Journal of Artificial Intelligence and Engineering Applications

Website: https://ioinformatic.org/

15th February 2026. Vol. 5. No. 2; e-ISSN: 2808-4519

Application of Augmented Reality and First-Person Games in Introducing Gravity as a Learning Method in Astronomy

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Abstract

The development of digital technology brings significant opportunities for learning innovation, particularly in the fields of science and astronomy. One technology that can be utilized is Augmented Reality (AR) combined with a first-person game-based approach. This research aims to develop interactive learning media that can help students understand the concept of gravity more easily and enjoyably. Through the application of AR, students can see the gravity values on each planet in three dimensions as if they were present in a real environment, while the first-person mode allows them to experience the experience of being directly in a space simulation. The implementation results show that this approach can increase the appeal of learning, motivate students to be more active, and strengthen conceptual understanding of gravity. Thus, the application of AR and first-person games in the introduction of gravity can be an innovative alternative to enrich science learning methods in the digital era.

Keywords: *Augmengted Reality, First Person Game, Gravity, Astronomy, Learning Media, Science*

1. Introduction

Gravity is a difficult concept to grasp, especially when it relates to the environment of outer space, such as other planets in our solar system. Gravity isn't just the gravitational force between two objects, but varies from planet to planet. These differences have a significant impact on the physical experiences of people and other objects in space, yet they are difficult to visualize or simulate in traditional classroom education. AR technology allows users to see and interact with virtual objects integrated into real-world environments, creating a more immersive and contextual learning experience. First Person Shooters (FPS) are games that aim to provide new experiences to players, usually played in the form of 3D video games, namely "First Person" and often referred to as "First Person Shooter" by gamers [1]

The use of AR in education has been shown to increase student interest and engagement in learning. Being able to directly observe how gravity works on other planets using AR simulations allows students not only to learn theoretically but also to gain real-world experience. This research aims to explore the application of AR and First-Person Games to introduce gravity as part of Astronomy science learning. This innovation is expected to facilitate students' understanding of the concept of gravity and its practical application in the world of astronomy, thereby increasing their interest in science.

2. Theoritical Basic

2.1. Multimedia

Multimedia is a combination of various media forms, such as text, images, audio, animation, and video, used to convey information or messages to users. Multimedia is an integrated combination of two or more media used to convey information to users [2]. Multimedia is also used in business and education. As technology advances, multimedia has begun to penetrate all levels of society. In a technological context, multimedia generally refers to the use of computers to create, edit, and distribute content that includes a combination of media.

2.2. Augmented Reality

Augmented Reality (AR) is a technology that combines real-world and digital elements in real time to allow users to see and interact with virtual objects within a physical environment. AR is a technology that can integrate virtual and real-world dimensions, visible in real time

[3]. The goal of AR is to build a real world by combining several virtual technologies and adding contextual data to enhance human understanding as users [4].

2.3. Game First Person

A first-person game is a type of video game in which players view the game world through the eyes of the main character they control. This perspective provides a more immersive experience because what is seen on screen is what the character sees directly. A first-person shooter (FPS) is a type of video game that places players in a first-person perspective. This means players will see the game world through the eyes of the game's protagonist [5].

2.4. Gravity

Gravity is the relationship between objects that have mass in the form of an attractive force [6]. Gravity is responsible for many phenomena in the universe, such as the movement of planets around the sun, the fall of objects to the Earth's surface, and the formation of stars and galaxies. On Earth, gravity gives objects weight and causes them to fall toward the Earth's center. Earth's gravitational force is approximately 9.8 m/s^2, which means that any object in free fall will experience an acceleration of 9.8 meters per second squared toward Earth.

2.5. Astronomy

Astronomy is one of the oldest sciences, studied since ancient times to understand the movements of celestial bodies and predict events such as eclipses and seasonal changes [7]. Modern astronomy uses a variety of instruments, such as optical telescopes, radio telescopes, and space satellites, to observe and analyze phenomena in space. With advances in technology, scientists can observe extremely distant objects and study the universe in greater detail [8].

3. System Analysis And Design

3.1. Problem Analysis

Science learning, particularly astronomy, often faces challenges in conveying abstract concepts like gravity [9]. These challenges affect students' understanding of concepts that are actually crucial in science. Some of the problems that arise in learning gravity are as follows:

1. Lack of understanding of abstract concepts
   Gravity is an abstract concept that is difficult to understand solely through theoretical explanations or textbook text.
2. Limitations of traditional learning media
   Learning media such as images, text, and videos have limitations in providing students with real-world experiences.
3. Lack of interactive learning experiences
   Learning gravity through traditional methods often lacks interaction, leaving students passive listeners.
4. Difficulty in simulating gravity on other planets
   One interesting aspect of learning gravity is how gravitational forces differ on each planet [10].
5. Lack of student learning motivation
   Students often become bored with monotonous learning approaches, resulting in them losing interest in the material being presented.

3.2. System Analysis

To address the limitations of existing learning systems, a modern learning system is proposed that integrates Augmented Reality (AR) technology and First-Person games. This system aims to provide students with a more interactive and immersive learning experience. The AR component in the system allows astronomical objects to be visualized in three dimensions and manipulated in real time. Gravity simulations are presented visually and interactively so students can observe how gravitational forces act on other planets. Furthermore, a First-Person Game component is provided so students can see the visual forms of planets and other celestial bodies.

3.3. Use Case Diagram

Through this Use Case Diagram, we can understand the overall system and how various users interact with it. This diagram also helps identify system development needs and ensures that all necessary functions are included in the system design.

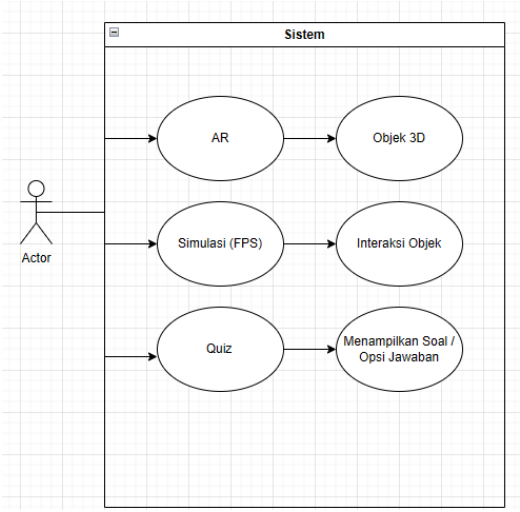


Fig 1: Use Case Diagram

3.4. Activity Diagram

The activity diagram in this Augmented Reality and First-Person Game-based gravity learning system illustrates the workflow and sequence of activities occurring within the system. This diagram provides a clear visualization of how the learning process occurs, from the moment a user logs in to the completion of a learning session. This activity diagram is crucial for understanding the logic and sequence of activities within the system, as well as how the various system components interact with each other.

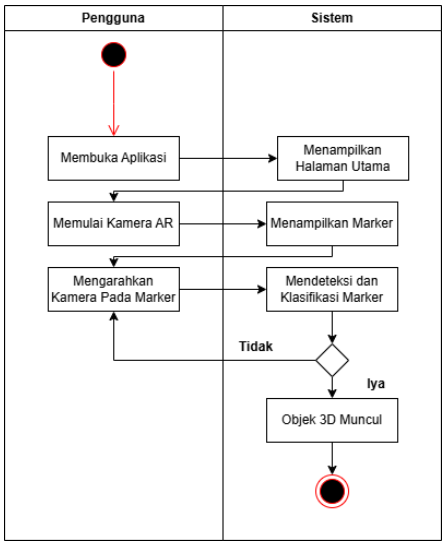
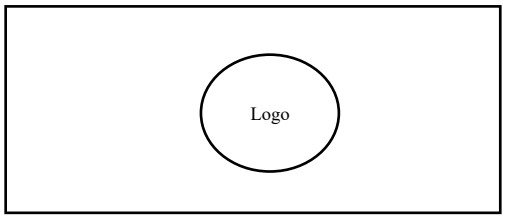
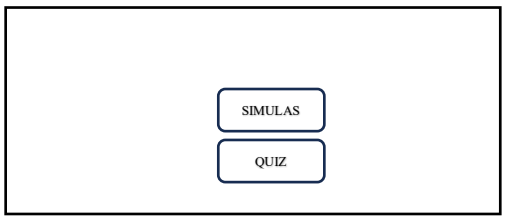
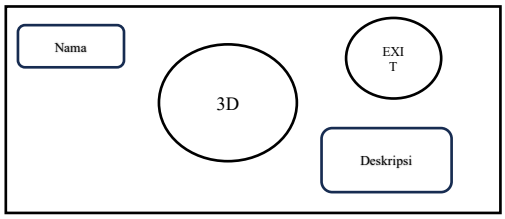
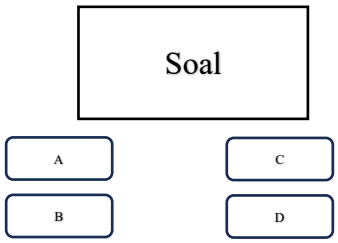


Fig 2: Activity Diagram

3.5. Storyboard

The storyboard was designed to provide an overview of the visual storyline, user interactions, and features that will be implemented in the application. The storyboard explains how users will interact with virtual objects in the AR environment and experience the visuals and gravity simulations on various planets.

Table 1 : *Storyboard* Aplication

Skenario	Keterangan
	Displays the splash screen of the Unity logo, Harapan University, and the application logo for 3 seconds.
	The menu display displays 4 buttons, including the start button to start the AR camera, simulation to start the First Person Game, Quiz to start the Quiz game, and finally the exit game button.
	The AR camera's initial view will change when a marker is detected. This view will display the 3D object the marker will be used to display, a description box explaining the meaning of the 3D object, and a name box for the 3D object..
	Contains questions related to astronomy and gravity on planets with multiple choice questions.

4. Implementation and Testing of Tools

4.1. Implementation of 3D Objects in Development

In developing Augmented Reality (AR) applications using the Unity platform enhanced with the Vuforia SDK, the implementation of three-dimensional (3D) objects is a crucial stage that requires special attention.

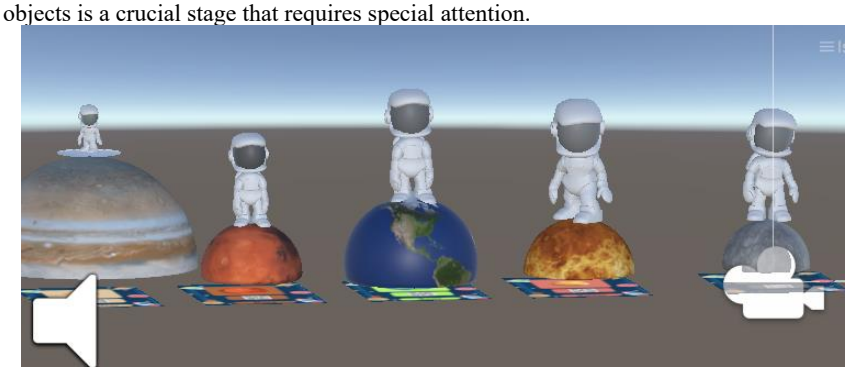


Fig 3 : 3D Object Implementation

4.2. Planning Results

After completing the application design, you can see the results of the application that has been designed, so that it can be assessed both in terms of appearance and how it works. There are 4 displays in the application, namely, the main menu display, then when starting the Augmented Reality (AR) camera, then the display for starting the First-Person Game, and finally the display of the quiz game.

4.2.1 Splash Screen Display

On the initial display, the Splash Screen displays the Unity logo then the Universitas Harapan Medan logo for 3 seconds, this is used as the identity of the application created by Harapan University students, then finally the logo of the application icon.

Fig 4 : Splash Screen Display

4.2.2 Main Menu Display

After all the splash screens appear, the main menu will appear, containing navigation buttons that take you to other pages, such as the AR page, simulations, and quizzes. There's also a button to exit the application.

Fig 5 : Main Menu View

4.2.3 AR Display

AR display is a display on a smartphone camera equipped with Augmented Reality technology. When the camera is pointed at a marker, it displays a 3D object followed by the object's name and description.

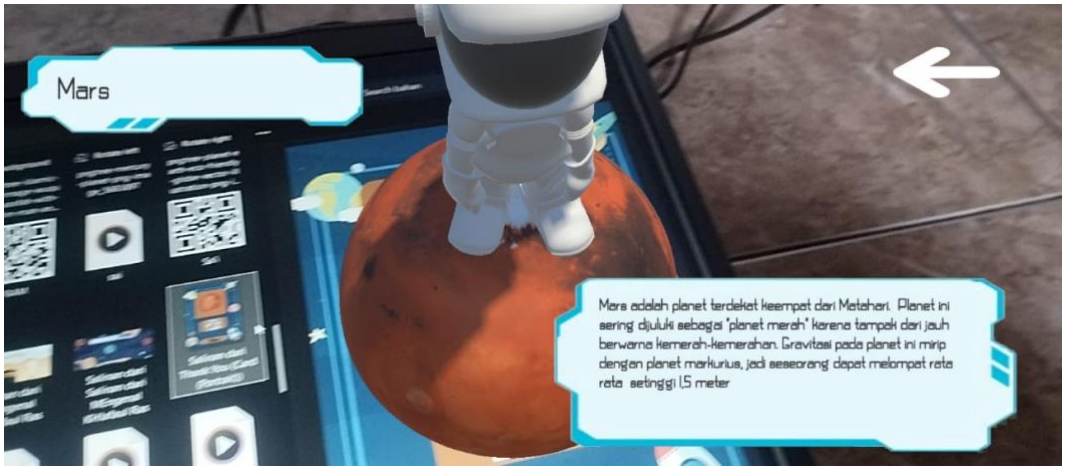


Fig 6 : Tampilan AR Ketika Objek Terdeteksi

4.2.4 Simulation View

This view is a First-Person Game view where users can move objects in any direction and interact with them.

Fig. 7 : Character Reaction When Approaching Object Description

5. Conclusion

After all the experimental results, we can draw the following conclusions from this research:

1. The application of Augmented Reality (AR) technology and first-person games allows for the visualization and simulation of different concepts of gravity at different levels. With AR, the abstract concept of gravity can be interactively visualized in the user's real world, for example, by projecting the trajectory of a falling object onto the side of a table.
2. The integration of AR and first-person games is highly effective in enhancing students' understanding of the concept of gravity in the context of astronomy.

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