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3D object implementation on bicycling at UI virtual reality application based on 3D-Gamestudio

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INTRODUCTION

THE Advancement in technology kept driving more development in many areas. There are many sophisticated games and applications exist during the last 20 years. 3D computer technology grows rapidly and provides some alternatives of 3D software applications to help making our imagination come true. 3D technology application or virtual reality enables people to feel their presence in a specific virtual world. In 2007, a 40 Kilometers bicycle track has been constructed on the grounds of the University of Indonesia (UI). More than 1000 bicycles have been provided by the university to be used freely by the students and staffs to encourage the use of healthy and enjoyable transportation facility. The bicycle track was built according to the green campus and world class eco-campus concept. This program shows UI commitment to address global warming issues.

We propose to create an application that can stimulate students to ride bicycle inside campus. It should simulate the real bicycle track environment. Students should be ensured that in addition to healthy lifestyle, cycling at the university's environment is also safe and fun, by means of having the experience from using the VR program. The main object in this application is a bicycle that moves on UI bicycle track. Imitating the real bicycle, in this application we provide some movement method for the bicycle such as forward, backward, turn left and right. To complete the real effect, the application is added with camera perceptions. The main perception is first person that can see the environment as if one rides the bicycle. Another perception is a third person perception which acts as a chase camera that orbits the bicycle.
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Kiri Fitri Sari; Anna Gianty; Citra Parameswari; Prima Dewi Pumamasari

Abstract

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3D OBJECT IMPLEMENTATION ON BICYCLING AT UI VIRTUAL REALITY APPLICATION BASED ON 3D-GAMESTUDIO

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Abstract — This paper reviews 3D computer technology and our experience in creating a virtual bicycling environment at the University of Indonesia Green Eco-campus. We explain the implementation of the VR environment using 3D-Games Studio and our experience in viewing the result with VR device, i.e. 3D E-Dimensional wireless goggle.

In this work, we present the real world elements with the graphics that imitate the real world such as bicycle movement, camera perceptions, and object collision handling to other entities such as wall, tree, or building. The environment includes bicycle track, trees and obstacles in the pathways.

This application is subsequently tested by the users in terms of the general object condition, user's respond to the virtual reality environment and the future development.

I. INTRODUCTION

The Advancement in technology kept driving more development in many areas. There are many sophisticated games and applications exist during the last 20 years. 3D computer technology grows rapidly and provides some alternatives of 3D software applications to help making our imagination come true. 3D technology application or virtual reality enables people to feel their presence in a specific virtual world. In 2007, a 40 Kilometers bicycle track has been constructed on the green campus and world class eco-campus concept. This program shows UI commitment to address global warming issues.

We proposed to create an application that can stimulate students to ride bicycle inside campus. It should simulate the real bicycle track environment. Students should be ensured that in addition to healthy lifestyle, cycling at the university's environment is also safe and fun, by means of having the experience from using the VR program. The main object in this application is a bicycle that moves on UI bicycle track. Imitating the real bicycle, in this application we provide some movement method for the bicycle such as forward, backward, turn left and right. To complete the real effect, the application is added with camera perceptions. The main perception is first person that can see the environment as if one rides the bicycle. Another perception is a third person perception which acts as a chase camera that orbits the bicycle.

The purpose of the application is to create a complete bicycle object and environment with some behavior which have a direct and indirect perspective camera, built using 3D GameStudio. This tool has three editors, i.e. World Editor, Script Editor, and Model Editor. The application is evaluated and viewed using E-Dimensional 3D wireless glasses for PC.

With VR we can see that the view in the glasses is more real, as if it is really in front of us. The glasses used in this experiment are wireless glasses which receive a signal to synchronize the glasses with the 3D image on the monitor. The 3D goggle in this experiment used the same concept with the equipment the 3D movie in the theatre.

II. LITERATURE REVIEW

A. Virtual Reality

Virtual reality (VR) is a technology which allows a user to interact with a computer-simulated environment, be it a real or imagined one. Users could wear many devices that can translate the movement to be used for manipulating virtual object [2]. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones [1].

Users can interact with a virtual environment or virtual artifacts (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus boom arm, and omni-directional treadmill [1].

B. Stereoscopic Equipment

One type of stereoscopic or binocular vision is 3D glasses. E-Dimensional 3D wireless glasses for PC are examples of these stereo-3D-devices. These glasses will help our eyes to see the real 3D vision effect of the simulations that will be viewed. These wireless glasses are not only having dongle as connector but also have one additional component, the infrared transmitter.

Stereoscopy is useful in viewing images rendered from large multi-dimensional data sets such as those produced by experimental data. The three-dimensional depth information can be reconstructed from two images using a computer corresponds the pixels in the left and right images [7].
1. Dongle

Dongle is a triangular box with a VGA cable coming out of one side. The dongle will control the glasses as well as synchronize the glasses with the monitor. The dongle has three connections on the back, one for the monitor in the middle, the larger circular one for the wireless transmitter and the other smaller silver connection for the wired glasses to plug in directly. Currently the dongle only supports a VGA connection, not DVI [8].

2. Wireless Glasses

The glasses work as a filter for what we see on monitor. We will know something 3D is being displayed when the screen looks blurry to the naked eye without the glasses on.

3. Transmitter

The transmitter is used to transmit signal produces by dongle to glasses. The transmitter for the wireless glasses plugs directly in to the dongle. The transmitter is placed on the top of the monitor.

4. Monitor

There are two kinds of monitor that usually used, i.e. CRT and LCD monitor. A CRT monitor is a thick and heavy monitor with a glass front part. An LCD monitor is a thin monitor that has a plastic-like material for the screen and can typically be lifted easily with one hand.

C. VR Applications

3D computer graphics software refers to programs used to create 3D computer-generated imagery. Most of the 3D packages have plug-in-oriented architecture costing tens or hundreds of thousands of dollars are often used by studios [9] such as 3Ds Max, Blender, Cinema 4D, LightWave 3D. For example 3Ds Max (Autodesk), which is used in the video game industry for developing models and creating cinema cut-scenes. Blender (Blender Foundation) is a free, open-source, 3D studio for animation, modeling, rendering, and texturing offering a feature set comparable to high end and mid range 3D animation suites. Cinema 4D (MAXON) is claimed to be artist-friendly, and is designed with the less-technical user in mind. LightWave 3D (NewTek) was originally bundled as part of the Video Toaster package and entered the market as a low cost way for TV production companies to create quality CG for their programming. Maya (Autodesk) has a high learning curve but has developed over the years into an application platform in and of itself through extendibility via its MEL programming language. SoftimageXSI (Avid) has additional features and integrates with mental ray rendering.

In 3D programming there are popular terms, i.e. 3D engine, 3D language, and 3D authoring system. A 3D Engine is a library of 3D graphics functions. Many 3D engines are available on the Internet, some (even good ones) are free, some for commercial use. 3D engines require programming with an external development system, normally Microsoft Visual C++. Programming a 3D application around a 3D engine offers a maximum flexibility, especially since the programmers usually have access to the engine's source code. However it also requires a maximum of effort and time to be invested before something is moving in a game or applications [4].

An easier approach is offered by a 3D Language, which is a scripting language specially designed for 3D games. Such languages do not offer the flexibility of a 3D engine, but avoid a lot of problems related to "real" programming. Many 3D languages use BASIC, C or Java-based languages, which are better suited for large program or complex projects [4].

The easiest way to create a game or 3D application is an authoring system, which has its own 3D engine and a visual editor. Only simple applications can be created without any programming. Thus authoring systems normally also provide a scripting language for programming or customizing the game. With an authoring system, an application can be completely develop without the need to understand the source code and library functions of a 3D engine [4].

There are various tools to create 3D applications. Programmers can choose anything due to their needs. For the next part, it will be explain about 3D GameStudio, a 3D software that is used to make the simulation in this project.

D. 3D GameStudio

3D GameStudio, often known as Gamesudio or 3DG for short, is a 3D computer game development system which allows users to create 3D games and other virtual reality applications, and publish them royalty-free. It comes with a model/terrain editor, a level editor, and a script editor and debugger, and also contains a texture and artwork collection [5]. GameStudio can be used to create 2D and 3D games, simulations, or other multimedia applications. A 3D game normally consists of one or several virtual environments - Levels. A level is built from geometric blocks, irregular terrain, variable entities, as well as special items like light and sound sources and actor paths. Image paths, called Textures, are put onto the surfaces of every block. Blocks can be of various shapes, and their material can have certain properties, like being fluid or solid. Entities can be simple sprites, animated models, or sub-levels. Anything that is moving, like a door or a monster, is under control of a program or script. Scripts are also responsible for the user interface and for special effects, like dynamic lights, flares, particles, fog, or shades [6].

3D GameStudio needs Model Editor (MED) or World Editor (WED), and we can use 3rd party programs if needed. 3D GameStudio imports many of the popular formats. It has a well-designed Script Editor (SED) where we can easily see all variables, functions and actions and go to any of them with one click of the button [6]. In 3D GameStudio, there is a huge library of 1000 prefabricated textures, building parts, furniture, vehicles, weapons and actors is included [1]. For complex and custom games or other applications, we need to use either the integrated scripting language Lite-c, or an external development system such as Visual C++ or Delphi [1].

Many 3D game systems use scripting languages for controlling objects or actors. The more things move in the game, the more script instructions have to be executed per second. Most script languages are interpreted. This means
that instructions are first translated into an intermediate byte code. The processor interprets the code byte by byte at run time, which causes a slow execution and affects the frame rate. A script compiler translates the language into real machine code—the native language of the processor. Compiled scripts run up to 10 times faster than interpreted scripts, and do not influence the frame rate even in huge games with hundreds of simultaneously moving objects [4].

SED is like a general plain text editor with a compiler and debugger. The script editor is used to program in Lite-C or C-Script, a scripting language similar to C used in previous generations but supported for compatibility.

1. Lite-C [7,8]
Lite-C is a programming language dedicated to the creation of multimedia applications and computer games, with syntax similar to the C programming language. The difference to C is the native support of multimedia objects like sounds, images, movies, user interface elements, 2D and 3D models, terrains, game levels, collision detection and rigid body physics. The intention is to achieve quick results using only a few lines of Lite-C code [7].

Lite-C supports FBX, 3DS, X, OBJ, ASE, MAP, MDL, MD2, FX, BMP, PCX, and Text Fragments file formats. It has the following features:
- Extended C syntax, easy and transparent multitasking.
- Compiles on the fly to machine code executable.
- Easy integration of external APIs (OpenGL, DirectX) with DLL or COM interface.
- Powerful ABT (Adaptive Binary Tree) rendering engine.
- 2D and 3D sprites and models, vertex and bones animation.
- Programmable particle effect generators.
- Rigid body physics and collision engine.
- Layered sky system with sky cubes, sky domes, clouds and backdrop images.
- Built-in vector, matrix, physics and collision functions.
- GUI objects with button, slider, gauge elements, true-type and bitmap fonts.
- Supports all DirectX 9 functions.
- Play functions for sound, music and movie files and CD tracks.
- Syntax-highlighting script editor with single-step debugger.

2. WorldEditor (WED)
WED is the editor for creating the virtual worlds, also called levels. It also serves as the 'control center' where levels, models, and scripts will be linked together to the final game [6].

With WED, the various objects can be arranged, actions can be assigned to models (also known as entities) which are defined through scripts, textures can be assigned to level geometry, and levels can be built using Binary space partitioning tree (or BSP for short) technique.

WED is the main program of GameStudio where all parts of the game or applications (programming, 3D graphics, levels) can be merged [5]. Fig. 1 shows the outlook of WED.

![Fig. 1 WED Views](image)

The layout for WED is fairly simple. The main part, the central right section, is where most of the editing is done. There are three graphs and a 3D view. The graphs are split into multiples of 128 and further split into multiples of 16 to help with snapping and spacing. The graphs will automatically resize when user zoom out a bit and in steps of multiples of 8 (1024 and 128 then 8192 and 1024).

The left central section lists objects in user level, textures, and some other things. The top is the tool bar which allows user to manipulate objects, add new objects (such as entities, sounds, and lights) and build levels.

Entering a position, assigning and action to an entity or readjustment of the textures to the individual sides of block can be done by right-clicking on something and choosing properties [5].

3. Model Editor (MED)
The model editor (or MED for short), provides the capabilities of designing models, and sometimes used to make levels with. Models can be made of anything ranging from simple boxes, to human models or complex environments like an entire city. Models are made of meshes, a group of vertices and triangles (often called "polygons") put together to form a shape; a skeleton of bones for animation; one or several textures for the skin; and effect files (.fx) for shaders [5]. Fig. 2 shows the outlook of MED.

Similar to WED, MED's general layout is with three graphs and 3D view. They are arranged in the same way as WED. However, by default, MED does not have the grids, but it can be configured that way. MED has a skin editor, which allows the model to be textured. The skin editor has a completely different layout. The texture is shown on the left side and the model is shown on the right with tool bars sur-
can directly save their models in GameStudio format by means of a plugin. Plugins for creating GameStudio models with MAX or Maya can be downloaded from the GameStudio site [6].

b. Sprite

A sprite (also called billboard) is a 'flat' 2-D object that can serve several purposes. It can be placed at a wall or floor. It can stand upright in the landscape like a billboard, or can behave like pseudo-3D by always facing the camera.

Sprites are stored in external PCX, BMP, TGA, or DDS files and can be created using a standard paint program, like Gimp, PaintShop Pro® or Adobe Photoshop®. TGA or DDS files can contain an alpha channel which gives a transparency value for each single pixel. PCX, BMP, or TGA files can be animated. DDS files can contain several mipmap maps for better quality and faster rendering. Sprite entities are rendered faster than map or model entities, and can be used for explosions, lights, flames, trees, grass or the like [6].

c. Sublevel (Map Entities)

Map entity is simply a small compiled level, stored in an external WMB file. Map entities can be used for level parts which move as a whole, like doors, platforms, or vehicles. Because they are nothing else than compiled maps, it can be created using WED.

Textures and shadow maps of the level and of map entities are pre-allocated in video memory at loading time, in order to maintain smooth game play. Textures of all other entity types are only allocated when the entity becomes visible [6].

d. Terrain

Terrain consists of one or several textures mapped onto a rectangular grid of height values. It is stored in an external HMP file. As the name says, terrain entities can be used for level parts that are irregular terrain. They can be created with MED, or imported from RAW height maps or BMP or PCX height image bitmaps that are created with terrain builder programs. Terrain can not be animated, rotated, moved, or scaled; however it can be deformed in real time by the engine. The texture is projected vertically; for that reason the texture on slopes will look 'stretched'.

The engine supports two types of terrain, unchunked or C chunked. Which type a terrain has is determined by the terrain_chunk variable or by a file name ending with .n' (e.g. "nonchunked_n.hmp"). Unchunked terrain is rendered just like a model, and must not exceed a size of 128x128 vertices. The engine's sophisticated terrain rendering algorithm unfolds its power with chunked terrain [6].

III. DESIGN OF THE APPLICATION

In this work we design a VR environment and make a 3D bicycle object with some moving behaviors such as forward, backward, turn to the left and to the right, and stop. The addition parts are 1st person camera that act as a direct camera from the object and 3rd person camera that orbit or act as chase camera.
A. Architectural Design

Architectural design will be shown using Unified Modeling system (using 3 diagrams). The Use Case diagram is the diagram that show work system from the user perceptions, as shown in Fig 3.

- Choose camera perception
- Bicycle movement
- Respond to protagonist

User

Fig. 3 Use Case Diagram

Activity diagram is the diagram that shows the flow activities of the system. The activity diagram is seen on Fig. 4.

Use-case is a technique based on scenario for conditional elicitation that the first introduced to object method. Use-case presently has been a UML notation base feature to describe object oriented system model. In the simplest form, use-case identifies actor involved in the interaction and interaction type name.

Every use-case represents interaction and system. We can use any technique to describe use-case as long as the description is short and easily understood. Use-case description helps identifying object and operation system [11].

Fig. 4 Activity Diagram

The activity diagram can be seen in Fig 4. Class diagram is the diagram that shows the classes in program with their relationship. Fig 5 depicts the Class Diagram of the system.

The objects in these figures are motionless object. It consists of every object sees along road such as trees, buildings, cars, street lamps, biking locker, biking block, and map. Fig. 6 shows the class diagram used for bicycle application in UI.

This design includes environment planning so that the most applying editors are WED and MED. MED is to create object model and terrain then they are united in WED.

WED also has a function as environment editor which the objects have created in MED.

Model consists of thousands of polygons. In MED there are some tools at menu bar can be used to start the desired model. The tools are 3 dimension structures, are cubes, spheres, cylinders, and prisms. Model is composed and textured as desired by using manage skin. There are Scale, Move, and Rotate tool in WED. Other tools can be use to weld and subdivide polygon of model and also extrude.

MED function as a terrain creation is location map with contoured surface. Terrain can be created by using magnet. It can be done by importing .bmp, .pcx, and .tga image; it requires power-of-2 texture sizes. Fig. 7 shows a created terrain, by importing image from Photoshop. The bicycle model can be seen in Fig. 8.

In WED, object can be created as in Fig. 9. In addition to the bicycle, there are some inserted objects such as build-
ings and vehicles. All of created objects are called and united in WED.

To make texture in WED, inserted standard wad or imports supported wad file format is used. Texture Manager helps choosing texture that displays in dialog box at left side of WED.

Fig.11 shows the running application in which the bicycle object is shown in the 1st perspective camera.

IV. RESULT AND EVALUATION

A. System Evaluation

After the environment is implemented and united with objects and some syntax in SED, the program is then compiled and run in .exe file format. Therefore the program can be run without the presence of 3D Gamestudio software.

With VR device, users can try bicycle path in UI environment virtually although it is not resembled with the origin environment as UI proclaims.

This application has been evaluated by 10 respondents and the result has been present using the following formula:

\[
\text{95\% Confidence Interval} = \text{Average} \pm (1.96 \times \text{Standard Deviation}) / \sqrt{\text{Populations}}
\]

Table 1 shows the test results:

<table>
<thead>
<tr>
<th>Table I. RESULT OF THE USER TESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question</strong></td>
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<tr>
<td>-------------------------------------</td>
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<tr>
<td>1. Familiarity with 3D Applications</td>
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<tr>
<td>2. Familiarity with Lite-C</td>
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<tr>
<td>3. Familiarity with 3D Gamestudio</td>
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<tr>
<td>4. 3D bicycle object design</td>
</tr>
<tr>
<td>5. Object control</td>
</tr>
<tr>
<td>6. Object forward movement</td>
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<tr>
<td>7. Object backward movement</td>
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<tr>
<td>8. Object to the right movement</td>
</tr>
<tr>
<td>9. Object forward movement</td>
</tr>
<tr>
<td>10. Direct perspective camera</td>
</tr>
<tr>
<td>11. Un-directed perspective camera</td>
</tr>
<tr>
<td>12. Object speed</td>
</tr>
<tr>
<td>13. Collision handling</td>
</tr>
<tr>
<td>14. Virtual world can really imitate the real world</td>
</tr>
<tr>
<td>15. Future projections</td>
</tr>
</tbody>
</table>

In terms of the use of the 3D Wireless goggle, the following is our description of user testing. Glasses have a direct line of sight from the glasses to the transmitter. The glasses work as a filter for what we see on monitor. When the 3D is turned on, the images on the screen should appear slightly blurry or doubled to the naked eye. If we have ever seen a 3D movie in the theater this is the same concept.

The first simple way to test whether the glasses are working and the communication between the transmitter (wireless only) and the glasses is to download our program called the E-D activator (E-D.exe). This can be found in the software updates section of the cDimensional.com website.

To know that the 3D is turned on, first the images on the screen should appear slightly blurry to the naked eye. Lens glasses should work well. When a 3D image is being dis-
played, wears the glasses and press the ON button. In Fig. 12 shows user wears the E-Dimensiononal wireless glasses.

Fig 11. The use of E-Dimensional wireless glasses

From survey it concludes that environment design is good, and environment structure is good. According to respondents, VR devices such as glasses, dongle, and transmitter, are easy to use and handle and enable them to see the 3-dimension effect. The users know about VR and 3D Gamestudio well. Figure 12 shows the 3D implementation results. Respondents advise that further development and more detailed environment should be created to provide a real presence in the the VR environment.

V. Conclusion

The implementation of virtual reality bicycling at University of Indonesia green eco-campus environment using 3D Games studio software has been shown in this paper. The user test results show that users are relatively satisfactory with the 3D built environment. However, further more detailed implementation is necessary by adding more features. The use of 3D Glasses for the VR experience has provided an extra experience using different devices to create a more real environment.

Future work will involve improving the virtual reality environment of the bicycle track and all buildings at the University of Indonesia’s Depok campus. We will also explore other VR application development platform such as using Alice. We plan to put the system in public spaces in which students and other users can use the VR system. This is also will promote the preservation of environment by using the free bicycling facility at the University of Indonesia.

REFERENCES


B. Software Evaluation

3D Gamestudio software has been chosen because it can be used for VR. Not all of 3D software can be used for VR. Although this 3D creation concept is not very much different from other 3D software, the existing feature such as grid and extrude are useful.