Shooting Simulator System Design Based on Augmented Reality

by Oky Dwi Nurhayati

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Abstract— **Development of computer technology** today has a major role in the development process of interaction in computer-based applications. Various innovations in creating the user experience of applications began are increasing. Augmented reality is a technology model the interaction between humans and computers by using a model of a merger between the real world with the virtual world. This development certainly can help people or community in various fields, especially in the field of shooting. Shooting is one of the many activities carried out by members of the TNI, POLRI and PERBAKIN. Activities in course are requires skill and a good psychological condition. To obtain good craftsmanship, each member takes a routine of training activities. Computer graphics technology is use in the process of shooting practice. This process utilizes Augmented Reality technology roles. With this technology in practice shooting environment can be created artificially or virtually. Methodology used in this research is system software of development, it is called waterfall model. The use of this method is to generate a reliable system so that the system can work according to the needs. Based on testing the functionality of the system has meet the initial needs, the system works in accordance with the scenario. The minimum distance of the camera to the marker to be recognized is 20 cm and the maximum distance is 300 cm

Keywords— *shooting, Augmented Reality, marker, Computer graphics*

I. INTRODUCTION

Shooting is one of the many activities carried out by members of the TNI, POLRI and PERBAKIN. Activity ni course requires skill and a good psychological condition. To obtain good craftsmanship, each member takes a routine of training activities. Besides shooting activities, requires a rigorous process from making the viewfinder image, regulate breathing and set the rhythm to pull the trigger so that the bullet from the rifle off towards the intended target liking.

The development of computer graphics technology is currently in the process affects the human and computer interaction. Various innovations in creating the user experience of applications began to increase. New interaction technology is augmented reality, virtual reality and natural user interaction to be one part that interests the user. This development certainly can use in various fields, especially in the field of shooting.

Computer graphics technology can help in the process of shooting practice. This process utilizes Augmented Reality technology roles. With this technology in practice shooting environment can be created artificially or virtual. This paper will discuss the design of virtual environments on a shooting simulator system by utilizing Augmented Reality technology. This technology can help in overcoming the limitations at the time of conducting firing exercises. Virtual environment that will be developed in this study using a tool ARToolKit and marker base in the detection process.

II. LITERATURE

A. Computer Graphics

Computer graphics is the study of how to create images and animations involving computers, both hardware and software [1]. To obtain an image in a computer, then the first thing to do is to describe the geometric of the object to be used or displayed. To describe the object on a computer the same as the process performed when describing objects in paper, using Cartesian coordinate. A coordinate system is a way to determine the position of a point by a set of numbers (coordinates) that can be distances from a set of reference

planes, angles subtended with an origin, or a combination of both [2]. This is the most commonly used coordinate system in computers. The position of a point is determined by three distances, from each of the planes. The axes are at right angles (orthogonal) and are typically used to specify spatial dimensions: width, height, and depth (x, y, z). Cartesian coordinates are the most common data to represent real, theoretical, and artistic worlds [2]. Fig. 1 display about Cartesian coordinates 3D.
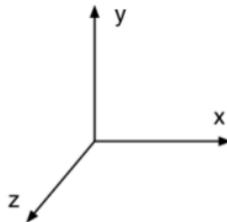

Fig. 1 Cartesian Coodinates[3]

X – Y - Z is matrix for describe component of a data. The x-axis and y-axis represent the first two dimensions; the z-axis, the third dimension. In a graphic image, the x and y denote width and height; the z denotes depth.

In computer graphics, there are several libraries used. The one used in this research is to use OpenGL. This library is an API that is used to develop applications of computer graphics 2D or 3D. This library has a cross-platform nature so that it can run on a free operating system. OpenGL provides a set of commands to draw objects either 2D or 3D. The original function of OpenGL itself always starts with gl contained in opengl32.dll library and header files gl.h. While some libraries that have been written to provide additional functions in OpenGL are:

1. OpenGL Utility Library (GLU) in which there are a number of routines that use lower levels of OpenGL commands. These routines have the prefix glu. This library is used as part of the implementation of OpenGL.

2. OpenGL Extension to the X-Windows which provides functions for creating OpenGL context and associate it with a machine that uses XWindows. These routines have the prefix glx.

3. Auxiliary or aux library contained on glaux.lib library and header files glaux.h. Command to be used always use the prefix aux

4. OpenGL Utility Toolkit (GLUT) is a toolkit for the Windows system.

Here is a sample piece of the program by using the OpenGL library to draw an object in the form of 3D.

```
glBegin(GL_POLYGON);
    glVertex3f (0.25, 0.25, 0.0);
    glVertex3f (0.75, 0.25, 0.0);
    glVertex3f (0.75, 0.75, 0.0);
    glVertex3f (0.25, 0.75, 0.0);
glEnd();
```

glVertex commands are used within glBegin/glEnd pairs to specify point, line, and polygon vertices. The current color, normal, texture coordinates, and fog coordinate are associated with the vertex when glVertex is called. When only x and y are specified, z defaults to 0 and w defaults to 1. When x, y, and z are specified, w defaults to 1. glBegin and glEnd delimit the vertices that define a primitive or a group of like primitives. glBegin accepts a single argument that specifies in which ten ways the vertices are interpreted, example is GL_POLYGON [3][4]. To create a 2D object then writing program is as follows :

```
glBegin(GL_POLYGON);
    glVertex2f (0.25, 0.25);
    glVertex2f (0.75, 0.25);
    glVertex2f (0.75, 0.75);
    glVertex2f (0.25, 0.75);
glEnd();
```

B. Augmented Reality

Augmented reality is a technology that is becoming a trend at the moment. This technology is a combination of the virtual world with the real world. This technology is breakthrough that can be used to improve the user experience interact with a system [5]. In building augmented reality -based applications can use two kinds of access methods, namely the marker base and Marker less . Fig. 2 is one example of augmented reality apps

Figure 2.2 Application of Augmented Realty [5]

Broadly speaking, the components used in augmented reality applications include cameras , markers and computer . The camera is a tool that will be used to take pictures and the results will be sent into the computer . Marker used for the marker to be translated by a computer to the process of displaying objects or virtual objects . While the computer is part of a computer used to process graphics. Fig.3 is a schematic of the processing of augmented reality systems .
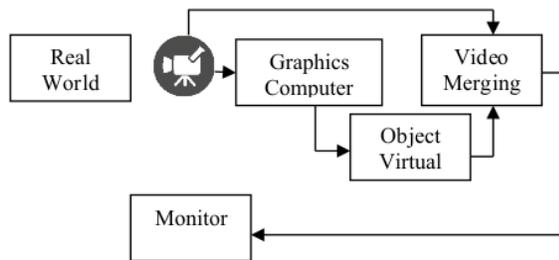

Fig. 3 Schematic of Augmented Reality

The camera is a component used to capture the image in the real world that will be forwarded depth chart system computer systems and video merging. This chart of the computer system will be created virtual object. While the video merging used mixed of the virtual object with images captured by the camera. Component of the monitor is a device used to display the output of the augmented reality system.

To identify or detect images that will be displayed in an augmented reality system uses two kinds of models of marker base and Marker less. Definition of image with the marker is a specific pattern that will serve as a target for the detection of a virtual object to be displayed. The computer will recognize the position and orientation of the marker and create a 3D virtual world that is the point (0, 0, 0) and three axes, namely X, Y, and Z. Once detected, it will be defined the right scale and pose of the camera. This approach is called marker-based tracking, and is widely used in AR [6]. Fig.4 is one example of marker used in augmented reality applications.

Fig. 4 Marker Design [6]

To display the application can use the output monitor or using a head mounted display. The use of head mounted display will give a more real effect because the viewpoint of users will experience the difference compared to when using the monitor. The method used in displaying the object in the head mounted display is divided into two types, see video tracking and optical tracking see. Fig.5 shows the methods in displaying the object .
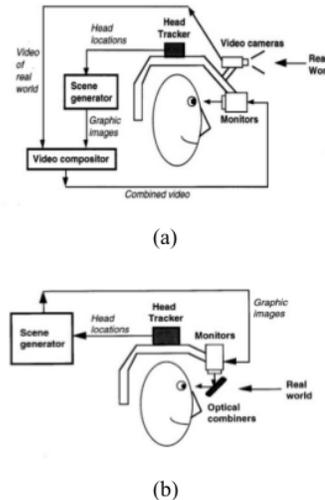
(a)

(b)

Fig. 5 a. Video See Tracking, b. Optical See tracking [7]

ARToolKit is one of the libraries used to develop augmented reality applications. This library is a library that involves overlaying virtual imaging to the real world. To do this, use tracking ARToolKit video, to calculate the real camera position and orient the pattern on the paper marker in real time. After, the original camera position is known, then the virtual camera can be positioned at the same point, and 3D objects are described above marker. So ARToolKit resolve issues in AR ie, the viewpoint of the object tracking and interaction of virtual objects. 3-D object that can be supported by, among others ARToolKit VRML files and 3ds file.

VRML (Virtual Reality Modeling Language) is a computer language to create three-dimensional models of objects in a virtual world. Not only that, to simulate a moving object that can be done with VRML The Virtual Reality Modeling Language (VRML) and Java provide a standardized, portable and platform independent way to render dynamic, interactive 3D scenes across the Internet. Integrating of two powerful and portable software languages plus Provides interactive 3D graphics programming capabilities, plus complete network access [8]. Here are pieces of programs used to create the object by using VRML

```
DirectionalLight {
  direction 0 -1 0
}
Transform {
  rotation 0 0 -1 1
  children [
    Shape {
      appearance Appearance {
        material Material {diffuseColor 1 1 0}
      }
```

III. METHODOLOGY

Methodology used in this research is to use system software development with the waterfall model. The method is to generate a reliable system so that the system can work according to the needs. Phase - stages are as follow:

1. Analysis of needs

The needed resources to making this system such us interface system, hardware requirements, the needs of libraries used to support the system. Hardware needed: webcam, rifles, and computers. While the library used is OpenGL, ARToolKit, and VRMLpad.

2. Design

The design process is to perform interface design, system design flow through the system flow chart. Fig. 6 shows a flow diagram of the system.
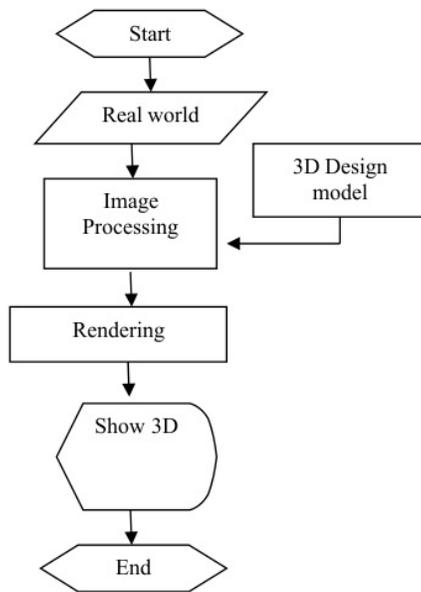
Fig. 6 Flowchart Simulator System Shooting

3. Implementation

This stage is create programming process by using Visual Studio with the programming language C ++, OpenGL Library and ARToolKit.

4. Testing

This stage is testing process are using a black box testing. This test includes functional testing of the detection marker and the position of the camera to the marker.

IV. RESULT

1. Implementation

Implementation is done on a desktop computer with the following specifications:

1. Processor : Intel Core i5 (3.2 GHz , 6M Cache) up to 3.6 GHz
2. Memory 8GB RAM
3. Camera Webcam

Fig. 7 shows the results of the implementation on the start screen shooting simulator system
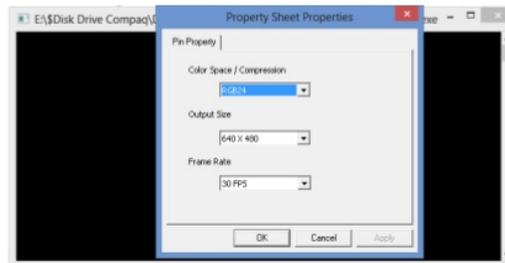
Fig. 7 The initial view of the system

At the beginning of this there is a menu option to display the output . Users can set the color space with a choice of RGB24 or I420 , screen size and frame rate. In Fig. 8 are shown the application window that is ready for use.
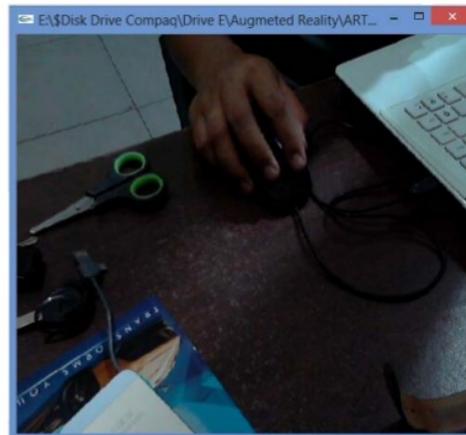
Fig. 8 Windows Application

The width of this window will depend on the process of setting the beginning. Fig. 9 shows the marker detection process with hiro pattern. Marker detection process is intended to identify markers and then the computer will perform image processing and will display the virtual object and will be incorporated in the real world.
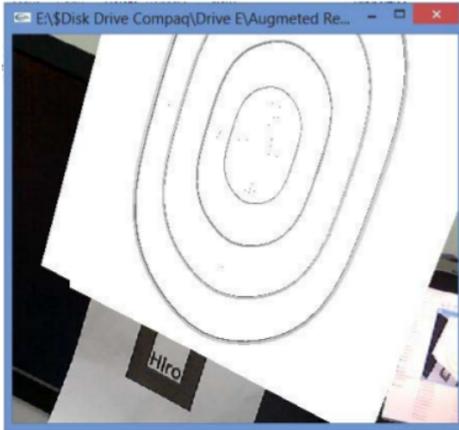

Fig. 9 Display Virtual Object

2. Testing

Testing is done by using the black box testing is intended to test the functionality of the system. Table 4.1 shows the results of the application of black box testing simulator shooting.

Table. 1 Black Box Testing Results

No	Testing	Expected Results	Results
1	Cammera Detection	Applications can recognize the camera	succeed
2	Output function setting windows size	The window size can be adjusted according to choice	succeed
3	Marker Detection	Displaying virtual object	succeed

Based on the results of black box testing every function of the application can operate in accordance with the initial scenario. The next stage is to test the minimum and maximum distance so that the marker can be detected by the camera. Table 4.2 shows the test results within the camera to the marker.

Table. 2 Tests of the Distance Marker to Camera

No	Distance Marker on the camera (cm)	Result
1	5 ± 0.5	Fail
2	10 ± 0.5	Fail
3	15 ± 0.5	Fail
4	20 ± 0.5	succeed
5	25 ± 0.5	succeed
6	30 ± 0.5	succeed
7	35 ± 0.5	succeed
8	40 ± 0.5	succeed
9	45 ± 0.5	succeed
10	50 ± 0.5	succeed
11	55 ± 0.5	succeed
12	60 ± 0.5	succeed
13	65 ± 0.5	succeed
14	70 ± 0.5	succeed
15	75 ± 0.5	succeed
16	80 ± 0.5	succeed
17	85 ± 0.5	succeed
18	90 ± 0.5	succeed
19	95 ± 0.5	succeed
20	100 ± 0.5	succeed
21	200 ± 0.5	succeed
22	300 ± 0.5	succeed
23	400 ± 0.5	Fail

At the distance of the camera to the marker test is obtained where the minimum distance of the camera to the marker is 20 cm and the maximum distance is 300 cm.

CONCLUSION

The conclusions obtained from this study are as follows:

1. Based on testing the functionality of the system has met the initial requirements, the system works in accordance with the scenario

2. The minimum distance of the camera to the marker to be recognized is 20 cm and the maximum distance is 300 cm.

Suggestions in this study are as follows:

1. The development of the system further by adding calculation accuracy

2. Increase the number of virtual environment object

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