting to get more attention. A role-playing virtual campus is proposed in this paper for Institut Teknologi Brunei (ITB) to provide an additional route to enhance the learning experience of students. The study adopted in this proposal used the Massive Multiplayer Online Role-Playing Games approach in which open sources software i.e. OpenSimulator was used as the development platform for Virtual World (VW) and 3D Virtual Learning Environment (3DVLE). SLOODLE was used as the Learning Management System (LMS) for the VW. The main viewer used is the Firestorm viewer. The prototype developed focused at Phase 2 section of the campus as the study area and was tested on a group of existing undergrad students. The responses and feedback to this preliminary novel approach was very encouraging and the acceptance of Virtual Reality based learning is positive.*

Keywords: *Virtual World, OpenSimulator, eLeaning, Role-playing*

1. Introduction

Virtual World (VW) has already existed since the late 1980s during the booming of communication through the Internet, and continued to evolve in the late 1990s through the substantial development of Massively Multiplayer Online Games (MMOG). However there was an uncertain definition to the term even until the year 2003 when the 3D virtual world Second Life was first launched. Angel Learning Inc. [1] defined VW as an Internet-based, simulated environment where users interact via motional avatars, graphical images that represent people. There are complications in defining VW and accordingly Bell et. al. [2] suggested that one way to define VW is by drawing together the key terms. The terms used to define VW: *Synchronous, persistence network of people*: Shared activities necessitate synchronous communication. Just like real life, the networked community continue to be active regardless the user logged in or not. *Avatar representation:* Avatar is a simulated person-like form in the VW to represent the user while they logged in. *Networked computer facility:* Using networked computer facility to create an environment or world.

VW is also defined as a networked technological simulated environment that allows users to communicate and interact with one another via simulated human i.e. avatar representation. Angel Learning Inc. [1] in their paper discovered that over the past several years educators have begun exploring VW as a powerful medium for any instruction. This is due to

VWs' persistence allows for continuing and growing social interactions, which can serve as a basis for collaborative education and VWs give users the ability to carry out tasks that could be difficult in the real world due to constraints such as cost, scheduling or location. In addition to that VWs can adapt and grow to meet different user needs.

Game-based education and simulation in VW helps students to involve in an improved cognitive thinking, such as interpreting, analyzing, discovering, evaluating, acting and problem solving. A growing demand in these types of technologies evidently displayed by an enormous number of registered accounts in hundreds of VWs as of 2012 in the research [3] for both entertainment and educational purposes, and the emerging demands for educators and schools to motivate students, prevent high dropout rates, and provide more authentic learning and assessment opportunities. There are indications that educators have started recently to study the application of VWs for the purpose of teaching and learning because they believe that such technologies provide alternate, and the closest and almost transparent way for a user to "be in the situation" and thus, the ability to learn is plausible without spending a lot of money.

ITB Virtual Campus using OpenSimulator is a preliminary investigative project to study whether VW supports teaching and learning in Institut Teknologi Brunei (ITB). In this research, a group of students using VW to learn was observed and feedbacks were collected on their responses. OpenSimulator was used as the development platform for VW and 3DVLE in this research; and Firestorm Viewer as the main viewer. Area of study is the Phase 2 section of the campus of ITB.

The next section outlined related work and our motivation. Section 3 discussed the framework, the study area of the project and the design and how the implementation of the project was carried out. This will be followed by the implementation method. Section 5 consists of the results and analysis with regard to the proposed system and followed by the conclusion and future work.

2. Related Work and Motivation

ELearning has become one of the main stream of Teaching and Learning methods that is widely implemented at all level of educations with the users range from children to elderly. Developers have provided various techniques and methods of eLearning through the main stream of communications especially the mobile phones, tablets and personal computers. This approach allows learning beyond the traditional means and enhances learners' desires to learn than the formal approach.

On the other hand, an effective and operational 3DVLE enables user to gain information via interaction from a first-person perspective, offering different environment experiences such as in health and medical field, fashion industries, communication and business study. Such activities can prepare students for future employment without the constraints of 'real world' industry placements. 3D VWs such as OpenSimulator can assist in smoothening the learning of communication skills and their understanding of cultural differences and other aspects of diversity according to Denise [4]. OpenSimulator is an open source multi-platform, multi-user 3D application server. It can be used to create a virtual environment (or world) which can be accessed through a variety of clients, on multiple protocols [5].

Due to demands, VWs have grown in line with the other technologies. Other factors, such as changes in economic environment and increase familiarities with VW especially those who immersed in Massively Multiplayer Online Role Playing games (MMORPGs).

The opportunities and potential use of VW in education is promising with evidence from conference proceedings, workshops and literature surveys. Educators and researchers are exploring this VE from seeking evidence 'if' VW have a substantive influence in learning (question of the past) shifting toward "how", "why", "under what circumstances", and "for which populations" [6].

Kirriemuir [7] reported that in choosing VWs for use in teaching and learning, Second Life (SL) and OpenSimulatorulator (OpenSimulator) were mostly mentioned or used by UK higher education. Kirriemuir [8] revealed that over 80 per cent of UK universities were developing or teaching within SL. Other regions of universities are offering classes in SL, including Harvard University, Ohio Sate University and National University of Singapore [9].

Academics who continue to use VWs are persistent across several departments in UK universities [10]. The report noted that the Open University, University of Edinburgh and Coventry University, have many groups, courses and departments using VWs as a central technology for teaching and learning activities. Other universities, such as Lancaster, Teesside, Southampton Solent, Glasgow Caledonian and Strathclyde, are also developing a significant VW presence.

The main characteristic of rich interactivity in VWs compared to other web applications that are mainly based on plain text and voice [11], bring out the unique affordance for learner experience. The three-dimensional representation of avatars and environment in which the avatars can move and interact with each other through communication tools affords a sense of self and presence which may result in immersion and support socialisation and collaborative learning [12].

Bouras et al. [13] claimed that meeting-focused tools that support synchronous communication such as video conferencing and synchronous training tools are not appropriate for collaborative e-learning. The authors further suggested that the general problem of these tools is the reduction of social presence.

Avatars are unique solutions that Computer Virtual Environment offers to group communication and interaction. The main benefit of avatar representation is the psychological feeling of a sense of presence that results in suspension of disbelief (feeling of immersion) and an increase in motivation and productivity [14].

In an online education context Petrakou [15] claimed that VW provide enhanced interactivity because it allows synchronous communication in combination with a spatial dimension. The author also suggested that VW is not adequate as a learning environment on its own. Recent approaches try to combine the features of LMS and VW. The improved interaction capabilities of LMS and VW lead to platforms that benefit from the advantages of both sides. One such approach is Simulation Linked Object Oriented Dynamic Learning Environment (SLOODLE) [16]. These results influenced some of the opinions we have had when we think about using the VW as an environment for teaching and learning in Institut Teknologi Brunei (ITB).

Framework and Design Approach

As VW is synchronous i.e. persistence network of people, the proposed prototype is designed to meet this requirement. Thus, the system used a basic client-server model where a high end sever was installed as the main server and users connected as clients. The prototype developed in this study is in standalone mode, where the server hosted an OpenSimulator server and, at the same time, the device also launched the client application software. The framework of the system is illustrated in Fig. 1 below.

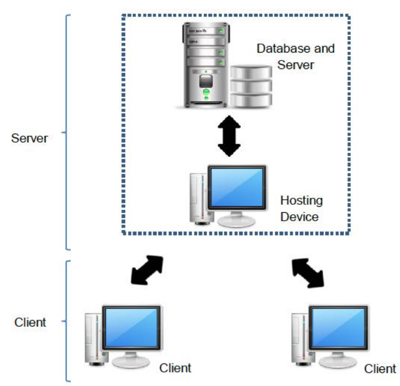

Fig. 1. ITB Virtual Campus Framework

2.1. Development Phases and Model

A hierarchical approach as shown in Fig. 2 was adopted in this study to determine the layers in which the prototype development will be implemented. The development phase is categorized into five stages of work: Terrain phase, Building phase, Communication phase, Production phase and Exploration phase.

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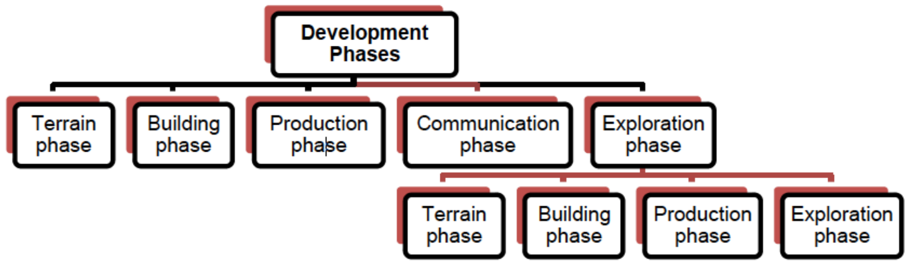


Fig. 2: Development Phase of ITB Virtual Campus

As the research is a preliminary study for supporting teaching and learning, only the important focus of this project which is the study area is mandatory. The replica of the university's Geographical Information System (GIS) is further restricted and therefore details such as terrain, transport and vegetation which are not essential at this stage was not fully developed.

In the baseline iteration cycle, two phases would be conducted which was to develop the physical building of the ITB Campus. In the Determine Requirement (DR) stage, data such as blueprint, floor plan, room number and camera shots were determined. Determining which data to use in the system, such as eliminating phase 1 and 3 sections of the campus, is being done in the analyse and design (AD) stage. Google Sketchup and Blender were used to create a three-dimensional models of features in the study area. Textures were also a crucial tool in creating a true reflection of the actual object. After processing the textures through photo-editing software tools such as Photoshop, it was imported into Google Sketchup for adding details to the models. All the models were placed on the terrain, and then, further details of the environment were added through the features found in OpenSimulator, such as doors, roads and lights. All these processes are done for the development and testing (DT) stage. After that, review and plan (RP) stage took place by planning the next cycle.

Once the physical static features were done, the second essential ingredient to this system was implemented which was to make the ITB Campus come to life. This was the second cycle of the Software Development Life Cycle model. In the DR and AD stages, Linden Scripting Language (LSL) scripts for items in the campus were used to add videos, animations, slides and images. Necessities for the campus architecture were amended in the project and irrelevant objects were eliminated during the DT stage. This was needed in order to optimize the scenes so that a close-to realistic environment could be achieved.

3. Implementation and Modelling

In the implementing process, there were three main tasks and one observation to be made: Working outside OpenSimulator (i.e. external work), including complex modeling, textures and video editing / animation; Work inside OpenSimulator (i.e. internal work), which includes, programming / scripting, simpler modeling; and synchronising which to concurrent the work in and outside of OpenSimulator such as Moodle and SLOODLE.

On the other hand, modeling is an important piece of the virtual reality project. Wang et al (nd) in his research mentioned that modeling a system is better to be completed and prepared earlier in the development process in order to obtain a successful virtual reality system. In developing the prototype, Google Sketchup Pro 2015 3D Modeling software is used to build the main ITB Building campus i.e. phase 2 section of ITB.

3.1. Terrain Phase

Terrain Layer comprises of the ground or the landscape description of the Study Area. Obtaining an exact geometrical landscape for development of the terrain phase would make the VW seem realistic but as terrain interfered a minimum amount with the process of learning and teaching in ITB, which is the main goal of the project, the layer is restricted to minimal possible effort for this project. This resulted to an initial prototype terrain model comprised of huge piece of flat ground filling the whole region of the land shown in Fig. 3.

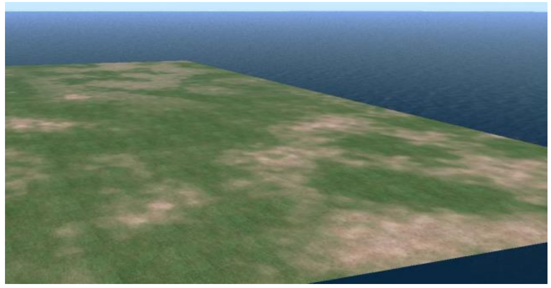


Fig. 3: Flat ground terrain used in ITB virtual campus

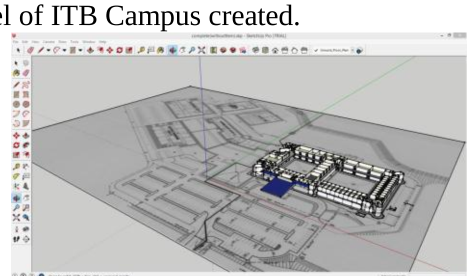
3.2. Building Phase

The replica (model) of an ITB Campus was used as the main building construction and it is one of the most mandatory phase in reaching this project objectives. There were several ways on how this phase can be implemented and an external application i.e. Google Sketchup Pro 2014/15 (64 bit) was used. Majority of the building component were created using this software.

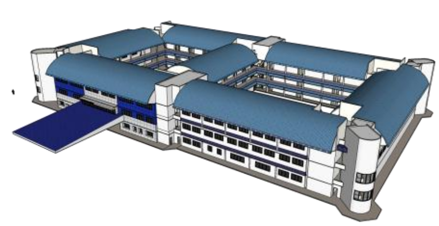
Initially, the skeleton of the building information was used from the architectural blueprint of ITB to guide in modeling process. The blueprint is used to scale the building to estimate the measurement. Textures were added to the building after editing using Photoshop.

OpenSimulator supports mesh uploads. A mesh is a collection of vertices, edges, and faces that describe the shape of a 3D object. Mesh model that is uploaded to OpenSimulator are all static and because of this, not all of the objects can be modeled. Objects that are prone to be logically responded to actions such as doors and lights were excluded in the Google Sketchup.

Once modeling in Google Sketchup was completed, the 3D model was exported to a .dae file format for it to be compatible with OpenSimulator project in which it will be recognized as a new prim (primitive), a term to describe object(s) in OpenSimulator. Uploading to OpenSimulator was done by using the Firestorm viewer, and this viewer was used to access the user interface of the prototype for the entire time. Fig. 4 (b) indicated the model of ITB Campus created.



(a)



(b)

Fig. 4: (a) Architecture Blue Print used by Google Sketchup (b) ITB Campus Model Created form Google Sketchup Pro 2015 64-bit version

3.3. Production Phase

Production phase is also one of the most important development phase in this project development. It is further categorized into two different sections. One is Programming and the other is implementing video object in OpenSimulator.

The action-respondent objects that was excluded in the modeling section was added in this phase. The doors for the campus was the first object to be created by the create tool found in one of the options of Firestorm viewers. Once the object was created, LSL script was later injected in the object for it to listen for action as shown in Fig. 5 below. Some of the main script used in the project was automatic door sliding, rotating and manual door rotating. The sliding door was done by implementing the llSetPos() function and the rotating door was implemented by llSetRot() function. The final touch was the textures for the door details and the labels. This texture was first designed in Photoshop and once ready all the textures were uploaded to OpenSimulator to add a realistic touch onto the building.

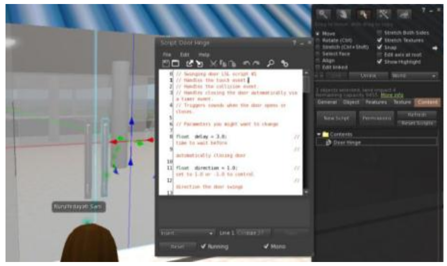


Fig. 5: Injecting LSL Script into an Object

Other type of objects created in the project consisted of lights and roads. Lights were not modeled through external application because OpenSimulator provides a “glowing” feature that helps the light object glow in darkness, which is necessary during the night time of the VW. Roads however, are made directly in OpenSimulator to reduce the file size and more importantly was to optimize the features available in OpenSimulator.

The fourth object being created in the production phase was the tutorial poster and animation screens that would be used in the testing session. This poster made use of texture and the animation screen was produced by a video file stored in the project folder. The texture image was also prior-created using Photoshop or any photo editing tool, and the animation was created using Windows Movie Maker before it was implemented into the system.

The final object being created was the sample on how scripting was able to demonstrate how the study should be made. There was one prim being created in one of the tutorial room to demonstrate how the term “stretch and squash” was used in animation.

3.4. Communications

SLOODLE was implemented in the scene for the next cycle. SLOODLE comes with a package for Moodle and OpenSimulator items and the entire package is collected in the DR stage. SLOODLE is an extended implementation feature of Moodle for VW and therefore Moodle installation and configuration were also performed in the development of this prototype. After both installations were done, they were connected to sync with one another. All these processes were done in the DT stage of the cycle.

As it was important to let new users to get familiarized with the system before they adapt themselves in the VW, the prototype was further sub-developed by tallying additional tutorial scene. This was done using the tools in OpenSimulator, which reduced the use of 3D modelling software.

In the observation phase, few undergraduates who were interested could take part as the initial users for the prototype to test the system. These users consisted of individuals with different devices and Operating Systems (OS). The next step of the observation phase to this layer is to train the candidates. And the final phase was to conduct the experiment and collect survey from the candidates to obtain the feedback after using the proposed developed system.

3.5. Exploration Phase

The exploration phase is further broken down into four phases: re-terrain phase, re-building, re-production and exploration phase. The initial flat-land terrain was remodeled into a mini island as shown in Fig. 6. There were two separate sceneries in the prototype; Campus Area and Introductory Tutorial Area for new users.

In the Introductory Tutorial Area, there was only one building, where a collection of instructions was displayed. Whenever a user first registered in the campus, their avatar was positioned inside this building. The texture images to show these instructions was also prior-created using Photoshop before being inserted into the prototype system.

Fig 6. Remodeling the terrain into a mini island

4. Testing and Analysis

A group of eight undergraduates took part in the initial study of this project to test the proposed prototype of which three are female and five are male. Two of them were non-gamers, four were heavy gamers and other two are casual gamers. Six of them used Windows64-bit OS, one used Windows32-bit OS and one used Macintosh OS. Each of them had their own avatar created for them and a dummy Moodle account. The group also had the Firestorm viewer and Quicktime (for viewing the animation) installed in their device.

4.1. Experiment

Once the group logged in ITB Virtual Campus, they were given chances to get used to the environment and they were able to change the avatar appearance according to their preferences. Lecture session was started afterwards and additional feature could be used, such as, disabling the door opening function so that latecomers were not allowed to enter the session. After teaching session ended, the students were able to move about the campus to look for additional learning materials, such as posters and animated screen for answering mini quizzes. Questionnaires were distributed to the users after the testing session ended to obtain their feedback for their experiences. Fig. 7 (a) and (b) are some screen shots when students first arrived at the scene and their conversations with peers while in the VW.

(a)

Fig. 7: (a) New users positioned on tutorial area

(b)

(b) Students taking part in conversation, some conversations are in local vernacular.

4.2. Feedbacks and analysis

Easiness in maneuvering, ease of use, enhance learning, productivity, motivation and fun in learning in the VM were measured using questionnaires designed based on Likerd scale range from 1 to 7, 1 being strongest disagree and 7 strongly agree. The feedback collected from students was tabulated in Table 1.

The feedback indicates that the proposed system is very favourable especially in the last two items of "motivating learning" and "fun to use". Although this was a very small sample, it is evident and very much inline to the fact that experiential, active and investigative mode of pedagogical engagement [17] in Virtual environment can play a significant positive role in enhancing learning.

TABLE I. Feedback From Students Using ITB Virtual Campus

	Items	Strongly Disagree to Disagree	Neutral	Agree to Strongly Agree
1	Ease of Maneuverability	12.5%		77.5%
2	Ease of Use	12.5 %		77.5%
3	Enhance learning		12.5%	77.5%
4	Increase productivity		12.5%	77.5%
5	Motivate learning			100%
6	Fun to use			100%

5. Conclusion

In this paper we demonstrated the implementation of ITB Virtual Campus using OpenSimulator as a Preliminary Study of using 3DVLE to support Teaching and Learning in the university. The designed functional components and services meet the proposed objectives to implement OpenSimulator based VW system using ITB Campus as the study area. The prototype was also tested on a group of undergraduate for observations on their adaptation in this technology. Their responses and feedback were collected and are favourable especially in motivating learning and to see that learning is fun. It can be said at this stage that the present state of development is in a good rate of usability, and the acceptance of VR based learning is positive.

This is a preliminary study of using 3DVLE in supporting teaching and learning in ITB. Further study is required to obtain more accurate results and findings. This can be done by further developing the Virtual Campus into a full fledge system to present a more realistic scenario of the university in terms of physical environment and to include more learning materials for students to access.

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