Augmented Reality Application Development for Elementary School Purpose

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Abstract

The world is being hit by a pandemic due to the COVID-19 virus outbreak. The changes brought by this virus are huge, one of which is school activities that are transformed into online learning. Online learning causes students to not do their own classroom learning. This causes students to become un familiar with their school properly, such as the layout of classrooms and school facilities. By using Augmented Reality the problem can be solved. Augmented Reality (AR) is the merging of real and virtual objects in a real environment with interactive results and presented in real time. AR can be used to modeling the entire shape of the school, making it easier for users to get information about the building from the school instead of walking manually. Users only need to install the app on their smartphone and scan the specified QR code in order to be able to bring up the building object along with the information. The result of this research is an AR application which can provide information about the rooms and buildings at SDN 1 Padangsambian.

Keywords: 3D Model, Augmented Reality, Vuforia, Unity, School, Waterfall, Marker Base

1. Introduction

Currently the world is experiencing a pandemic due to the COVID-19 virus outbreak. COVID-19 is a disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which can cause respiratory system disorders [1]. The virus changes many daily activities in general. One example is to minimize the work done directly by applying Work From Home (WFH) if the work can be done from outside the field. Not only work, school activities are also transformed into online learning.

SDN 1 Padangsambian is one of the elementary schools in Bali Province that conducts online learning. Online learning also applies to new students accepted in 2020, resulting all of the students not learning in their classrooms. This causes students to not know their school environment well. The introduction of the school environment can be done by providing a photo of the school floor plan or video. Photos or videos have the drawback of being only visible from one side and not interactive.

Based on journal [2] which develops augmented reality applications with vuforia and unity as an information medium. The result is that the application can be used to solve problems as a medium of introduction of UNWAHAS faculty building and the use of augmented reality may interest the public [2].

Based on research [3] wich develop AR as a map replacement on SMPN 36 Purworejo, it's explained that AR can be an innovation to the map that depicted on paper because the information on AR is using 3D object and it can be interactive. This is considered more informative because it can describe the building and room more clearly [3].

In this research, the software that will be used to develop the AR is Unity Game Engine. Unity is an application for creating 3-dimensional object shapes in video games, architectural visuals,

3D animation in real time. The library that used to create the AR is Vuforia. Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that enables the creation of AR applications. In unity applications, vuforia will be imported as a library or extension in order to create AR applications.

Based on the problem and literature, appropriate technology is needed to provide information about the buildings and rooms owned by SDN 1 Padangsambian to those who need the information. Augmented Reality apps can be the solution to the problem. Augmented Reality (AR) is the merging of real and virtual objects in a real environment with interactive results and presented in real time. Augmented Reality serves to add meaning and information to a real object or place [4]. The use of AR in modeling school buildings is not only used to describe classrooms, but also serves as an introduction to school facilities such as canteens, toilets, libraries and others.
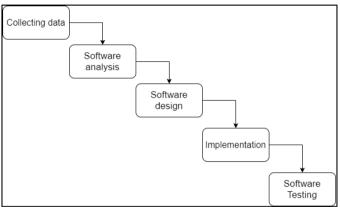
2.   Reseach Methods

Figure 1 Waterfall model

This research uses SDLC method (System Development Life Cycle) with waterfall model. Waterfall models are sequential and systematic in building software, ranging from the stage of needs analysis, system design, implementation, and testing. In this model each phase must be completed before going into the next phase as there is no option to return when it is in the next phase. Therefore in this model, the results obtained in the next phase depend on the previous frame [5]. Based on research [6], waterfall model has advantages including :

- The stages of the development process are fixed, easy to apply, and have an orderly process.
- Suitable for software products that are clearly needed at the beginning, so that there are minimal errors
- Software that developed with this method usually produces good quality software
- The system development document is highly organized, because as each phase must be completed before going into the next phase.

2.1.   Collecting Data

The data obtained in this study obtained by doing interview with some teachers and staff from the school and also direct observation to the school.

2.2.   Software Analysis

Analysis of software is the stage where the specifications or requirements are collected from the application to be built. This includes data requirements, usability, and application limitations to be built. The analysis of the software is described as follows,

a. Software Requirement
- Application can display 3D objects through Marker Based technique
- The app can display complete 3D object containing room descriptions
- The app can zoom in and zoom out
- The application can perform object shifts
- The application can rotate the 3D object

b. Software Limitation
The operating system on android has various versions so that in the development of software roles, restriction analysis is indispensable to know the extent to which the software can be used. This app only runs on the minimum operating system Android 4.1 'Jelly Bean' and above.

c. Software Input and Output
The input in the software created is the marker used as a marker along with the image or frame of the camera capture during the marker identification process. The output of this luni device is the object of the building along with the name of the room located at SDN 1 Padangsambian.

2.3. Software Design

After the analysis process, the next stage is the design process. The design process is a step in meeting software requirements or needs based on the analysis created. The technical details of the design are explained according to various parameters e.g. risk, technology used, team capabilities, project constraints, time and budget which is then the best design approach to be selected for the product [5]. The design model for this application are as follows,

a. Software Technology
Based on previously created system analysis, the design of the software technology used is Augmented Reality (AR) technology. AR created using marker based tracking method. Marker Based tracking is an AR that uses a two-dimensional object-shaped marker with a specific pattern that the computer reads through webcam media or a computer-connected camera [4].
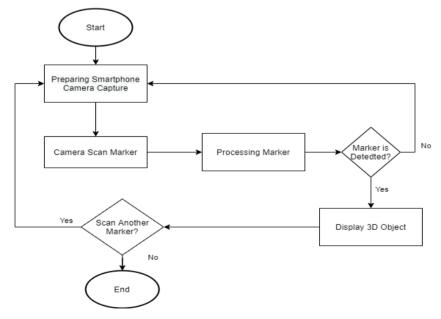

Figure 2 Flowchart Design of Marker Based AR

Based on the flowchart image in Figure 1, the first stage is to set up the camera before tracking the marker. The second stage is to point the camera towards the designated marker which will then be done in the process of recognizing the marker. If the marker is recognized or detected then a 3D model will appear and if not then the process will repeat to the first stage. This process will be repeated until completion in the marker search process.

b. Software Functional Model

Use case diagram has function to model and display the services or functionality in the system, it's describe the system requirements from users point of view, focusing on automated processes [7]. The use case diagram can be seen on Figure 3.
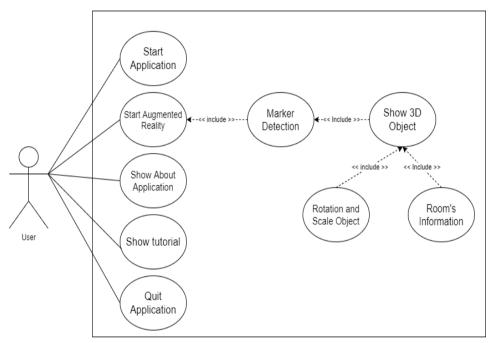

Figure 3 Application Use Case Diagram

Based on Figure 3, there are 9 processes that occur in the application including start application, start augmented reality, show about application, show tutorial using the AR, marker detection, show 3D object, play 3D object (rotation and scale), show room's information, and quit application. Based on the usecase diagram, the next step is to determine the activity diagram. Activity diagrams is a diagram that describe more processes and activity paths from the top level in general, in the form of a sequence of activities in a process [7]. The activity diagram of this application is described as follows,
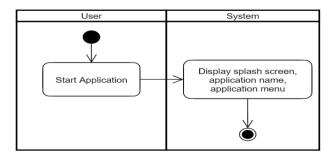

Figure 4 Activity Diagram Start Application Phase

The diagram in Figure 4 describes the process when the user opens the application. In this section, the system will display a splash screen and go to the app's main menu page. In the main menu there are 4 buttons namely Augmented Reality, About Apps, How to Use, and Exit.
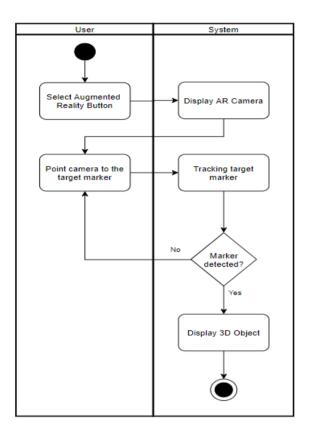

Figure 5 Activity Diagram of Tracking AR

Activity Diagram in Figure 5 shows the process when the user presses the Augmented Reality button on the main menu. The system will dispose of the camera containing the back and rotation buttons. Then the user must point the camera towards the designated marker so that the system will perform the tracking process of the target marker and if the marker can be detected then the 3D object will be displayed by the system and if not it will continue in the camera process.
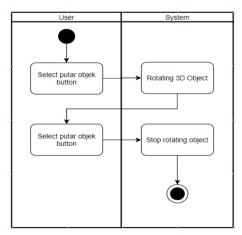

Figure 6 Activity Diagram of "Putar Objek" button

The Activity Diagram in Figure 6 contains the process when AR is executed. The process is the process of image rotation, if the user presses the rotating button of the object then the system will perform a 3D object rotation until the user presses back the object's play button to stop rotating the 3D object.
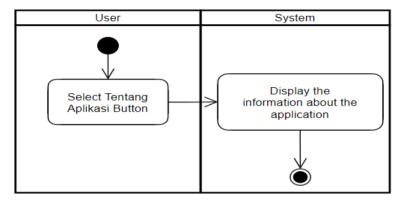

Figure 7 Activity Diagram of "Tentang Aplikasi" button

Activity Diagram in Figure 7 describes the process when user pressing the "Tentang Aplikasi" button on the Main Menu. The user will then be redirected to a page containing about the application being built.
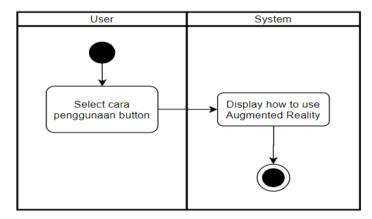

Figure 8 Activity Diagram of "Cara Penggunaan" Button

The Activity Diagram in Figure 8 describes the process when the user presses the "Cara Penggunaan" button on the Main Menu. The user will then be redirected to the AR usage page of the built-in application.
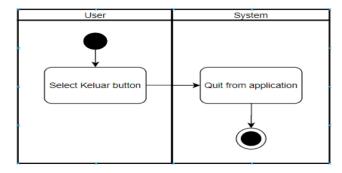

Figure 9 Activity Diagram of "Keluar" Button

The Activity Diagram in Figure 9 describes the process when the user presses the Exit button on the Main Menu which will then make the user exit the application.

3.   Result and Discussion

The results and discussions section contains application implementations and testing of software that has been created.

3.1.   Application Implementation

a.   Main menu
The main menu is the main page of the software, through this page the user can run the application according to the buttons. The activity diagram when starting the app can be seen in Figure 4, and when the exit button is pressed the running activity diagram can be seen in Figure 9. The display from the main menu page can be seen in Figure 10.

Figure 10 Main menu

b.   Augmented Reality Display
Figure 11 is the displayed page when the AR button is pressed and the user aiming at the QR Code. The diagram activity that running on this page can be seen in Figure 5 and Figure 6.
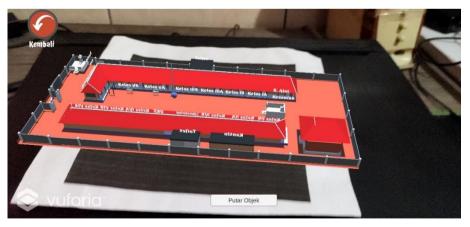

Figure 11 Augmented Reality Display

c.   About Application
Figure 12 is the displayed page when the "Tentang Aplikasi" button pressed, The Activity Diagram that explaining the display of this page can be seen in Figure 7.

Figure 12 About Application

d. How to Use
Figure 13 is the displayed page when the "Cara Penggunaan Augmented Reality" button pressed. The activity diagram that explaining the display of this page can be seen in Figure 8.

Figure 13 How to Use

3.2.   Application Testing

The test is blackbox testing to find out the correctness and suitability of the process on the application as well as the use of the app on several different android smartphones. Where this test is only viewed based on the output generated from the data or input conditions provided for the functionality contained in the software regardless of how the process to obtain output. The devices tested include Oppo A83, HUAWEI nova 5T, Xiaomi Redmi K20Pro, Xiaomi Mi 9T Pro, Samsung A10. The result of the black box testing can be found on Table 1.

Table 1 Blackbox Application Testing

No	Action	Result	Testing Result
1	User launch or start Application	Successfully running the application	Success
2	User pressing "Augmented Reality" button	Display smarthphone camera	Success
3	User pressing "Tentang Aplikasi" button	Displaying about application page	Success
4	User pressing "Cara Penggunaan" button	Displaying How to use application page	Success
5	User using Camera to track the marker	Succesfully displaying 3D object on the marker	Success
6	User pressing " Kembali " button	Back to Main Menu	Success
7	User pressing "Putar Objek" button	Rotating 3D Object	Success
8	User pressing "Keluar" button	Running the exit button script and exit application	Success

4.   Conclusion

Augmented Reality Application Introduction of SDN 1 Padangsambian was built to address the problem of lack of information about the layout of the room in the school. AR applications are built using the Marker Based method so that it requires input in the form of QR Code and output in the form of 3D objects from the school building. Virtual object modeling is created with blender application, then AR Software created using Unity application with the help of Vuforia library. The software design model uses the SDLC (System Life Cycle) method with waterfall models and testing of applications using blackbox testing. The result is that the application can run according to the minimum specifications of the device or above and all the feature was executed well.

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