Mobile Augmented Reality Application for Component Identification

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Abstract. This article discusses the development of augmented reality (AR) based object identification applications. The purpose of this study is to improve the distribution station component identification workbook. Through the implementation of the developed application, it is assumed that it will be easier to understand the functionality of the components of the distributing station. The augmented reality application was developed for the android platform. The result showed the application of Distributing Station-AR has been developed by applying a marker-based tracking method. The application test has successfully displayed the three-dimension components of distributing station using a marker on the component identification workbook of distributing station. Product performance is known to be very good and product validation is also very good, including material validation, media validation, and first user responses. For further development, this application is expected to add animation of the working principle of AR-based components.

1. Introduction

Augmented Reality (AR) is a technology that combines two and/or three-dimensional objects into a virtual environment in real time [1][2]. AR is a technology that can display a virtual object contained in a virtual environment to the real world [3]. The AR concept combines computer vision, image processing, and computer graphics to form a new paradigm of interaction between humans and computers [4][5]. AR is classified into two types, namely Geographic location-based AR and Computer vision-based AR. Computer vision-based AR is classified into two types, namely Marker-based AR and Marker-less AR [6]. In this paper, we apply the concept of Marker-based AR as the type of AR technology adopted. Marker Based Tracking will distinguish between existing markers and objects that are outside the marker or other objects in the real world. Position and orientation are considered in markers, where multiple positions and content will result in multiple markers. The implementation of many markers is very visible when capturing marker data on 3D objects. The marker will be divided into black border and white background as an illustration at the implementation stage [7].
AR applications can be an alternative interactive learning media. In the era of distance learning or online learning, it is necessary to renew learning media as a source of learning for students. Learning materials are complex, abstract, and difficult to understand, with AR technology to make it easier for students to understand the material [8][9]. Currently, smartphones are the most widely used devices by the community, including students. Distance learning requires every student to have a smartphone to participate in distance learning, so this condition is very supportive in the application of AR-based learning media. The purpose of this study is to introduce AR applications as interactive learning media. This application complements the learner's workbook for machine component identification with additional information displayed in the virtual world. This application was developed for the Android platform and the first version has been tested to material validation, media validation, and first user validation.

2. Methods
This study is development research by adopting the ADDIE development model [10]. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation. Figure 1 is a model of the development stages.

![Figure 1. The ADDIE model [10]](image)

The analysis phase aims to determine the current conditions and conditions that should be expected, to set goals and determine priorities for action. During the covid-19 pandemic, in the online learning process problems were found, namely students had difficulty understanding machine components caused by the limitations of the media used to visualize component images online. So that in the analysis stage it has been determined to identify AR-based components. The design phase aims to establish the expected performance and the appropriate testing strategy. Software requirements, user interface, and flow charts are also developed at this stage. Software requirements are described separately in the sub-chapters of this paper. Storyboards are used to describe the initial visualization of the user interface on the screen. The user interface is shown in Figure 2 up to Figure 7. Flowcharts are used to simplify the development process. The flow chart is shown in Figure 8. The development stage aims to produce and validate the selected learning product. The application developed is an application with AR technology that can project a two-dimensional image marker into three-dimensional form. A two-dimensional image is projected from the workbook. The implementation stage is to prepare a learning environment by involving students. This study discusses the steps of product development to the step of testing the performance of the product. The implementation stage has not been carried out in this study. The evaluation stage is to assess product quality and evaluate the learning process, both before and after implementation. The first product evaluation is done by black box test. Black box test is performed to assess product performance. Then continued validation by experts in the field of software engineering and experts in the field of pneumatic machine component materials, as well as responses from potential users to the developed AR products.
Figure 2. User interface of main menu page

Figure 3. User interface of learning objective page

Figure 4. User interface of help page

Figure 5. User interface of information page

Figure 6. User interface of about the application page

Figure 7. User interface of AR marker scanner camera page

Figure 8. The flowchart of application
3. Technologies and Tools

AR technology is the latest trend and continues to grow in shaping human-computer interaction behavior. There are several platforms used to develop AR technology.

3.1. Unity

Unity is software that provides various tools in it to make it easier to make games (game engines) through objects that are already available or by adding scripts that are used to adjust the game as desired. Unity 3D is a software that is usually used to create multi-platform games that have high-optimized graphics performance. Applications created using Unity 3D can be run on Windows, Nintendo Wii, Mac, PS3, Xbox 360, Pad, Android platforms, and iPhone operating systems [11].

3.2. Visual Studio

Visual Studio is software that can be used to develop applications with various programming languages [12]. Microsoft Visual Studio is integrated development software that can be used to develop applications in native code or managed code. Visual Studio can also be used to develop Silverlight applications, windows mobile applications (running on .NET Compact Framework). Microsoft Visual Studio is supported by several programming languages such as C++, Visual C#, and Visual Basic. Visual Studio can also support other programming languages, such as M, python, and ruby, all of which are included in additional packages that are separate from visual studio [11].

3.3. Vuforia

Vuforia is software used to support AR creation. Vuforia which focuses on image recognition (image recognition). The features and capabilities provided by Vuforia are very diverse, so that it can help AR application developers to realize their thoughts without any technical limitations [13].

3.4. Blender

Blender is software that can be used to create 3-dimensional objects in the form of models and animations. Blender can also be used as software used to create games (game engine) for free with a file size of less than 100 MB and is available for various operating systems such as Windows, Mac OSX, Linux, and Free BSD. Blender is a software for three-dimensional modeling based on Windows. In the world of architecture, blender has been widely used to create three-dimensional modeling which is used as a presentation medium to be presented to customers because the results of three-dimensional shapes resemble real shapes [11].

3.5. Android SDK

The Android SDK is a toolkit that functions as an emulator when the application is completed. In the manufacture of AR technology, the Android SDK is not only used as an emulator, but also at the deployment stage in the form of an "*.apk" application. If the Android SDK is not installed, the application that has been developed cannot be deployed in the form of an application [14].

3.6. Canva

Canva is a comprehensive website that can be used for designing covering a myriad of graphic design concepts. The basic features are free, very suitable for the development of info graphic designs, presentation slides, certificates, posters, banners, greeting cards, and so on [15].

4. Finding and discussions

This section will be divided into three topics, including component identification workbooks, Distributing Station-AR applications, and product validation results. The AR application is devoted to the identification of distribution station components. Students install AR applications on smartphones, then with guidance on workbooks, students identify components on the distribution station machine.
The workbook is equipped with the steps of the work that must be done, as well as the parts that must be scanned with the AR application to see in detail in three-dimensional form.

### 4.1. The Component Identification Workbook

Assembling, programming, and testing industrial machines requires an understanding of the machine. Work principles, electrical wiring, pneumatic wiring, component names, function of components, etc., must be mastered by an engineer. Distributing station is one of the replicas of industrial machines that can be disassembled for assembling, programming, and testing training. Learning about distributing station, already equipped with a workbook. The distributing station workbook contains instructions regarding the identification of component names, program descriptions, and program evaluation. This workbook is equipped with AR technology that can be scanned with a smartphone to display three-dimensional shapes. The images presented in the workbook are two-dimensional images, so they can only be observed from one side. With AR technology, objects displayed can be observed from various sides. The identification of the distributing station component is presented in the form of an image accompanied by an explanation of the component name. Figure 9 shows a page snippet from the distribution station component identification workbook.

![Page snippet from the distribution station component identification workbook.](image1)

**Figure 9.** The workbook parts of the distributing station component identification

The distributing station workbook has been equipped with Marker-AR which can be scanned by smartphone. The purpose of adding Marker-AR is to clarify component images, so that component identification is more real because component images appear in a virtual environment in 3D. Figure 10 and Figure 11 show examples of Marker-AR in a workbook for identification of distribution station components.
4.2. The Distributing Station-AR

Distributing Station-AR is an android application with Augmented Reality technology that can project two-dimensional images into three-dimensional shapes. The Distributing Station-AR application is used to project component images on the distributing station so that it is easier to understand. Figure 12 is the icon for the Distributing Station-AR application that has been installed on a smartphone. Figure 13 is a user interface display on the welcome page. On the welcome page there are main menus, including the learning objectives menu, instructions menu, info menu, about menu, and AR-Camera menu.

To use workbooks with AR technology, users must launch the Distributing Station-AR application, then allow the application to use the smartphone camera. In the AR scan menu, point the camera at the Marker-AR distributing identification workbook. On the display of the smartphone appears a three-dimensional model of the scanned component image. The three-dimensional model can be seen from various sides by moving the smartphone according to the side to be observed.

4.3. Product Validation

The performance of the AR Distributing Station is known through the black box test. There are two aspects to the black box test, covering the application installation aspect and the application operation.
aspect. The test uses a questionnaire, consisting of 23 statements items with two answer choices, namely "0" and "1". Four statements on the application installation aspect and 19 items on the application operation aspect. A total of 3 respondents as test subjects. The results of the black box test are known to all respondents giving a maximum rating on all statement items. Thus, it can be concluded that the performance of the Distributing Station-AR application product is in the “Very Good” category with a percentage of 100%.

Product validation includes material validation about distribution station machines, software-based media validation, and first user response. Assessment by material experts consists of two aspects, including aspects of the suitability of the material and aspects of the usefulness of the material. The test uses a questionnaire, consisting of 24 statement items with a Likert scale of 1 - 4 as answer choices. There are two respondents as subject matter experts. The results of material validation are known to obtain an average assessment of 90.63% and are included in the "Very Good" category. Assessment by media experts consists of two aspects, including aspects of multimedia design and aspects of multimedia usefulness. The test uses a questionnaire, consisting of 18 statements with a Likert scale of 1 - 4 as the answer choices. There are two respondents as the subject of media experts. The results of media validation are known to obtain an average rating of 81.94% and are included in the "Very Good" category. The assessment by the first user consists of five aspects, including application design aspects, technical quality aspects, application usefulness aspects, material quality aspects, and AR technology aspects. The test uses a questionnaire, consisting of 28 statements with a Likert scale of 1 - 4 as the answer choices. There are 31 respondents as the subject of the first user. The results of the assessment are known to have an average rating of 90.01% and are included in the "Very Good" category.

5. Conclusion
The application of Distributing Station-AR has been developed by applying a marker-based tracking method. The application test has successfully displayed the components of Distributing Station using a marker. Component identification of Distributing Station can be displayed in a three-dimensional model using a smartphone camera. The three-dimensional model can be observed from various sides by rotating the smartphone according to the side to be observed. Product performance is known to be very good and product validation is also very good, including material validation, media validation, and first user responses. For further development, this application is expected to add animation of component working principle.

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