

Implementation of Augmented Reality Technology as a Learning Media for Fruit Introduction

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ABSTRACT

Fruits are one of the natural food sources that contain a variety of different vitamins, minerals, and nutrients. Introducing children early to various types of fruit can help develop cognitive thinking skills and increase environmental knowledge. However, formal early childhood education today still uses paper media, which is less effective when delivered to children who have never seen the fruit being studied. Based on the problems that have been described, the author makes an application by utilizing mobile-based information technology combined with the augmented reality system. This research aims to help introduce users to the fruits that exist in Asia with technology that can display virtual objects in the form of fruit and their information projected on the real world. To measure the ability of children, the application also provides a quiz. Users can run this application anywhere and anytime because, in addition to being offline, this application uses a markerless method, so that learning can increase rapidly and effectively. Navigation and features available in the application are made as easy as possible to operate.

General Terms

Unity 3D, Vuforia, C#.

Keywords

Augmented Reality, Fruit, Learning Media, Mobile, 3D Objects.

1. INTRODUCTION

Providing knowledge about the environment can help build character, morals, and potential in children. One of the environmental knowledge areas that can be given to children is introducing fruits early on, which will play a role in children's cognitive development. Introduction to fruits is one of the first steps to learning about the environment.

With the development of technology, Android is a technology that can be utilized as an interactive learning medium. Interactive learning media is considered more effective when delivering material to students because students can actively and more freely use the media to find and learn the information contained in it. Learning media that contain interactive multimedia elements can help in the teaching and learning process. Interactive multimedia is a new technology with great potential to change current learning methods [1].

Augmented reality technology is one of the alternative media that can facilitate the process of delivering learning materials. Augmented reality is a technology that can combine virtual objects into the real world in real-time [2]. Especially currently, device technology has developed and is widely used by almost all circles, ranging from trade, campaigns, advertising, and education.

Augmented reality scanning generally uses two methods, namely marker-based and markerless. By prioritizing flexibility and convenience, the author applies markerless tracking technology to facilitate users running applications that can be operated flexibly without the help of markers [3]. A simple system display and uncomplicated navigation will make it easier for users to obtain information, so that learning is not only in formal education but can also be done outside the school environment.

2. LITERATURE REVIEW

2.1 Unity

Unity Engine is a multi-platform software that focuses on developing 3D applications. Although it focuses on 3D, this application can also be used to create 2D-based applications. Unity Engine is currently a very popular game engine platform compared to its competitors. This is because the documentation and tutorials are quite complete, making it easy for beginners to learn. In addition, this platform has complete libraries and tools. To create AR applications in Unity Engine, the Vuforia SDK is needed as an AR processor. Vuforia is an SDK (Software Developer Kit) powered by Qualcomm for making AR applications aimed at mobile devices (IOS, Android).

2.2 Media

In the communication process, it requires media or means as an intermediary to convey messages. In general, the meaning of media is everything that can channel information from the sender of information to the recipient of information. So, learning media is software or software that contains messages or educational information that is presented using a hardware tool so that the message or information can be conveyed to students or users. Media is different from equipment, but both are elements that are interrelated with each other to convey messages or information. Thus, it can be concluded that the media is a container of messages that the source or sender wants to convey to the recipient of the message, the information to be conveyed is educational material, and the goal to be achieved is the occurrence of an effective learning process. The benefit of media in the learning process is to facilitate interaction between teachers and students so that learning activities will be more effective and efficient. But in a general sense, there are many uses of media that can be utilized other than the education sector [4].

2.3 Augmented Reality

Augmented reality provides a view of the real world in which elements are superimposed by computer-generated files such as graphics, sound, video, or digital information [5]. Augmented reality brings virtual information or objects to the indirect world environment to enhance user perception and interaction with the real world. Augmented reality tries to add real virtual objects or scenes to maximize the natural and intuitive user experience in real-time. This technology is a medium for

enhancing interactive environments where real life is enhanced by virtual things in real-time [6].

2.4 Education

Some of the coincidental benefits of applying AR in education are mostly an increase in learning motivation. Of the 12 articles studied, there is an Augmented Reality Education (AREd) application where students of different educational levels receive 3D materials to be applied in school practice. This was evaluated to determine the knowledge gained, and it was found that AREd increased learning speed and comprehension [7].

There is a study of 60 children between the ages of 6 and 10 evaluated with AR games based on kinesthetic activities that allow children to follow different and systematic activities. This is useful for children to improve their behavior and adaptive abilities related to visual perception. An important element of this game is that the therapist can adapt the AR application according to the needs and context of the child [8].

2.5 Unified Modelling Language (UML)

UML (Unified Modelling Language) is a language for reference in the industry as a tool for the visualization, design, and documentation of software systems. UML is used as a reference for designing a system model. This modelling aims for the process of designing software before coding [9]. The design of the current system is done using the Unified Modelling Language (UML). The diagram used to describe the current system is a use case [10].

3. METHODOLOGY

3.1 Research Stages

The implementation of research on this system uses a literature study approach method that includes requirement analysis, design, implementation, testing, and maintenance.

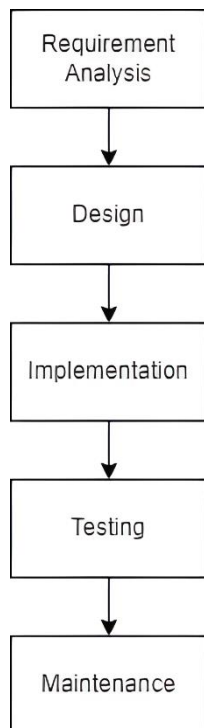


Fig 1 : Research Stages

Based on Figure 1, the initial step of the research stage starts with requirement analysis, which is the process of collecting information about software requirements and analyzing user

needs. This information is obtained through surveys, interviews, and discussions. The information that has been collected is then developed according to the user's needs.

The design stage is the process of designing a system display to help specify the overall system requirements. At this stage, it also describes the system architecture that will be created.

The implementation stage is the process of writing application system code. At this stage, the application module is broken down into several small parts, so that checking can be more in-depth in each module.

The testing stage is the merging of modules that have been made before and testing the application to see whether it has run properly or not.

The last stage is maintenance, at this stage the application must be able to be run and operated by the user. However, maintenance and system development will still be carried out so that all functions in the application continue to run well.

3.2 Flowchart

A flowchart or flow chart aims to describe the steps and functions of a feature in the application system. Here is the flow of the AR-based fruit recognition application.

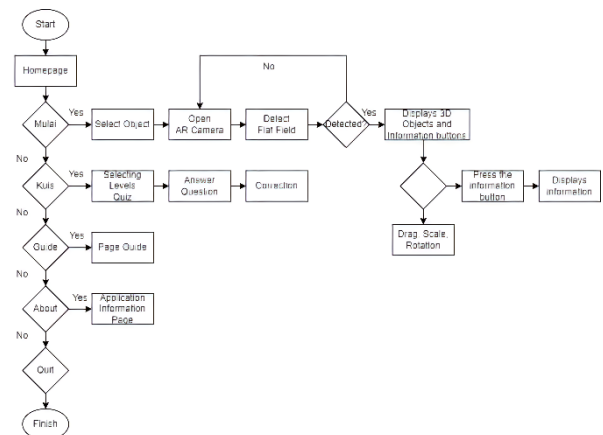


Fig 2 : Flowchart

Figure 2 is a flowchart diagram to describe the workflow of the augmented reality-based fruit recognition application system. The diagram illustrates that to display virtual objects, they must be on a flat plane.

In the Start section, the system will display several fruit options that are already available in the database, then switch to camera mode to scan the flat field to see if it has met the criteria for displaying virtual objects or not. If the flat field is detected according to the criteria, the system will display virtual objects along with several features, such as drag, rotation, information, and audio, according to the type of fruit selected. On the Quiz page, there is a quiz level that presents multiple-choice questions with different contents as well as answers stored in the database to correct answers from users. On the Guide page, the system will display static application usage instructions so that there is no interaction on the Guide page. The About page is also static to display information related to the application and technology used.

3.3 Use Case

A use case is a technique used in the development of an information system to capture the functional requirements of the system so that system users understand the usefulness of the system to be built [11].

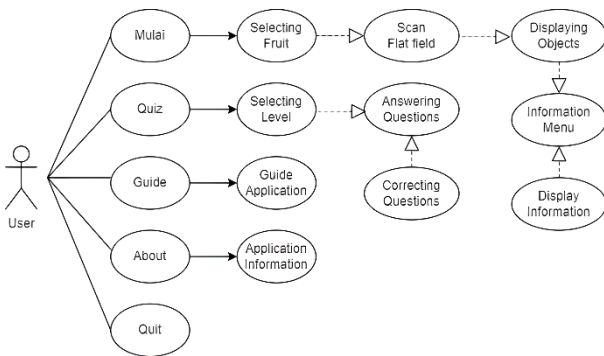


Fig 3 : Use Case

Figure 3 is an illustration of the interaction that can be done by the user and the system of the augmented reality-based fruit recognition application. There are four features on the main display that can be input by the user.

On the Start section, users will encounter an array of fruit options, and upon selection, a digital representation of the chosen fruit will be presented. If the user proceeds, the interface will transition to camera mode to identify a flat surface. Once the flat surface is recognized, the virtual object and an information button will be displayed, leading to a page containing details about the selected fruit. In the Quiz section, users will be prompted to choose the question difficulty level, and their responses will be evaluated by the system. The Guide section will provide instructions on navigating and utilizing the application effectively. On the About page, users can access information regarding the application, and a home button will be available for exiting the application.

4. RESULTS AND DISCUSSION

4.1 Requirement Analysis

System requirements are all the activities that the new system must perform or the supports and constraints that the new system must fulfill. In general, analysts divide system requirements into two categories: functional and non-functional requirements. Functional requirements are the activities that the system must perform (i.e., the business use to which the system will be applied) [12].

Functional analysis is a functional requirement that can be explained in three ways: the need for input types, required processes, and expected outputs.

- 1) Input Requirements
Users can activate the camera as a link between the real world and the virtual world, and they can take the available quizzes.
- 2) Process Requirement
The system can correct quiz answers from users and detect flat areas through the camera.
- 3) Output Requirements
The system can display 3D virtual objects, and the system can display information related to the selected object.

Non-Functional Analysis is the equipment (hardware and software) used to create this application.

- 1) Software Requirements
Some of the software used to build the system is Windows 10 Home as an operating system, Vuforia SDK and Unity 3D to build the system, and Blender 3.0 to create 3D objects.
- 2) Hardware Requirements
The hardware details used to build the system are a computer that has an Intel Core i7 7700HQ processor, 16

GB of SDRAM memory, 4GB of DDR5 GTX 1050 Nvidia GeForce Graphics, 4GB of GDDR5 Intel HD Graphics 630, and an FHD (16:9) 1920x1080 60Hz wide screen stretch.

4.2 Design

At this stage, describe the design sketches that will be used in the system. making application display designs that are very important in the development of Android-based learning media. The user interface (UI) becomes a bridge of interaction between users and the system, and the system developed must be easy to use by users. application interface design is made using flat design. Flat design is a minimalist design concept that prioritizes functionality and usability [13]. This design will be used as a reference in creating the application interface (UI). The layout and placement of icons, information, and buttons will adapt to this design.

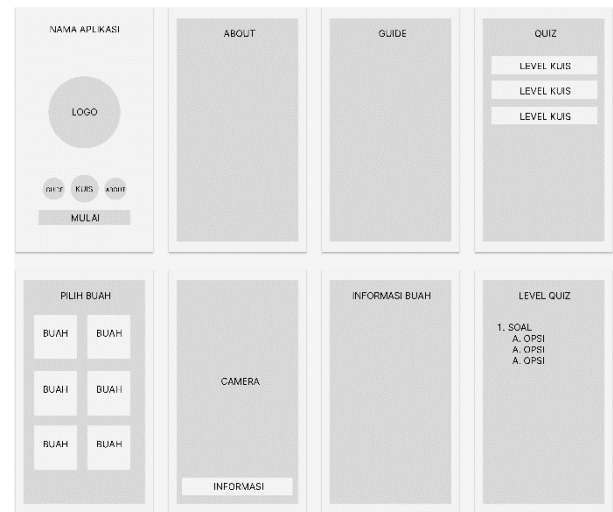


Fig 4 : Design

4.3 Implementation

The results of implementing an augmented reality-based fruit recognition application will display several screenshots of each part of the application. The main features of this application contain a list of fruits that can display 3D virtual objects, material about fruits, and quizzes for learning and measuring the user's abilities..

The splash screen is the initial page when loading the AR-based fruit recognition application. This page contains Unity 3D branding and the name of the application, which below shows the loading bar.



Fig 5 : Splash Screen

The main menu page of the AR-based fruit recognition application displays four main features, namely the Start, About, Guide, and Quiz pages.

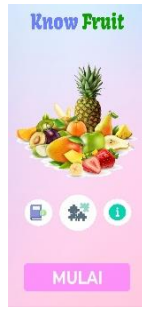


Fig 6 : Main Menu

The Guide page displays a page that serves as an instruction in the use of augmented reality-based fruit recognition applications. This page is static, so there is no interaction between the system and the user because it only displays instructions for using the application.

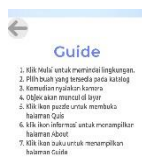


Fig 7 : Guide

The About page is also static because it only displays information related to the augmented reality-based fruit recognition application.



Fig 8 : About

The quiz page contains levels with different levels of difficulty, and then the question system is multiple choice. If the user chooses the correct answer, a "Correct" pop-up will appear, and if it is wrong, a "Wrong" pop-up will appear. All question-and-answer data has been stored in the database.



Fig 9 : Quiz Page

The start page is the main feature of the AR-based fruit recognition application. The page displays several fruit options that are already available in the system, and if users have selected the fruit, the system will switch to the scan page and open the camera. If a flat field is detected, the virtual object of the selected fruit will be displayed. On the page, there is also an information button that contains information related to the selected fruit, and there is also an audio feature to read the information. This makes it easier for users to receive information because the main target of this application is minors. All application data has been stored in an offline system database so that users can operate all application features without an internet network.



Fig 10 : Start Page

4.4 Testing

The results of the augmented reality-based fruit learning system built in this study were carried out with black box testing. The black box testing method is a program test that prioritizes the function requirements of a program. Testing with the black box method is done by providing input to the program. The input is then processed based on its functional requirements to see if the application program can run according to the desired output.

Table 1 : Testing

Page Testing	Testing Scenario	Expected Result	Result
Home Page	Pressing the start button	Display the fruit list	Success
	Pressing the about button	Display the application information page	Success
	Pressing the quiz button	Display the quiz page	Success
	Pressing the guide button	Display the application instructions	Success
Fruit List	Pressing one of the fruit images	Switch to AR camera mode	Success
	Pressing the back button	Return to the main menu page	Success
AR Camera	Flat field scanning	Display 3D objects according to the selected fruit image	Success
		Drag and rotate 3D objects	Success

		Display the information button	
	Pressing the button Information	Display page Information	Success
	Audio	Turn on the voice feature	Success
	Pressing the back button	Return to the fruit list page	
About Page	Pressing the back button	Return to the main menu page	Success
Guide Page			
Quiz Page	Select a quiz level	Display questions according to level	Success
	Answer questions	Correcting	Success

Based on Table 1, the results of testing the application system using the black box method show that most of the main features of the application have run well.

4.5 Maintenance

The maintenance system used in this research is carried out using corrective and periodic maintenance methods. Once every year, the developer will make developments and improvements if there are errors in function, design, or assets to be added or reduced. This is based on cost considerations and the level of complexity of the application. But it does not rule out the possibility of carrying out maintenance on an emergency basis if a sudden, unpredictable error occurs.

5. CONCLUSION

The conclusion of the augmented reality-based fruit recognition application is that it has been running according to its function and can be utilized as a learning medium in formal, non-formal, and personal settings. This application contains information about fruits and can display 3D virtual fruits. With these features, users can more quickly understand about fruit. Besides that, users can also measure their knowledge about fruit with quizzes prepared in the application. Because the intended target is all groups and does not rule out the possibility for minors, the developer has also added an audio feature to read fruit information for users who have difficulty reading.

The creation of this augmented reality-based fruit recognition application aims to help the learning process of fruit recognition for children or even adults who want to learn knowledge about fruits. This application has a user interface that is not too complicated and easy to operate by children. Because it is still in the development process, this application has features that can be developed for the better, such as a more attractive user interface, creating a database system to store account data as well as user progress, and creating application logo that is more in line with the contents of the application.

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