



Development of a 3D Solar System Learning Media Application Based on Augmented Reality

Ardiani Putri Rahmawati, Alya Nanda Novanti, Muhammad Ihsan Tirta, Lina Maisaroh,

Risma Cahyani Nur Viranti

Program Studi Pendidikan Guru Sekolah Dasar, Universitas Negeri Yogyakarta, Indonesia

Correspondence: E-mail: ardianiputri075@gmail.com

ABSTRACT

The present learning process is a unique challenge for teachers because the media created has to be creative, innovative, and not boring one of them on a 6th-thematic system learning material that USES book media as a learning tool. Students became less interested in studying these materials especially in today's era where society especially students coexist with technology. Interesting learning media is also essential for elementary school students. Teachers can use current learning media by taking advantage of technologies like augmented reality. Teachers can use the MBLC (multimedia development life cycle), which consists of six precepts, concept, design, collection of material, assembly, testing, testing, until distribution. Augmented reality is an application joining the real world with the virtual world in two and three dimensions projected in a real environment at the same time. Augmented reality can be used in entertainment, medicine, mechanics and learning media. Augmented reality can be built using the help of vuforia and unity 3d software. The end result of interactive learning media with augmented reality especially on solar system material that can later be created as a 3d image in an application

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1. INTRODUCTION

Currently, the solar system learning media applied in the world of education is using books and using teaching aids as aids in learning. The learning process is directed at students' ability to memorize information. Students' brains are forced to remember and store various information obtained from educators. This usually causes learning about the solar system to have shortcomings or limitations in the learning media. The media usually used in this material is print media such as books.

This causes children to lack understanding and get bored easily. Using these images in student books makes students passive and less interactive because students cannot provide maximum feedback. This is because the existing learning media is less visible and less interesting (Yusniawati, 2011). Moreover, children currently use technology more and therefore consider books boring. This is because smartphones can be used for various things, such as calling, sending messages, browsing the internet, etc. Meanwhile, books only have static writing or images.

This main problem makes teachers rack their brains to create an innovation for teaching in the current era. For this reason, we need other ways to get around this with the technology available on smartphones. In fact, teachers can use it as a learning medium so that it can be used anywhere and at any time. The development of smartphone hardware specifications at this time has resulted in the development of software that previously could be run on PC devices and can be run on smartphone devices. One of them is by using Augmented Reality technology to create 3-dimensional (3D) animation to make it look more real-time and attractive. The animation was built using Blender and the Augmented Reality development process.

The use of this technology also has the same goal as the independent curriculum currently being implemented. Omar Hamaliek in Pribadi and Katrin explained that the existence of media can make communication and interaction between teachers and students in the learning process more effective (Pribadi & Katrin, 2004). This is also reinforced by the current curriculum system, the 2013 Curriculum or the Merdeka Curriculum, which implements a student center in learning activities. In short, students can utilize technology-based media in various ways to improve learning outcomes.

James Valino explained that Augmented reality, often shortened to AR, is a technology that combines two or three-dimensional virtual objects into a three-dimensional real environment, which will then be projected in real-time (Setyawan et al., 2019). Augmented reality does not replace existing reality, but through the help of augmented reality, the real environment can be interacted with in a digital concept. The use of augmented reality technology is expected to be able to display objects in the form of planets in the solar system in virtual 3D using drawing markers. The marker image detected by the camera on the Android smartphone will display a 3D (Hendriyana, et al., 2022) planetary object that can be enlarged and reduced independently so that application users can observe the shape of the planets one by one in real time.

Nowadays, augmented reality is often used widely, one of which is in the field of education. This is supported by augmented reality's innovative, real, and real-time characteristics (Shofwan, 2014). This opinion was also reinforced by Kangdon Lee (2011), who said that Augmented Reality can potentially increase the efficiency of the learning process and time management by providing information at the right time and place and presenting rich content by providing 3D product results. The advantage of using AR compared to other media is the full stimulation of several senses, namely the senses of touch, hearing, and sight, so that

learning becomes more interactive (Lopez et al., 2013). However, the advantages of augmented reality in the learning process above have not led many teachers to adopt it in the classroom.

AR technology has been developed for various devices, such as Android and iPhone, which have features that support the use of AR. Therefore, AR can be widely used by society, including students. This aligns with today's flexible learning, where students can access learning materials anytime and anywhere. In the end, AR is hoped to become a solution and innovative learning media for students.

The solar system is a series of celestial bodies centered on the Sun as other objects around it because of gravitational forces. The solar system contains the Sun, planets, and all celestial bodies spread across various galaxies. The main planets in the solar system include Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Solar system material was first given in Class 6 in Theme 9, Exploring Outer Space, Subtheme 1, Amazing Order. Unfortunately, the presentation of material in textbooks is deemed less interesting for students. Textbooks only present two-dimensional images with text as explanatory material. In fact, the Solar System material contains abstract objects. Objects with abstract properties will be difficult to see in real life, and learning to understand these objects requires a model that can be explained in real life (Neny, 2020).

Therefore, learning about the Solar System using media in the form of Android-based augmented reality can make students more interested in participating in learning. Augmented reality can visualize the virtual world into the real world or, in short, change real forms into three-dimensional objects. This research will use the UNITY game engine to create a 3D Solar System model. The author created a class 6 lesson with 9 elementary school themes, a science subject about "Outer Space Objects and Their Secrets" in the form of an AR application regarding the shapes of planets that can be seen in three dimensions. So, it is more interesting for students to learn because they can rotate parts of the planets and the solar system provided in the application. The explanation may be in the form of images, audio, and video. By developing learning media in the form of this application, it is hoped that students will be more interested and easily understand the material being taught.

2. METHODS

There are many software development methods. Several methods that can be used to build a multimedia product include the Vaughan, Luther, and Luther-Sutopo methods. According to Sutopo, who modified Luther's method, the multimedia software development method consists of six stages: concept, design, material collecting, assembly, testing, and distribution. This application was developed using the MBLC (Multimedia Development Life Cycle) method, which consists of six stages: concept, design, material collection, creation, testing, and distribution.

2.1. Method of Collecting Data

The methods used for data collection are the field method, which involves document study, and the library method, which involves collecting data from books, articles, journals, etc.

2.2. Fields Methods

This method involves collecting data that is not directly aimed at the research subjects. It examines various documents useful for analysis.

2.3. Library Methods

The activity of citing several readings related to the material used to provide a strong theoretical basis through books or literature available in the form of lecture materials, electronic journals, or electronic documents.

2.4. Research Stages

a. Concept

At this stage, we review various websites and look for learning media about the solar system that is used during the learning process to obtain appropriate concepts for creating learning applications.

b. Design

At this design stage, researchers create material designs, canvas designs, and several planet shapes to determine specifications regarding program architecture, style, appearance, and material requirements for the program.

c. Material Collecting

At this stage, researchers looked for 3D planetary object models in the Unity Asset Store and collected the materials needed to create the application.

d. Assembly

The application creation process uses Unity 3D and Unity 2D software at this stage.

e. Testing

At this stage, the researcher tested the application created by displaying several applications displays on an Android smartphone.

f. Distribution

After testing the application and finding no errors, the next step is the distribution step. This step is to save the application. When saving, the application is modified as an installer file with Unity 3D software so that the files are packaged neatly and make it easier for users to complete the installation.

2.5. Analysis System

System analysis is a breakdown of a complete information system into its components with the aim of identifying and evaluating existing problems, opportunities, and obstacles. It is needed to make improvements. An analysis is required to create an Augmented Reality-based learning media application with Android, especially functional analysis, user analysis, software requirements analysis, and hardware requirements analysis.

a. Functional Analysis

Functional analysis aims to discover or describe the services, functions, or features offered by Android learning media applications using augmented reality created for users.

b. User Analysis

User analysis aims to determine who the users involved are and the level of user understanding of the learning media application that will be created. Users who will later use this learning media application are educator and learners

c. Software Requirement Analysis

Designing an AR-based learning media application requires software to design applications, 3D models, and characters. To learn AR-based learning media applications on smartphones, the software needed is:

- Unity 3D is used to create augmented reality applications.
- Unity 3D, to create models of planets in three dimensions (3D).
- Unity 2D, to create materials in applications
- Canva to create canvas designs on application materials
- Unity Asset Store, to search for designs that will later be uploaded to the Vuforia Website.
- Vuforia SDK will create markings in a marker that has been uploaded to the Vuforia Website.
- Android, with a minimum version of 4.1 (Jelly Bean), runs learning media applications.

d. Hardware Requirement Analysis

Creating augmented reality-based learning media applications requires hardware. The hardware required is:

- Laptop (computer)
Laptops are used to run software and design learning media applications with augmented reality that will be created.
- Android smartphone with minimum version 4.1 (Jelly Bean)
Smartphones are used to run learning media applications; apart from that, by using the camera on the smartphone, which is directed at the character, the planet character will display 3D objects.

2.6. Application System Flow

At the application design stage, a solar system learning media application system flow was prepared using augmented reality (AR) technology to describe the user's access. The system flow for implementing learning media is shown in **Figure 1** below.

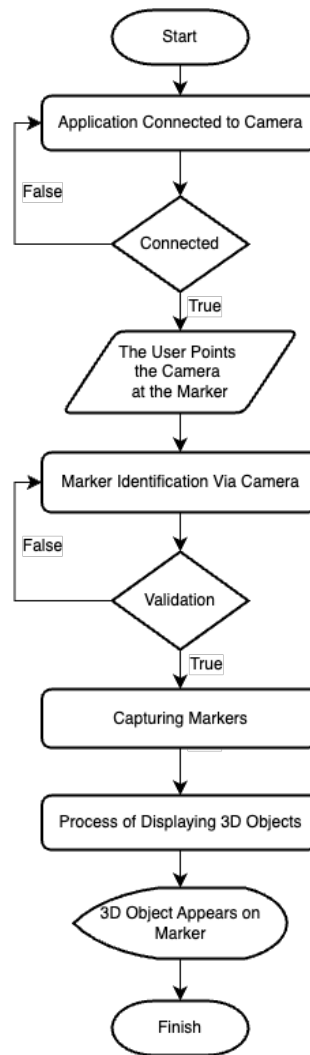


Figure 1. Application system flow

2.7. Use Case Diagram

A use case diagram was created to design a solar system learning media application based on augmented reality (AR). This use case diagram aims to explain the behavior desired by the user. In this application, users can select menus such as developer profiles, materials, and videos. The user can also select another menu in the material menu: the solar system, sun, and planets. The following is **Figure 2**, namely the use case diagram in this research.



Figure 2. Use Case Diagram

3. RESULTS AND DISCUSSION

3.1. Storyboard Design

Storyboard design facilitates application creation and helps users clearly understand the flow of learning media applications. Below is an example of a storyboard that was created.

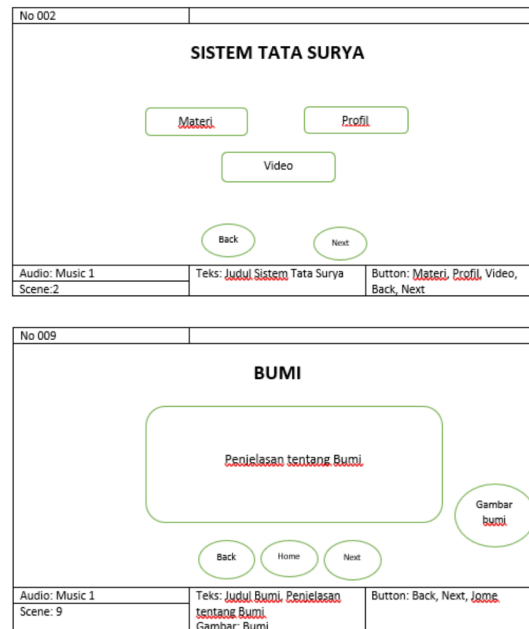


Figure 3. Storyboard design

3.2. Program Structure

The design of the 3D solar system learning media application based on augmented reality has several scenes displays that are adapted to the existing application menus. The program structure provides a clearer picture of how the application program is prepared. The program structure can be seen as follows.

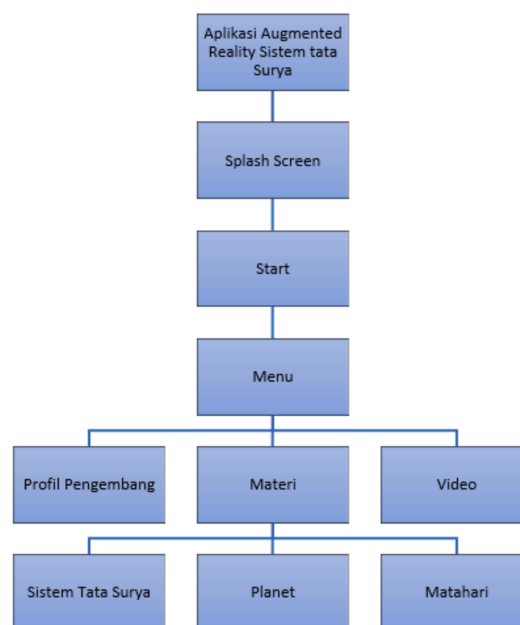


Figure 4. Program structure

3.3. Marker Search

In this marker search, researchers used the Unity Asset Store website to search for 3D objects that would be used in learning media applications using augmented reality technology.

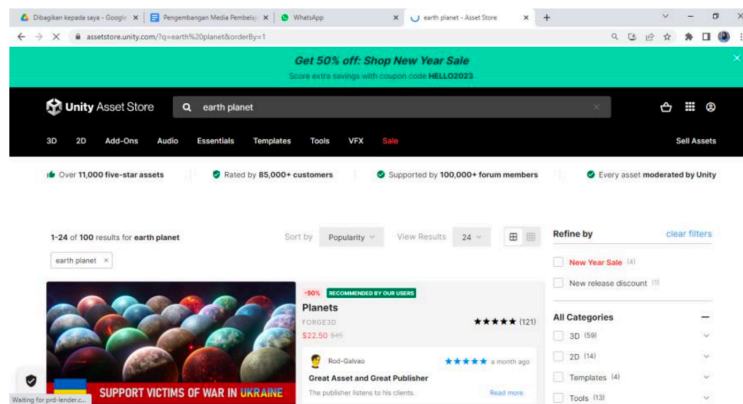


Figure 5. Search marker in unity asset store

After all the markers are obtained, the next step is to upload the marker image to the Vuforia developer website which is also the database for the markers that will be used. During the upload process, the Vuforia system will automatically perform image tracking on the uploaded image. For maximum results in later applications, images with a rating of 4 or 5 are needed.

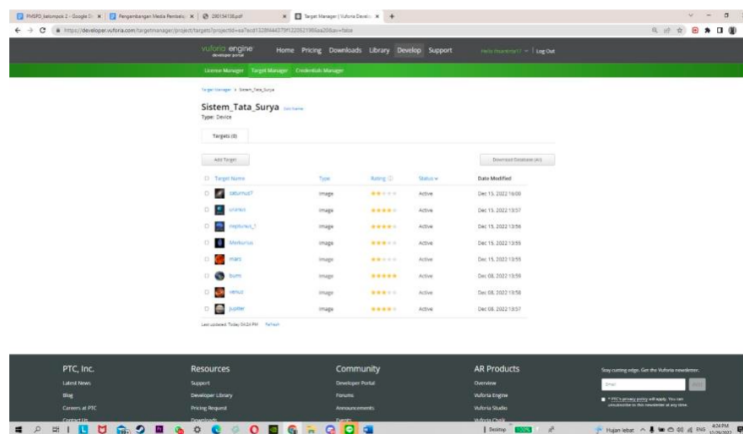


Figure 6. Vuforia Engine

3.4. Application Design

In designing this 3D application using Unity software. All necessary 3D files are imported into the Unity editor which will later be displayed as augmented reality. At this stage, the coding process, marker determination, texturing, and application building are carried out.



Figure 7. Design applications with Unity

3.5. Application Interface Display

The following is an image of each interface display in the application.

a. Start Screen



Figure 8. Start screen

When the application user opens it, a display entitled Solar System will appear. In this display, users cannot see the menus. To start using the application, users can press the start button to move to the next page. In the top left corner of this page, there is also a button to exit the application if they do not want to continue using it.

b. Developer Profile View



Figure 9. Developer profile view

The next display is the developer profile. This page contains the identity of the application developer. After observing the developer profile, users can press the home button at the bottom of this page to go to the application's main page.

c. Main Menu Page Display



Figure 10. Main menu page display

Display of the main menu page entitled "Solar System". This page contains menus such as material, solar system profiles and videos. Users can select the desired menu. The material menu will direct users to enter a selection of materials regarding the solar system. The profile menu contains the application developer profile display. Then the video menu contains learning videos about the solar system. In this scene there is also a back button to return to the previous page and next to go to the next page.

d. Solar System Material View



Figure 11. Solar system material view

When the user presses the material button on the main menu page, a material display entitled "Solar System Material" will appear. The material menu choices include material about the solar system in general, the planets and the sun. On this page there is also a back button to return to the previous page and a home button to return to the main menu page.

e. **Solar System View**

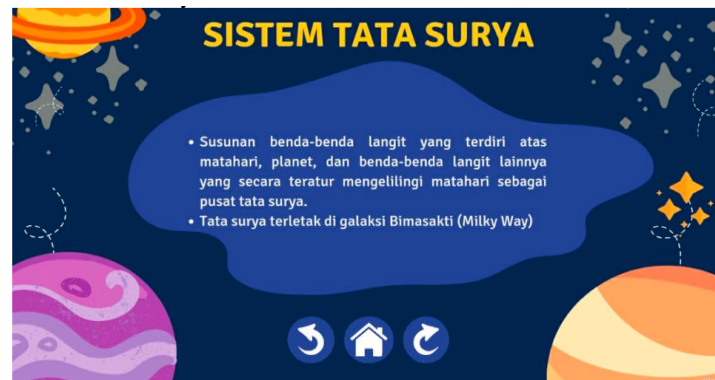


Figure 12. Solar system view

When the user presses the solar system button on the Solar System Material page, material regarding the solar system will appear. Then, the user can continue to the next page by pressing the next button, and if they want to return to the previous page, they can press the back button and the home button to return to the application's main menu.

f. **Material View of the Planets**

When the user presses the planets menu on the Solar System Material page, a discussion material page regarding the meaning of planets will appear, as shown in the image below.



Figure 13. Material View of the Planets

Then, if the user presses the next button, the display will switch to the page display for each planet, as in the following example of the display for the planet Mercury.



Figure 14. View of the material page for the planet Mercury

On this page, material will appear regarding the meaning and characteristics of the planet Mercury. There is an image of the planet Mercury at the bottom right and information regarding the characteristics of the planet. When the user presses the next button, the AR play display will appear, and the user can point the camera at the marker provided. When the camera is pointed at the marker, the 3D planet object corresponds to the marker. Likewise, other planets will also appear similar.



Figure 15. AR camera page view

g. Video View



Figure 16. Video page view

One of the menu options in this application's main menu is video. When the user presses the video menu, the video will automatically play, as in the image above. Users can observe the video until it ends. After that, the user presses the next button.

h. Application Exit View

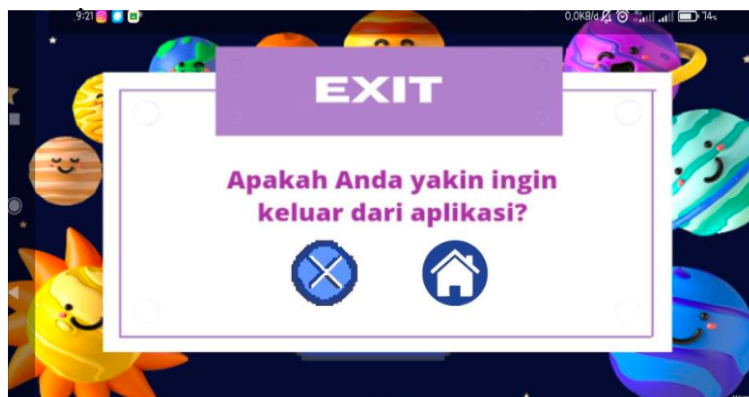


Figure 17. Display the application exit page

The following is the display at the end of using this application. Users can press the cross button (X) to exit the application. However, they can press the home button to continue using it.

3.6. Implementation

This Solar System application will display a 3D object view of each planet. By using Augmented Reality technology, the screen on the smartphone will automatically activate the camera to display an image if directed at the appropriate marker. The following are the results of implementing the interface using a Redmi Note 9 smartphone device with the Android operating system. The results of capturing examples of planets are as follows.



Figure 18. (a) AR capture of Mercury and (b) Venus

4. CONCLUSION

From the description above, several conclusions can be drawn. Nowadays, the challenge for a teacher is to create a learning innovation that is innovative, interesting and creative. In this modern era, learning media is certainly very easy to obtain. Besides being easy to obtain, you need to be careful in choosing the media used. Media must be as accessible as smartphones. In smartphones, there is technology that has various features that can be used to make learning more interesting, one of which is learning.

One way is through Augmented Reality, teachers can create learning media that is fun, interactive and easy to use. Augmented Reality can also replace learning books that are not yet available in schools in virtual or virtual form. Students can still view and use the module like the original module but in virtual form.

Through this breakthrough, more variations of learning media can be built to support learning activities for elementary school students on grade 6 solar system material, such as the breakthrough made by researchers, namely the development of 3D solar system learning media. So that when students learn about the solar system, they can better understand the existing material by being able to experience it digitally which can be zoomed in and out on their smartphone. Students will be more enthusiastic in learning because the learning media used follows their technology-based era which means students do not get bored easily when studying.

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