FORMAT: Jurnal Ilmiah Teknik Informatika
Akreditasi Sinta 5 RISTEKBRIN No. 164/E/KPT/2021; E-ISSN 2722-7162 | P-ISSN 2089-5615

Vol. 13, No. 2,
July 2024,
226 - 235. 2024

Applications for Learning Fruits And Animals Using Android-Based Augmented Reality Technology

Yoseph Martin Lay [1]; Emil Kaburuan [2]

[1,2] *Fakultas Ilmu Komputer, Universitas Mercu Buana, Jakarta Barat*

martinlay99@gmail.com [1], *emil.kaburuan@mercubuana.ac.id* [2]

Kata kunci:
accuracy, decision tree, default prediction, f1-score, k-nearest neighbors, knn, logistic regression, precision, random forest, recall

Abstract

The use of Augmented Reality (AR) technology in education has become an area of research that has attracted attention in recent years. In the context of learning animals and fruits, AR has great potential to increase students' interest and understanding through interesting interactive experiences. By using Unity 3D as a development platform and Vuforia as an AR toolkit, this application is equipped with features such as object detection, visualization of fruits and animals in 3D, as well as additional information about names, descriptions, and additional information about characteristics and characteristics of each object. This study aims to develop a fruits and animals learning application using Android-based Augmented Reality (AR) technology. This application takes advantage of AR capabilities on Android devices to visualize fruits and animals in three dimensions (3D) in the real world.

Pendahuluan

A. Latar Belakang

In the contemporary educational landscape, the integration of technological innovations has revolutionized traditional teaching approaches, ushering in dynamic and engaging methods of knowledge dissemination. One such innovation, Augmented Reality (AR), has emerged as a powerful tool that amalgamates the physical and digital realms to create immersive learning experiences. AR overlays virtual elements onto the real world, offering a novel way to captivate learners' attention and foster deeper understanding. In this context, the present study delves into the development and evaluation of Android-based Augmented Reality (AR) learning applications tailored for early childhood education, specifically focusing on animals and fruits [1].

Early childhood education plays a pivotal role in shaping young minds and establishing a strong cognitive foundation [2]. The integration of AR technology into learning applications holds the promise of transforming early childhood education by infusing it with interactivity, visual stimulation, and experiential learning. This study seeks to explore the potential of AR-enhanced applications in cultivating the cognitive and sensory skills of young learners, while concurrently introducing them to fundamental concepts such as animals and fruits.

The core objective of this research is to develop a set of AR-based learning applications that cater to the unique learning needs of early childhood. By harnessing the capabilities of Android devices and AR technology, these applications aim to provide an engaging platform for children to interact with 3D models of Animals and Fruits [3]. The applications are designed to spark curiosity, facilitate multisensory engagement, and promote active exploration, thereby laying the groundwork for effective knowledge acquisition and retention. The development of mobile applications, particularly on the Android platform, has provided new possibilities for integrating AR technology into education [4]. Several previous studies have revealed the benefits of using AR in learning. For example, research conducted by [5] found that the use of AR in science learning can improve concept understanding, student engagement, and the development of problem-solving skills. Likewise, research by [6] shows that the use of AR in history lessons can increase students' interest and broaden their understanding of the topic being studied.

The significance of incorporating AR technology into early childhood education extends beyond its novelty [7]. This study contributes to the ongoing discourse surrounding educational technology by delving into the practical implications of AR in fostering an enriched learning environment. As digital natives, today's young learners are intuitively drawn to interactive digital experiences [8]. By leveraging AR technology, educators can harness this innate affinity for technology to create engaging and effective learning tools.

Methodology

This section presents a comprehensive overview of the materials and method employed in the development and evaluation of the Augmented Reality (AR) based learning applications for early childhood education. The section is structured to provide insights into the software tools, development approach, and systematic process undertaken to create the interactive and engaging AR learning applications.

Development Approach

The development of AR-based learning applications followed a structured approach based on the Multimedia Development Life Cycle (MLDC) method [9]. This method encompasses a series of stages, namely needs analysis, design, implementation, testing, and deployment, ensuring a systematic and comprehensive development process. This methodological choice enabled a holistic consideration of various aspects, from conceptualization to user satisfaction, leading to the creation of effective and user-friendly applications.

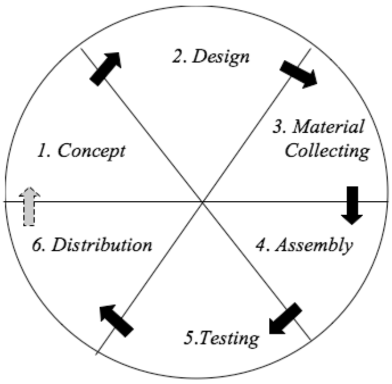

Figure. 1. *Application Development Stages*

Development Process

The development process of the AR learning applications adhered to the Luther-Sutopo Development Model, a sequential approach that consists of six distinct stages. These stages were meticulously executed to ensure the successful translation of design and conceptualization into functional applications. The stages include:

Concept: This initial stage involved the determination of the application's purpose and target audience, namely early childhood learners aged 0-6 years. The concept encompassed the design of an attractive yet user-friendly interface that aligns with the cognitive abilities of the target audience. Additionally, the type of application (educational), goals (fruit recognition), and key criteria (offline functionality, interactive objects) were established.

Design: In this stage, the design of the user interface, markers, and flowcharts were meticulously crafted. User interface elements were designed using Photoshop and Unity's UI system to ensure clarity and intuitive navigation. Marker designs were developed with distinct characteristics for animal and fruit markers, enabling accurate marker-based AR interactions.

Material Collection: The materials required for the application, including 2D images, 3D models, audio, and text, were collected in preparation for the assembly stage.

Assembly: The assembly stage involved the integration of collected materials into the application. Assets such as 2D images, 3D models, audio, and text were incorporated based on the design specifications. The Unity software, augmented by the Vuforia SDK, facilitated the creation of an Augmented Reality-based educational game scan, aligning with the designed user interface and markers.

Testing: Rigorous testing was conducted to ensure the functionality and quality of the developed application. The Black Box Testing method was employed, allowing for a comprehensive assessment of input-output behavior without knowledge of the software's underlying code structure [10]. Testing covered aspects such as marker detection accuracy, 3D model placement, interaction responsiveness, and overall application performance.

Distribution: The final stage involved the distribution of the application to storage media, including the Google Play Store. Beta testers were invited to use the application, providing valuable feedback for further enhancements.

Tools and Materials

The development of AR-based learning applications necessitated the utilization of various tools and materials, contributing to the creation of a seamless and immersive learning experience. The following tools and materials were employed:

- Development Software: Android Studio served as the primary development environment for Android-based applications, while Unity provided a robust platform for AR development. Blender was utilized for intricate 3D model design, and Visual Studio was used as a script editor. Adobe Photoshop played a crucial role in user interface design.
- AR Markers: Visual markers were meticulously designed using Adobe Photoshop to serve as reference points for AR content. These markers, distinct for letters, animals, and fruits, enabled accurate marker recognition and interaction.
- Learning Content: Educational content, including images, text, and audio related to letters, animals, and fruits, was gathered to form the core learning materials within the application.

Results And Discussion

Application Development and Features

The AR-based learning applications for fruits and animals were successfully developed, following a structured and systematic development process. These applications offer an interactive and captivating learning environment, allowing users to explore virtual 3D models of fruits and animals within their real surroundings. The implementation phase involved translating design specifications into functional applications, including the integration of AR technology, user interface design, and educational content.

Unity 3D facilitated the creation of lifelike scenes that mimic real-world environments, serving as a backdrop for the AR content. The applications utilized two distinct scenes: the Main Menu scene and the AR Game scene. The Main Menu provided users with options to either play the game or exit, while the AR Game scene immersed users in the augmented reality learning experience.

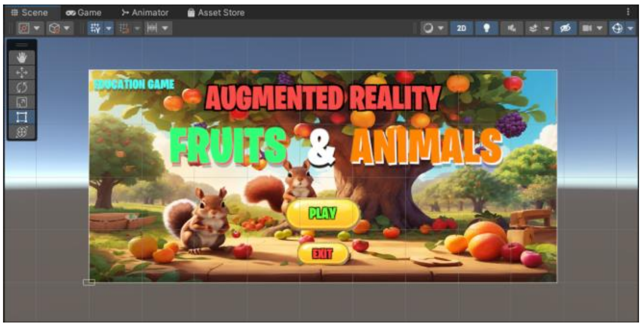

Figure. 2. *Main Menu Scenes*

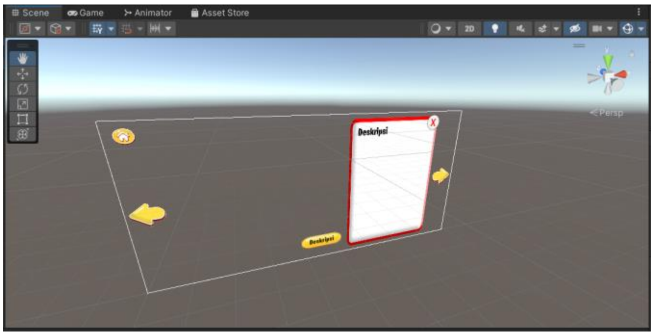

Figure. 3. *App Scene*

User Interface Design: The user interface (UI) elements, such as buttons, menus, and background visuals, were strategically designed and positioned within the applications. This design process was facilitated using tools such as Photoshop and Unity's UI system, ensuring a coherent and user-friendly interface for seamless interaction.

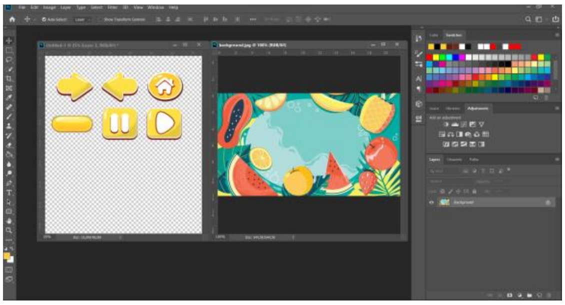

Figure. 4. *UI Element Design*

Vuforia was configured to accurately recognize specific markers placed in the physical environment. These markers acted as triggers, prompting the applications to display AR content. The effectiveness of marker detection and tracking capabilities was ensured through the implementation of the FAST (Features from Accelerated Segment Test) algorithm, which facilitated corner detection and image recognition [11].

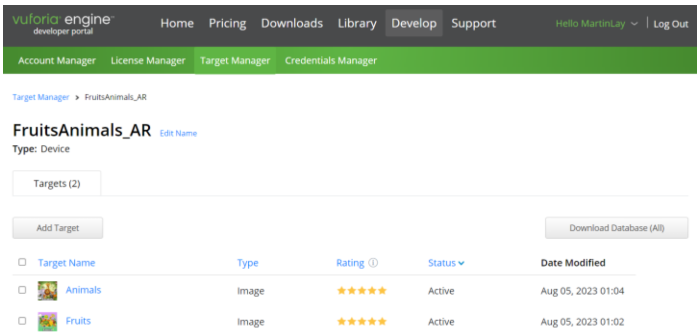

Figure. 5. *Vuforia Database*

Upon marker detection, 3D models of fruits and animals were precisely superimposed onto the markers' positions. This seamless integration of digital objects within the physical environment created an augmented reality experience that enhanced user engagement and learning.

Figure. 6. *Fruits and Animals Marker*

Blender was employed to intricately design and create detailed 3D models of various fruits and animals. Attention was paid to capturing accurate proportions, textures, and visual attributes, resulting in lifelike virtual objects that closely resembled their real-world counterparts.

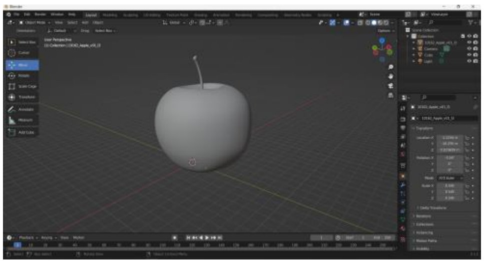

Figure. 7. *Model design*

Blender's capabilities for texturing and applying materials were harnessed to enhance the realism of the 3D models. By simulating attributes such as color, glossiness, and surface details, Blender contributed to a heightened sense of immersion and engagement within the AR learning environment.

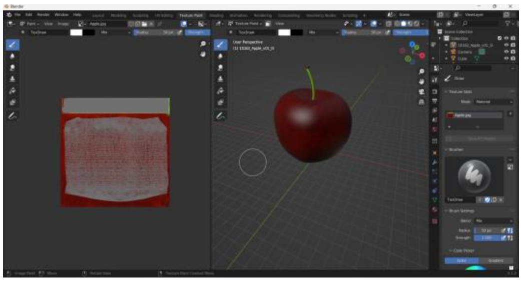

Figure. 8. *Model texturing*

Application Testing

The development of AR-based learning applications required rigorous testing to ensure optimal functionality, usability, and educational effectiveness. The testing phase encompassed various methodologies aimed at evaluating the applications' performance and user experience.

Functionality testing was conducted to ensure that the applications performed as intended across diverse scenarios and interactions [12]. A comprehensive set of test cases was meticulously designed to cover different functionalities, such as marker detection accuracy, placement of 3D models, interaction responsiveness, and content display. The applications were systematically tested on various Android devices to ensure consistent performance and behavior. From the test results, all functions run normally from the display, buttons and audio. Below is a picture of the test results.

Figure. 9. *App Main Menu*

Upon launching the application, users are greeted with the Main Menu screen. The Main Menu serves as the starting point and offers two primary options: "Play" and "Exit". Users have the choice to initiate the learning experience by selecting the "Play" button or to exit the application if desired.

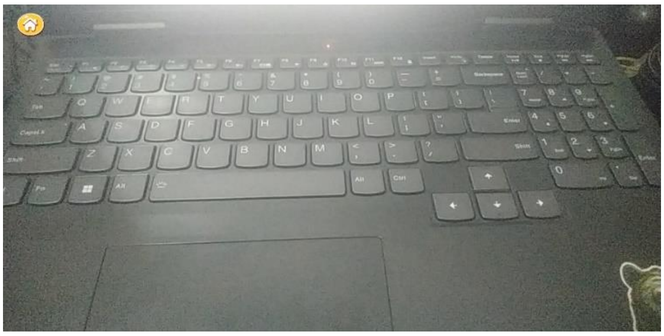

Figure. 10. *App Interface*

Upon selecting "Play," users are directed to the game environment. Within the game, users are presented with the visual representation of a fruit or animal on the screen. The interface provides users with two directional buttons, "Left" and "Right," which allow them to cycle through various objects.

The core AR functionality is activated when the user's device camera is directed toward a physical marker. As the camera captures the marker, the application's image recognition capabilities are employed to detect and track the marker's position. Once the marker is recognized, the corresponding 3D model of the object, be it a fruit or an animal, is superimposed onto the marker's location in the user's physical environment.

Figure. 11. *App plays fruits object*

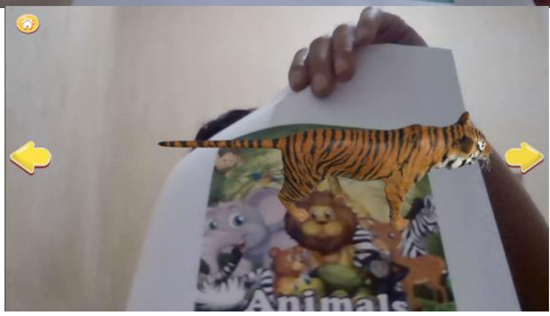

Figure. 12. *App plays animals object*

Simultaneously, the application provides audio feedback to enhance the user experience. Upon marker detection and object display, the application plays a sound that corresponds to the recognized object. This audio feedback element adds an additional layer of interactivity and engagement, reinforcing the user's connection between the digital and physical realms.

Users are encouraged to interact further by tapping on the displayed 3D object. When a user taps on an object, the application responds by producing an associated sound, reinforcing the auditory and tactile experience. This interaction deepens the user's engagement and understanding

Performance Evaluation

Performance evaluation aimed to assess the applications' responsiveness, stability, and resource consumption. Stress tests were conducted to gauge the applications' ability to handle a range of user interactions without compromising performance. Furthermore, Black Box Testing was employed to ensure that the applications' functions operated according to their intended purposes.

Tabel 1. Blackbox Testing

No	Testing	Expected results	Test results
	Enter the app	The user enters the application	ucceed
	Displays the main menu	A menu page appears containing the play and exit buttons	ucceed
	Play Button	Make button sound and Displays an AR page with the camera open	ucceed
	The camera is pointed at the marker	Displays 3D objects according to the marker and the object animated	ucceed
	Marker not detected	3D Objects disappear or not displayed	ucceed
	Left and right object change button	3D Objects switch and make sounds based on the object	ucceed
	Press Object	Make sounds and animated objects pop up quickly	ucceed
	Home Button	Return to Main Menu	ucceed

[a] Sample of a Table footnote. *(Table footnote)*

Evaluation Results

The implementation of the AR-based learning applications underwent a comprehensive evaluation process to assess their usability, learning impact, and user satisfaction. The evaluation results shed light on the applications' effectiveness and offer insights into their potential contributions to the field of early childhood education.

Based on the research results and previous projects, participants reported a high level of usability and user-friendliness in navigating the application. The majority of participants found the application easy to use and navigate. Intuitive interaction design, clear instructions, and responsive AR elements contribute to a smooth and engaging user experience [13].

Based on the tests that have been carried out by [14] the Assessment before and after tests are carried out to measure the learning impact of the application. The results showed a significant increase in participants' knowledge and recognition of fruits and animals after using the application. The visual and interactive nature of AR content contributes to better retention and understanding of the subject matter.

Qualitative feedback collected by [15] through surveys highlighted the positive impact of the applications on the learning process. Users appreciated the multi-sensory experience offered by the combination of visual and auditory elements, emphasizing the applications' role in increasing engagement.

Discussion

The discussion of the implementation results underscores the significance of integrating Unity 3D, Vuforia, and Blender to create a seamless and engaging AR-based learning experience. The successful integration of these technologies has broader implications for education and paves the way for future enhancements, such as expanded content and improved user interfaces. The discussion further highlights the potential of AR technology to enhance engagement, interaction, and learning outcomes in early childhood education.

Conclusion

The development and evaluation of Augmented Reality (AR)-based learning applications for fruits and animals have yielded valuable insights and outcomes. This section provides a comprehensive conclusion that summarizes the key findings, discusses the significance of the research, and outlines potential avenues for future research and application.

In conclusion, the development and evaluation of AR-based learning applications for fruits and animals have demonstrated the efficacy of integrating technology and education. The positive outcomes observed in this study underscore the potential of AR technology to enhance early childhood education by fostering engagement, improving learning outcomes, and creating dynamic and immersive learning environments [16]. As technology continues to advance, further exploration and refinement of AR applications in education hold promise for transforming the way young children learn and interact with their surroundings.

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Yoseph Martin Lay
Fakultas Ilmu Komputer
Universitas Mercu Buana, Jakarta Barat

Emil Kaburuan
Fakultas Ilmu Komputer
Universitas Mercu Buana, Jakarta Barat