Learning Application of Astronomy Based Augmented Reality using Android Platform

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Learning Application of Astronomy Based Augmented Reality using Android Platform

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Abstract. Astronomy is a branch of science involving observations of celestial bodies such as stars, planets, nebular comets, star clusters, and galaxies as well as natural phenomena occurring outside the Earth's atmosphere. The way of learning of Astronomy is quite varied, such as by using a book or observe directly with a telescope. But both ways of learning have shortcomings, for example learning through books is only presented in the form of interesting 2D drawings. While learning with a telescope requires a fairly expensive cost to buy the equipment. This study will present a more interesting way of learning from the previous one, namely through Augmented Reality (AR) application using Android platform. Augmented Reality is a combination of virtual world (virtual) and real world (real) made by computer. Virtual objects can be text, animation, 3D models or videos that are combined with the actual environment so that the user feels the virtual object is in his environment. With the use of the Android platform, this application makes the learning method more interesting because it can be used on various Android smartphones so that learning can be done anytime and anywhere. The methodology used in making applications is Multimedia Lifecycle, along with C# language for AR programming and flowchart as a modelling tool. The results of research on some users stated that this application can run well and can be used as an alternative way of learning Astronomy with more interesting.

1. Introduction
Astronomy as a branch of science involving the observation of celestial bodies is very interesting to learn. However the learning media used today is less interesting; just using a book containing 2D astronomical images. While other learning media using telescopes is quite expensive so this research will use Augmented Reality technology as one of technology in introducing astronomy interestingly.

There are several studies on astronomy using Augmented Reality technology. Soga et al. [1] in 2008 already did a research using Augmented Reality in learning Star. The result of this research stated that the learning process is more interesting. Another research also comes from Fleck and Simon [2]. In their research, they also using Augmented Reality to create astronomy environment. They compared the physical mode and the AR environment in learning astronomy for elementary grades. The result concluded that learning astronomy in AR environment significantly improved the students’ way of learning astronomy.

In Indonesia, there is a similar research related to AR and astronomy. For example the research of Sagita and Amalia [3] on Learning of Solar System Using Augmented Reality Technology. This study focuses on the planets that exist in the solar system. Planetary objects are displayed in 3D using markers. When a marker is detected, a 3D object will appear along with information about the planet.
in text, animation and sound. The weakness in this study lies in the sensitivity of the marker when it is not detected by the camera.

A similar study was also found by Sujati et al. [4] that makes apps about “Multimedia Application Development for NASA Astronomy Satellite Learning with Augmented Reality technology based on Android”. This research focuses on creating applications with satellite objects that combine multimedia technology and Augmented Reality on the Android operating system so that applications are easy to use anywhere. Just like the previous research, this application also has the same weakness that is light sensitivity to marker detection. Both of these studies also cannot interact with the 3D object.

Based on these two studies, this research also will make a similar research using Augmented Reality technology on the Android operating system with objects of celestial bodies (Milky Way galaxy and constellations). This research is expected to enrich the learning media for astronomy and make learning astronomy more interesting because there is an interaction with the 3D object.

2. Literature Review

2.1. Research Method

The research method used is Literature Review, by studying several applications and/or similar research, Milky Way galaxy theory and constellation, how to make 3D object from various sources and methodology of multimedia life cycle for making the application. The design in this study using flowchart, followed by making 3D galaxy object and constellation using Cinema 4D, designing marker and then making program using Unity.

2.2. Augmented Reality

Cushman and Habbak [5] explain that Augmented Reality (AR) is a technology that allows the addition of virtual content to the real world. This is usually associated with the addition of 3D content for direct view of the camera. Then Suryawinata [6] found the same definition of Augmented Reality (AR) which is a combination of virtual world (virtual) and real world made by computer. Virtual objects can be text, animation, 3D models or videos that are combined with the actual environment so that the user feels the virtual object is in his environment. AR is a new and fun way in which humans interact with computers, because it can bring virtual objects into the user's environment, providing a natural and fun visualization experience.

![Figure 1. Workflow of AR](image_url)

Figure 1 explains the workflow of Augmented Reality. It starts from camera to capture the image on the marker, then processes it to the database and if it is valid, the real picture will appear.

The AR application workflow generally begins with the capture of a marker image from the camera or webcam. The marker is recognized by features owned, then tracked by the object tracker provided by the Software Development Kit (SDK). But earlier, the marker has been registered and stored into the database.
The tracker object will track and match the marker in order to display the appropriate information. The result of marker detection is immediately displayed into the screen. The information displayed is attached to the corresponding marker in real time [7].

2.3. Vuforia
According to Fernando [8], Vuforia is a software for augmented reality developed by Qualcomm, which uses a consistent source of computer vision that focuses on image recognition. Vuforia has many features and capabilities, which can help developers to realize their thinking without any technical limitations.

With support for iOS, Android and Unity 3D, the Vuforia platform supports developers to create applications that can be used on virtually all smart phones and tablets.

2.4. Unity
According to Cushnan and Habbak [5], Unity is a cross-platform game engine developed by Unity. This game engine has been built with IDE and the ability to run on multiple platforms. Unity is designed for user convenience and high productivity.

The greatest strength of Unity is its ability to run on a number of large platforms with ease and some changes to the project structure. Unity can be run on Window, OS X, iOS, Android, Web Plugin, Flash, Xbox 360, Playstation 3 and Wii U.

Unity allows three languages to write scripts, available languages are Javascript, C#, and Boo.

2.5. Cinema 4D
Aaron [10] stated that Cinema 4D is a 3D application created by Maxon Computing. This app is relatively easy to learn and use. However, this app also has a number of powerful features that can be used to create dynamic images and animations that are dynamic and interesting quickly and efficiently. Cinema 4D has an intuitive interface and if you have questions about the features provided, the help documentation can be accessed easily and widely.

Cinema 4D has a long list of advanced features, including modeling, texturing, animating, lighting, and rendering. Cinema 4D also matches other applications, both 2D and 3D.

2.6. Related Article
Soga et al. [1] already did a research using Augmented Reality in learning Star. They made an interactive learning using finger pointing and augmented reality. They developed an environment to learn star using magnetic sensors. The environment had three functions. First function was star name. When a learner pointed out a star with the finger sensor, the system told the star name and constellation with voice. Second function was star navigator. If the learner know the name of a star, the system showed the path from current pointing position to the target star for the learner if the learner did not know where it was in the real sky. Third function was constellation tutor. By doing this, the learning process is more interesting. The similar research also comes from Fleck and Simon [2]. In their research, they also using Augmented Reality to learn astronomy. They stated that AR environment is particularly suitable for astronomy learning compared to the physical one. Furthermore, they said that using Augmented Reality to learn astronomy significantly improved the students’ way of learning astronomy.

3. Results and Discussion
Based on the previous researches, this research also will using Augmented Reality for learning astronomy. This research focus on how to make the application for supporting astronomy learner to learn astronomy more attractive and interesting. As mentioned earlier, AR application creation will use Multimedia Lifecycle method. This method is suitable for projects that have multimedia elements. According to Binanto [11] quoted from Luther (1994), multimedia lifecycle method consists of six stages, namely concept, design, collecting materials, assembly, testing and distribution. These six
stages are not necessarily sequential in practice, they can be exchanged positions. However, the concept stage should be the first thing to do.

**a. Concept**

This application is made for all users especially those with an interest in astronomy. The materials to be displayed in this application include the Milky Way galaxy and some constellations in the form of 3D objects on the mobile phone screen. In addition, 3D objects can interact through touch to bring up sound and information.

The existence of this application makes learning astronomy interesting and the use of learning media more sophisticated because it uses AR technology and combines multimedia elements.

**b. Design**

It is the stage of creating a navigation structure, a story board to describe the description of each scene, by listing all the multimedia objects and links to other scenes and flowcharts to illustrate the flow from one scene to another.

![Figure 2. A Navigation Structure](image)

This figure 2 describes the navigation for using the application. When we run the application, there are 3 menus: start the simulation, how to use the application and exit. On the first menu, there is an astronomy object and if you play the object, there will be a simulation, information of the object in text and voice.

Based on this structure, we can draw the flowchart of this application as follow:
Figure 3. Flowchart

Figure 3 shows the flow of the application when it detect the marker. If the marker detected, then the 3D object will appear directly and also the simulation of the object will be started. Otherwise, the position of the marker should be arranged again.

Story boards describe the interface of the application, which is used as a link between one page and another. Here are some examples of designed interfaces:
This is the initial view of the application (figure 4). In this view there is the title of the application, how to use button to see how the application usage, and start the simulation button to start using the application. Next is the page to set up the camera.

![Camera Input View](Image)

**Figure 5.** Set up the camera

In this view (figure 5), there is a camera to receive input in order to display 3D objects in augmented reality.

c. Material Collecting
This stage describes the collection of materials / data required in making this application. Required data in the form of images or 3D objects of Milky Way galaxies and constellations and software to be used. The software used to create this Augmented Reality application is Unity, Vuforia SDK and Cinema 4D. The required software can be downloaded from the official website of the software while the images are obtained from various electronic and non electronic sources.

d. Assembly
Tools, materials and software used in making this learning application are as follows:

<table>
<thead>
<tr>
<th>Table 1. Specification of Smartphone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
</tr>
<tr>
<td>CPU</td>
</tr>
<tr>
<td>RAM</td>
</tr>
<tr>
<td>GPU</td>
</tr>
<tr>
<td>Camera</td>
</tr>
<tr>
<td><strong>Operating System</strong></td>
</tr>
<tr>
<td>Display</td>
</tr>
<tr>
<td>Chipset</td>
</tr>
<tr>
<td>Sound</td>
</tr>
</tbody>
</table>

Table 1 explains the hardware of the mobile phone that used in making the application. The operating system minimum requirement for the mobile phone is Ice Cream Sandwich (Android 4.0) for running the application.
Table 2. Hardware Specification

<table>
<thead>
<tr>
<th>Name</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>Intel Core i5 3.20 GHz</td>
</tr>
<tr>
<td>RAM</td>
<td>4GB</td>
</tr>
<tr>
<td>VGA</td>
<td>NVidia GForce GTS 450</td>
</tr>
<tr>
<td>Web Cam</td>
<td>Logitec 2 MP</td>
</tr>
<tr>
<td>Operating System</td>
<td>Windows 7 64bit</td>
</tr>
<tr>
<td>Harddisk</td>
<td>1 TB</td>
</tr>
</tbody>
</table>

Table 2 explains the hardware computer that used in building the application. Higher specification requirements for computer should be provided because this application uses several 3D objects.

Table 3. Software Specification

<table>
<thead>
<tr>
<th>Name</th>
<th>Use as</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unity</td>
<td>Making animation and AR</td>
</tr>
<tr>
<td>Cinema 4D</td>
<td>Making 3D object</td>
</tr>
<tr>
<td>Adobe Photoshop</td>
<td>Making the marker</td>
</tr>
<tr>
<td>Sound Recorder</td>
<td>Recording the sound</td>
</tr>
</tbody>
</table>

Table 3 only explains the software used in designing and making the application. There are Unity to make animation and AR, Cinema 4D to build the 3D object.

e. Testing
This stage aims to test learning applications built and meet all the needs of the application. Testing is done to ensure all functions run properly, markers can be detected and bugs in the application can be resolved. Testing on this application will use black box testing. After testing with black box, there are several factors causing marker not detected, such as camera distance, light intensity, and the marker itself.

Table 4. Testing

<table>
<thead>
<tr>
<th>Activities</th>
<th>Expected Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run the application</td>
<td>Application runs well</td>
</tr>
<tr>
<td>Test the main menu</td>
<td>Main menu can be displayed</td>
</tr>
<tr>
<td>Test the marker</td>
<td>Marker can be detected</td>
</tr>
<tr>
<td>Test the constellations</td>
<td>Camera can read the marker and the 3D objects of the constellations appeared</td>
</tr>
<tr>
<td>Test the Milky Way</td>
<td>Camera can read the marker and the 3D objects of the Milky Way appeared</td>
</tr>
<tr>
<td>Test to the dark location</td>
<td>Marker can be detected</td>
</tr>
<tr>
<td>Test to the dark location using flash</td>
<td>Marker cannot be detected</td>
</tr>
<tr>
<td>Touch the 3D object</td>
<td>Information and voice appeared</td>
</tr>
</tbody>
</table>
There are some interfaces that tested as follows:

![Interface Image]

**Figure 6.** Constellations

Figure 6 describes the constellations object in the application. There are 12 zodiacs in the picture and each zodiac has its 3D object to appear. Information for each zodiac provides in figure 7. This application uses Bahasa Indonesia so the learner will easy to understand the information.

![Interface Image]

**Figure 7.** Information of Constellations

4. **Conclusions**

The making and testing of this learning application yields the following conclusions:

1. Augmented reality-based astronomy learning application using the android platform can draw interest to learn astronomy attractively.
2. This application help the learner to learn astronomy more interesting and attractive.
3. Augmented reality-based astronomy learning applications can complement existing learning media.
4. Light intensity determines marker detection.

**References**


