The Comparison Of Tracking Methods Using QR Code Marker And Texture Marker On Augmented Reality Application

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ABSTRACT

The research entitled " The Comparison Of Tracking Methods Using QR Code Marker And Texture Marker On Augmented Reality Application" aims to build augmented reality-based learning applications, implement tracking methods and then compare QR code markers with texture markers to determine which markers are better in augmented reality. This application displays 3-dimensional virtual objects by utilizing augmented reality technology with the help of the vuforia library, unity 3D software, and blender. Comparison of tracking methods using QR code markers and texture markers based on factors that affect the success of the application in detecting markers/detection objects. These factors are detection angle, detection distance and light intensity. Based on the results of testing on augmented reality applications with tracking methods using QR code markers and texture markers, it is known that QR Code markers can better display 3-dimensional virtual objects based on detection distance and detection angle.

Keywords : Augmented Reality, Tracking Metode, QR Code Marker, Texture Marker.

INTRODUCTION

According to Ronald T. Azuma (2014) Augmented Reality (AR) is a computer research field that combines 3D graphics data with the real world or in other words reality added to a medium. This media can be paper, a marker or marker through certain input devices. This technology does not completely replace a reality, but adds (augment) a or several virtual objects in the form of 2 or 3 dimensions into a real 3-dimensional environment and is displayed in realtime. Augmented Reality with tracking method uses markers / markers to display 3-dimensional virtual objects. Markers are markers with certain patterns, which can be QR code markers, texture markers, or other patterns. The position and orientation of the marker will be recognized and create a virtual 3D point (0,0,0) and 3 axes X,Y, and Z and will be displayed in realtime. Markers can be applied to 2-dimensional images or attached to 3-dimensional objects.

Factors that affect the success of the tracking method in displaying 3-dimensional objects are angle, distance and light intensity in detecting markers/objects. The angle is very influential on the success rate of displaying 3-dimensional objects, if the angle of detection of the marker / detection object is not appropriate then the 3-dimensional object cannot be displayed. Distance also affects the success of displaying 3-dimensional objects, a distance that is too close or too far causes the marker/object detection cannot be tracked. Light intensity is also an important factor because the camera used in the marker/object detection process is very dependent on light conditions, if the light conditions are poor then the 3-dimensional object cannot be displayed.

Based on the description above, researchers are interested in implementing augmented reality tracking methods, then comparing QR code markers and texture markers based on factors that affect the success of displaying 3-dimensional objects, namely angle, distance and light intensity in marker detection / object detection. Therefore, a study entitled " The

Comparison Of Tracking Methods Using QR Code Marker And Texture Marker On Augmented Reality Application " was made. Through this research is expected to know which marker is better in displaying 3-dimensional objects based on these factors.

LITERATURE REVIEW
Augmented Reality

According to Ronald T. Azuma (2014) defines Augmented reality as the merging of real and virtual objects in the real environment, running interactively in real time and there is integration and virtual is possible with appropriate display technology, interactivity is possible through certain input devices, and good integration requires effective explanation. Meanwhile, according to Stephen Coward and Mark Faila in his book entitled Augmented reality a partical guide, defines that Augmented reality is a natural way to explore 3D objects and data, AR is a concept of fusion between visual reality and world reality. So that the object of 2-dimensional virtual objects (2D) AR technology, users can see the real world around them with the addition of computer-generated virtual objects. In the book "Hand Book of Augmented reality", Augmented reality aims to simplify users' lives by bringing virtual information not only to the surrounding environment, but also to every direct view of the real world environment, such as live streaming video. AR enhances user perception and interaction with the real world.

The way augmented reality works in adding virtual objects to the real environment is as follows:

a. The input device captures the video and sends it to the processor.
b. The software inside the processor processes the video and looks for a pattern.
c. The software calculates the position of the pattern to know where to place the virtual object.
d. The software identifies the pattern and matches it with the information the software has.
e. The virtual object will be added according to the result of the information matching and placed at the previously calculated position.
f. The virtual object will be displayed through the display device.
   How this augmented reality works can be seen in Figure 1.
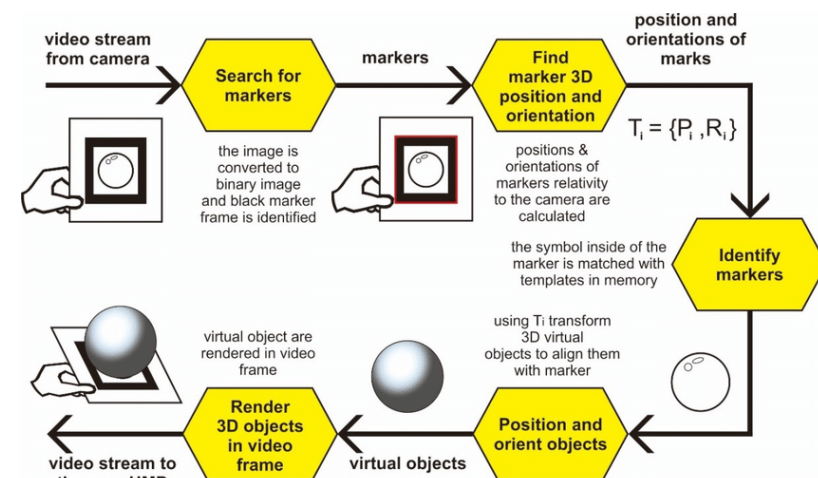
**Figure 1. System diagram of how Augmented Reality works**

357

Tracking Methods

The tracking method is an augmented reality method that recognizes the marker and identifies the pattern of the marker to add a virtual object to the real environment (Chari, 2008). The virtual coordinate point on the marker serves to determine the position of the virtual object that will be added to the real environment. The position of the virtual object will be located perpendicular to the marker. The virtual object will stand in line with the Z axis and perpendicular to the X axis (right or left) and Y axis (front or back) of the marker virtual coordinates. An illustration of the virtual marker coordinates can be seen in Figure 2.
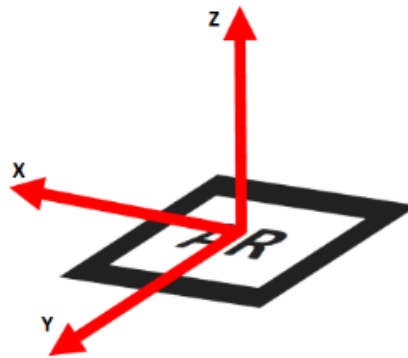

Figure 2. Virtual coordinate point on the Marker

The tracking process starts from the Image input stage. This stage is the stage where the processor processes in realtime frame by frame from the video captured by the capture trap. The next stage is image thresholding, at this stage each video frame undergoes a thresholding process to produce a black and white image. This stage aims to recognize the rectangular shape and marker pattern of the captured video (Christoper, 2012). The tracking process is marker detection or marker detection, at this stage consists of four processes, namely: contours extraction, corner detection, pattern normalization and template matching. The contours extraction and corner detection process can be seen in the next Figure.
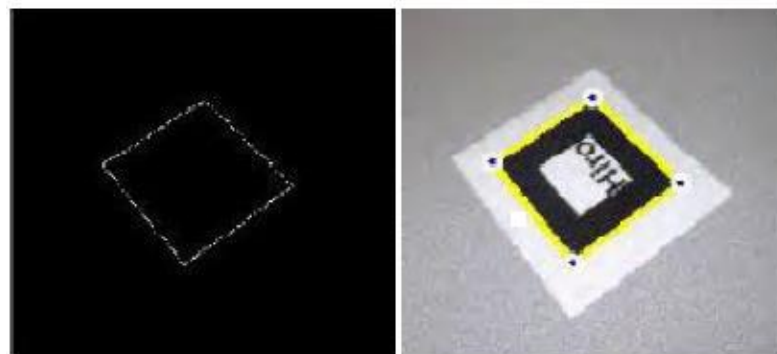

Figure 3. Contours Extraction and Corner Detection

The contours extraction and corner detection process utilizes the black and white image obtained in the second stage to obtain the coordinates of the four sides and four corner points of the marker (Christoper, 2012) in Figure 4.

$$a_1x+b_1y+c_1=0$$

$$a_2x+b_2y+c_2=0$$
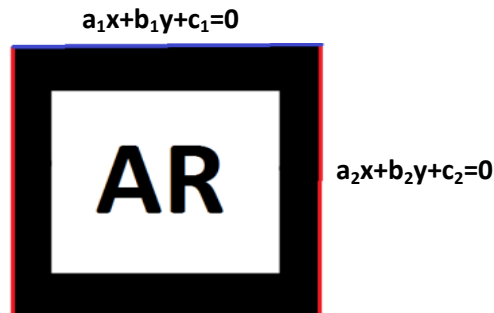
Figure 4. Two parallel lines on the Marker

The next two processes at the marker detection stage are pattern normalization and template matching can be seen in Figure 5. The pattern normalization process aims to normalize the shape of the marker so that the template matching process can be done appropriately.
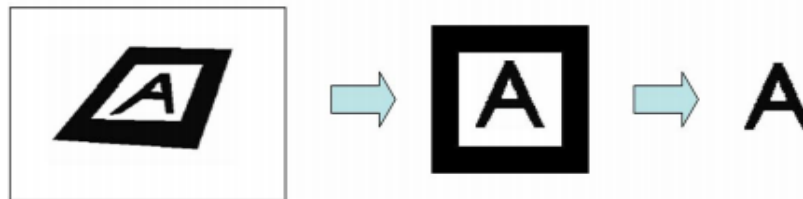
Figure 5. **Pattern Normalization and Template Matching**

The last stage is the pose and position estimation stage. This stage is responsible for placing the virtual object on the marker. At this stage, the relationship between three coordinates plays an important role, namely the coordinates of the display device (observed screen coordinates) (Christoper, 2008). The coordinate system can be seen in Figure 6.
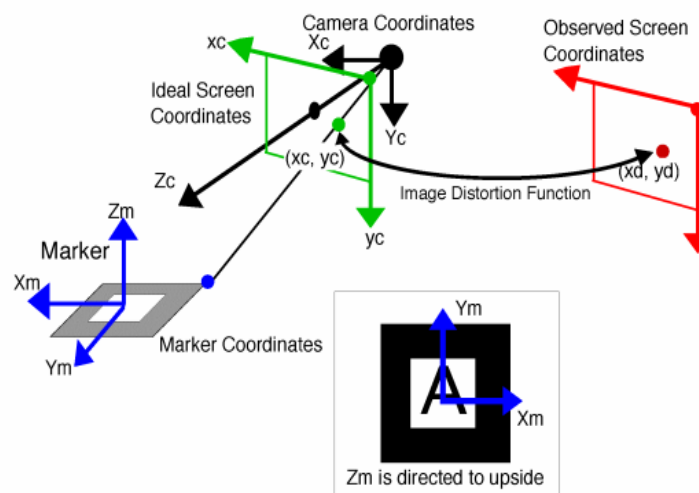
Figure 6. Coordinate System

In this stage, the transformation process needed to get the camera position relative to the marker in coordinates from the video capture is performed.

Marker

According to Siltanen (2012), Marker is a special patterned image that has been

recognized / stored in the application database. The marker will be read and recognized by the camera and then matched with the existing database, after which the camera will render a 3D virtual object on top of the marker. Markers can be applied to 2-dimensional surfaces, or pasted on 3-dimensional objects both flat and curved sides.

METHODS

In this research, the data collection method used is observation. Observation is done to find out the factors that affect the tracking method in displaying 3-dimensional objects. This research will compare the tracking method using QR code markers and augmented reality texture markers based on factors. This research compares QR Code markers and texture markers with augmented reality marker tracking method. The two markers will be compared based on 3 aspects of comparison, namely angle, distance and light intensity. The details are as follows:

a. Angle: 0°, 10°, 20°, 30°, 40°, 50°, 60°, 70°, 80°, 90°.
   The angle measurement uses a protractor tool with the help of a tripod.
b. Distance: 3cm, 5cm, 10cm, 20cm, 30cm, 40cm, 50cm, 60cm, 70cm.
   Distance measurement using a meter.
c. Light intensity: Daytime sunlight (in direct sunlight, on the terrace, indoors with open windows), closed indoor lights (5 watts, 15 watts, and 24 watts).
   Measurement of light intensity using a lux meter.

Research Flow

The research flow in this study is as follows:

a. Literature study, searching and studying literature from books, journals, and previous research related to augmented reality tracking methods.
b. Observing the factors that affect the tracking method in displaying 3-dimensional objects.
c. The process of learning media development approach with multimedia system development method, starting from design to material collecting.
d. The assembly stage is made augmented reality-based applications with a QR code marker database and texture markers.
e. Testing the application based on angle, distance, and light intensity. 3. Research Flow
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k. Testing the application based on angle, distance, and light intensity.

RESULTS AND DISCUSSION
Testing Tools and Materials
Testing the QR code marker tracking method and texture marker uses several equipment with certain specifications. Some of the equipment includes:

1. Android Smartphone with Specifications:
   a. Processor: Qualcomm Snapdragon 710
   b. RAM: 6 GB
   c. Memory: 64 GB
   d. VGA: Adreno 616
   e. Camera: 16 MP, f/1.7, 1/2.6", Sony IMX 519 sensor camera
2. Testing Media
   Testing will be carried out using three comparisons, namely detection angle, detection distance, and light intensity. The sources and conditions used as comparisons are as follows:
   a. Light intensity:
      1) Sunlight sources during the day in the sun, on the terrace, and indoors.
      2) White light source in a closed room. Using 3 lamps with different power, namely dim (5 watt power lamp), medium (15 watt power lamp) and bright (24 watt power lamp).
   b. Angle: 0°, 10°, 20°, 30°, 45°, 60°, 70°, 80°, 90°.
   c. Distance: 3cm, 5cm, 10cm, 20cm, 30cm, 40cm, 50cm, 60cm, 70cm.
3. Measurement Tool
   In measuring the light intensity of the light source, distance and angle of detection, the following tools are used.
   a. Lux meter: light intensity measuring instrument
   b. Length measuring tools: detection distance measuring instrument
   c. Protractor: detection angle measuring instrument
4. QR code marker and texture marker
   The specifications and sizes of the QR code marker and texture marker in the testing process are as follows:
   a. QR code marker
      1) Marker size: 8cm x 8cm, 6cm x 6cm, 4cm x 4xm
      2) Paper type: Matte photo papper

Figure 7. QR Code Marker

   b. Texture marker
      1) Texture type: Wood texture, stone texture, brick texture

2) Marker size: 8cm x 8cm, 6cm x 6cm, 4cm x 4xm
3) Paper type: Matte photo papper.

Figure 8. Wood texture marker, stone texture marker, brick texture marker

Testing Results

1. Light Intensity Testing

Testing is done by taking an angle of 0 ° to the QR code marker and texture marker and a distance of 20cm. The results of the light intensity test can be seen in table 1 below

Table 1. Light intensity testing table

Marker Type	Light intensity					
	Lamp Light			Daylight		
	Dim 7,2 lux	Medium 39 lux	Bright 56 lux	Under Sunlight 84.700 lux	Terrace 9.080 lux	Indoor 91 lux
QR code 8x8	T	T	T	T	T	T
QR code 6x6	T	T	T	T	T	T
QR code 4x4	T	T	T	T	T	T
Wood Texture 8x8	T	T	T	T	T	T
Wood Texture 6x6	T	T	T	T	T	T
Wood Texture 4x4	T	T	T	T	T	T
Stone Texture 8x8	T	T	T	T	T	T
Stone Texture 6x6	T	T	T	T	T	T
Stone Texture 4x4	T	T	T	T	T	T
Brick Texture 8x8	T	T	T	T	T	T
Brick Texture 6x6	T	T	T	T	T	T
Brick Texture 4x4	T	T	T	T	T	T

Description:

T = True

F = False

2. Detection Distance Testing

Testing was carried out in an open window room using a sunlight source during the day with a light magnitude of 91 lux, and taking an angle of 90 °. The results of the detection distance test can be seen in Table 2.

Table 2. Light intensity testing table

Marker Type	Detection distance (cm)								
	3	5	10	20	30	40	50	60	70
QR code 8x8	F	T	T	T	T	T	T	F	F
QR code 6x6	F	T	T	T	T	T	F	F	F
QR code 4x4	F	T	T	T	T	F	F	F	F

Wood Texture 8x8	F	T	T	T	T	T	F	F	F
Wood Texture 6x6	F	T	T	T	T	F	F	F	F
Wood Texture 4x4	F	T	T	T	F	F	F	F	F
Stone Texture 8x8	F	T	T	T	T	T	T	T	F
Stone Texture 6x6	F	T	T	T	T	T	T	F	F
Stone Texture 4x4	F	T	T	T	T	F	F	F	F
Brick Texture 8x8	F	T	T	T	T	T	T	T	F
Brick Texture 6x6	F	T	T	T	T	T	T	F	F
Brick Texture 4x4	F	T	T	T	T	F	F	F	F

Description:

  T = True

  F = False

3. Detection Angle Testing

Testing is done in an open window room using a sunlight source with a light amount of 91 lux and a distance of 25cm from the marker / object. The results can be seen in table below:

Table 3. Detection angle testing table

Marker Type	Detection Angle									
	0°	10°	20°	30°	45°	50°	60°	70°	80°	90°
QR code 8x8	F	F	F	T	T	T	T	T	T	T
QR code 6x6	F	F	F	T	T	T	T	T	T	T
QR code 4x4	F	F	F	T	T	T	T	T	T	T
Wood Texture 8x8	F	F	F	T	T	T	T	T	T	T
Wood Texture 6x6	F	F	F	T	T	T	T	T	T	T
Wood Texture 4x4	F	F	F	T	T	T	T	T	T	T
Stone Texture 8x8	F	F	F	T	T	T	T	T	T	T
Stone Texture 6x6	F	F	F	T	T	T	T	T	T	T
Stone Texture 4x4	F	F	F	T	T	T	T	T	T	T
Brick Texture 8x8	F	F	F	T	T	T	T	T	T	T
Brick Texture 6x6	F	F	F	T	T	T	T	T	T	T
Brick Texture 4x4	F	F	F	T	T	T	T	T	T	T

Description:

  T = True

  F = False

CONCLUSION

The conclusions of this research are:

1. Based on the results of testing the tracking method on QR code markers and texture markers, it can be seen that texture markers can better display 3-dimensional virtual objects based on detection distance.
2. Based on light intensity testing, QR code markers and texture markers can both be detected properly in all light conditions tested with a light intensity value of 7.2 - 84,700 lux.
3. Based on detection distance testing, the marker with the shortest detection distance is the 4cmx4cm wood texture marker with a detection distance of 5-20cm, while the marker with the furthest detection distance is the stone texture marker and the brick

texture marker measuring 8cmx8xm with a detection distance of 5-60cm.

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