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AUGMENTED REALITY FOR CHEMICAL ELEMENTS: PERIODIKAR

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ABSTRACT

A periodic table is a group of arranged chemical elements that contain some information for each element. Information in a periodic table usually provided in the text form, which is less interesting to learn. It can be overcome by creating a visualization of each element. Augmented Reality is a technology that can be used for visualizing objects. In this paper, augmented reality technology implemented for visualizing each element in a periodic table, named PeriodikAR. PeriodikAR is an application developed for Android platform by using Vuforia library. The object-tracking technique that is used in this application is markerless augmented reality technique. This application runs dynamically to provide some information of elements in an animated video. The information including the name of each element, atomic number, boiling point, melting point, density, atomic mass, standard atomic weight, oxidation state, symbol, phase, element category, electron configuration and visualization of electron orbital. In this case, the term of dynamic means all the marker and animated video of the application can be added or subtracted without modifying the source code of the application. It is because all the markers and animated videos storage are placed in the different place from the application's storage. PeriodikAR aims to help academics develop dynamic augmented reality applications. In addition, this application aims to increase the interest of studying the chemical elements. This application has six features that can be used. The result of application test showed that the smallest marker which can be tracked is 1x1,5cm. Animated video as the resulted from that marker has a good quality with no buffering. The contribution of this study is providing development of dynamic augmented reality applications that are used as a learning media of chemical elements.

Keywords: *PeriodikAR, Dynamic Augmented Reality, Augmented Reality for Chemical Elements, Animated Video of Augmented Reality*

1. INTRODUCTION

A periodic table is a group of arranged chemical elements that orderly by some rules [1]. The elements in the periodic table are grouped based on the properties that they have.

Periodic table contains information about elements which have been discovered [2]. However, the information is provided in text form, so that it became less interesting. It can be overcome with visualizing that information. Visualization give a kind of attractiveness because it can help the users to visualize an object they find difficult to visualize [3].

Augmented reality is a kind of technology that can be used to visualizing an object. By using augmented reality, information can be added in a reality object with the help of marker as a base to showing the information. That technology gives a visualization against a real object, which is interesting to the lesson [4].

Augmented reality technology heavily utilized in various sectors. One of them is in the tourism sector, namely introduction of Tanah Lot temple as the tourist attraction [5], which is used to promote Tanah Lot temple to foreign tourists. Another one in the tourism sector is an augmented reality translator [6], which is used to help foreign tourist to understand the local language. In addition to facilitating the tourist, combining augmented reality technology with local cultures will preserve and introduce local cultures to foreign countries [7]. Another use of augmented reality is in the security sector, one of them is face recognition [8], it is used to recognize person's face for getting the identity of owner's face [9].

Augmented reality technology has been widely used to visualize the object. Therefore, in this paper, developed an application using Augmented Reality technology to visualize chemical elements, named PeriodikAR.

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PeriodikAR is developed for Android platform by using Vuforia library. This application runs dynamically to provide elements information in an animated video. Dynamic, in this case, means markers and animated videos of the application can be added or subtracted without modifying the source code of the application.

Markers that used by PeriodikAR only elements on the Periodic Table. Provided information are the name of each element, atomic number, boiling point, melting point, density, atomic mass, standard atomic weight, oxidation state, symbol, phase, element category, electron configuration and visualization of electron orbital. This application stores markers and animated videos on two separate servers.

PeriodikAR expected to help academics who have an IT background to develop dynamic augmented reality applications. In addition, this application aims to increase the interest of studying the elements in the periodic table.

2. RELEVANT STUDIES

2.1 Related Work

Augmented reality technology has been developed for the learning media of chemical elements. A study by Hafidha[10] was developed an augmented reality application for android platform as a learning media of elements in periodic table. The application that was developed run statically and using black and white markers.

Another with the research from Falahah and Mulyani [11], they had developed augmented reality applications as a learning media of covalent bonding compound. Augmented reality application that they develop is the static one and using black and white markers.

From the two studies, all of them were developing static augmented reality applications. None of those who developed dynamic augmented reality application. Thus, in this paper, developed dynamic augmented reality application as a learning media of the elements on the periodic table.

2.2 Augmented Reality

Augmented reality is a technology that used to add information on the real object with help of markers as the basis of displaying the information. Augmented reality can also be regarded as a combination of 75% real world and 25% virtual world [12]. As a result, users can see the information on the real object and can interact with that information [13].

Augmented reality has some techniques to do object-tracking. Tracking is conducted based on the position, marker, or markerless [14]. In this paper, the technique used to perform object-tracking is markerless.

2.3 Metadata

In this paper, metadata is a file that contain URL of an animated video. Metadata is used to find location of the animated video in PeriodikAR server. In this case, metadata is used as a link between PeriodikAR application to Vuforia server and PeriodikAR server.

3. EXPERIMENT & RESULT

3.1 System Design

PeriodikAR application is interact with two server to run dynamically (showed in Figure 1), they are PeriodikAR server and Vuforia server. In this case, Vuforia server is a server that served to store and manage all the marker and metadata. Meanwhile, PriodikAR server is a server that served to store and manage all animated video. The addition of resource is only performed on both server side, not in application. In this case, the resource is all marker, animated video and metadata. So that, this application can only access the resources in both servers. Addition or substraction of the resource on the servers does not change the application source code.

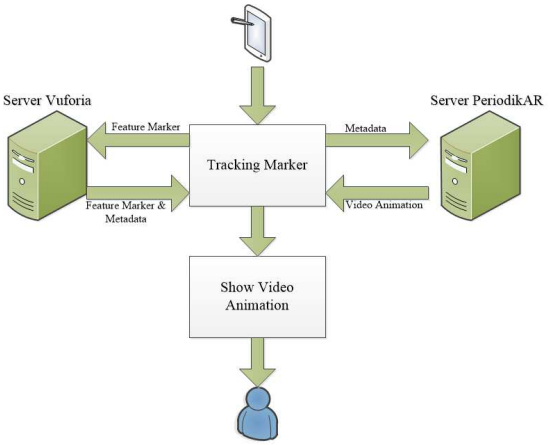

Figure 1: Overview System

This application is interact with Vuforia server and PeriodikAR server while doing marker tracking process. Marker tracking is a process that performs a reading of the features of marker. This application did a comparison of the result of tracking features to the existing features in Vuforia server. The result of the comparison forms of metadata is provided by

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Vuforia server to application. The result is this application will display an animated video to the user through streaming from PeriodikAR server.

3.2 Use Case Diagram

This application has six features which can be used by the users. The features are showed by the use case diagram in Figure 2.

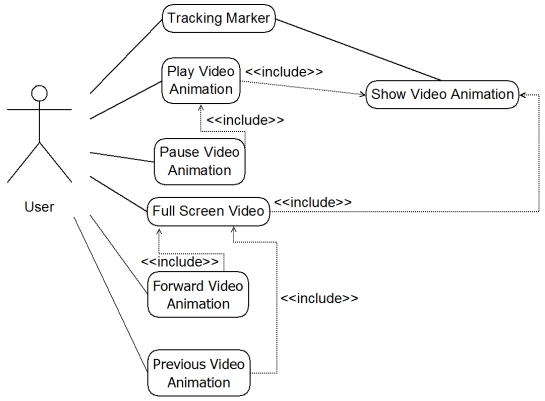

Figure 2 : Use Case Diagram

User in the use case diagram can use following features: Tracking Marker, Play Video Animation, Pause Video Animation, Full Screen Video, Forward Video Animation and Previous Video Animation.

Tracking Marker feature is a feature that can be used by the user to perform tracking on a marker. Marker tracking feature must be executed first before running the other features.

Play Video Animation feature is a feature that can be used by the user to playing the animated video. Such feature make the animated video can not be run automatically, but requires a user event to run the animated video.

Pause Video Animation feature is a feature that can be used by the user to pausing a running animated video. Such feature can only be executed when Play Animation Video feature is running.

Full Screen Video feature is a feature that can be used by the user to change the animated video size to full-screen size. Such feature is needed when the size of marker is too small.

Previous Video Animation and Forward Video Animation features can be used by the user to do animated video scene transition. Such feature can only be executed when Full Screen Video feature is runnning.

3.3 Marker Display

In this paper, the marker that is shown only is one of all marker that stored in Vuforia server. The marker is shown in Figure 3.

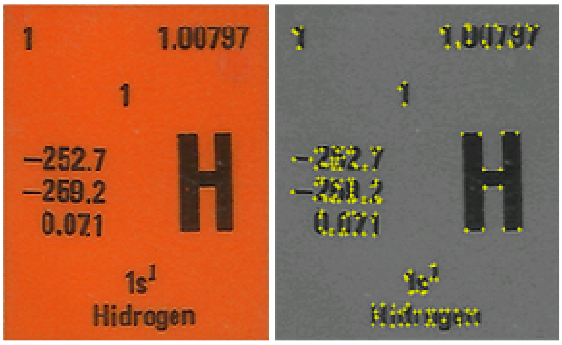

Figure 3 : Hydrogen Marker with Features

Figure 3 showed marker that is used in this application and it's features that are owned by the markers. The number of marker that can be registered is up to 1 million markers [15].

3.4 Main Display

In this paper, the main display is the camera view interface to performed marker-tracking. That main display is directly performed marker-tracking process. The main display is shown in Figure 4.

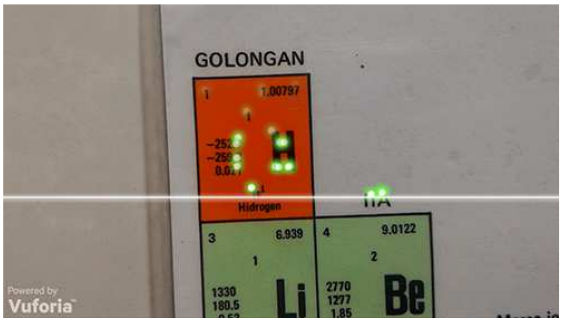

Figure 4 : Marker Tracking

This application is directly tracking the marker when application is running. Green dots that showed in Figure 5 is the features that are detected. Size of animated video will adjust to the marker's size. The result is shown in Figure 5.

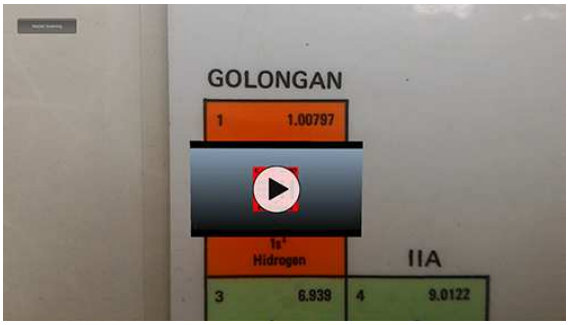

Figure 5 : Result of Tracking

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The user should give an event on the play button to playing the animated video. This application will make the process streams when the play button is pressed by the user.

Figure 6 : Full Screen Animated Video

Full screen view will dispel the theory of augmented reality. But full screen view can comfort the user when the size of marker that user use is too small.

3.5 Result of Application Test

The results which are given were the result of application tested using multiple android devices. The results of application tested are shown on Table 1.

Table 1: Result of Application Test

Item Test	Device 1	Device 2
Android Version	4.0	5.0
Type	Sony Xperia S	Asus Zenfone 2 ZE551ML
Processor	Dual Core 1.5 Ghz	Quad Core 2.3 Ghz
Back Camera	12 MP	13 MP
RAM	1 GB	4 GB
Min Size of Marker	1 x 1,5 Cm	1 x 1,5 Cm
Connection Bandwidth	1 Mbps	1 Mbps
Min Distance	6 cm	7 cm
Max Distance	25 cm	20 cm
Duration from Splash Screen to Main Display	3 Second	4 Second
Animated Video Stream	Normal	Normal
Video Size	12 MB	12 MB
Video Format	MP4	MP4
Buffer	No	No

The test was performed by using a marker with the smallest size of the application that can be read by the camera of the device. The result of the shortest and furthest distace marker detection depends on the size of marker, the larger the size of the marker, the distance will increase in size, and vice versa.

Both tested devices can run and used all features very well without any disruption to the marker reading process and displaying animated video process. This application can read small size marker due to utilizing camera's focus on the smartphone. That is because focus on the smartphone's camera help the detection of small features which is exists on the marker to avoid the blur.

The more resources in this application will not affect the processing speed and size of the application. The addition of the resources will not interfere by or change the source code in this application. That is because storage resources are in separated places with the application, not the same as static augmented reality applications. The addition of markers and animated videos in a static augmented reality application greatly affect the processing speed and sze of the application. So that, in the static augmented reality application, the more resource will make a large burden on the size and performace of the application.

4. CONCLUSIONS

The result of this study is an application namely PeriodikAR. PeriodikAR is an application that runs dynamically and uses augmented reality as the technology. This application was developed for Android platform by using Vuforia library. Object tracking technique that used is markerless.

PeriodikAR can help academics who have an IT background to develop dynamic augmented reality applications. In addition, this application increases the interest of studying the chemical elements.

The application that has developed provide information of the chemical elements in the form of animated video. Markers that used by the application only elements on the Periodic Table. Animated videos and markers stored in the separated server.

The result of the experiment showed that PeriodikAR has been success runs dynamically. These are the results of the experiment:

- The smallest marker size which can be tracked by the application is 1x1,5cm,
- The furthest or nearest distance to achieve success in marker tracking process depends on the size of marker,

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- The camera focus in the smartphone is very important in marker tracking,
- Animated video which is produced by the marker tracking process had a good quality,
- Size of animated video will adjust to the size of the marker.

The contribution of this study provides development of dynamic augmented reality applications that are used as a learning media of the chemical elements. Further development is expected to improve information on the elements with a better display.

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