

Application of Markerless Augmented Reality on E-Catalog of Car Variations Using Natural Feature Tracking

Stevens Khouw^{1)*}, Edy²⁾

¹⁾²⁾Software Engineering, Buddhi Dharma University
Imam Bonjol No.41 Karawaci Ilir, Tangerang 15115, Indonesia

¹⁾stevengkhouw2000@gmail.com

²⁾edy.hu4ng@gmail.com

Article history:

Received 20 Sept 2023;
Revised 10 Oct 2023;
Accepted 04 Nov 2023;
Available online 28 Dec 2023

Keywords:

Augmented Reality
Car Variation
E-Catalog
Natural Feature Tracking
Unity

Abstract

Information technology is widely used by business people in promoting the products and services they sell, this is very important especially for businesses that sell products that are not common, for example car variations. Car variation business is already widely found in various regions in Indonesia, but the car variation business has a relatively small and specialized market. The main cause is the lack of promotion of product knowledge to the public and the lack of interesting and practical forms of promotional media that make car variation products rarely seen by vehicle owners. Therefore, in this study, attempted on the application of augmented reality technology into the e-catalog application of car variations using the natural feature tracking method to help the visual augmentation process of car variation products that want to be seen as a form of promotional media for car variation products in general, the e-catalog itself were made using unity engine. From this research, the results obtained are: the application of augmented reality was successfully carried out on the Android e-catalog application, the attractiveness of the application display with a good indicator of 100%, the attractiveness of augmented reality with a percentage of 88.9% on good indicators and the appropriateness of application development with a percentage of 100% on good indicators, these result are obtained from questionnaires that are distributed to both coworker and random users as sample.

I. INTRODUCTION

The development of information technology greatly affects human activities today [1]. The use of information technology is considered to have had a significant influence in various sectors and elements of the organization both in the fields of sales, marketing, learning, and government. Information technology has been widely used in organizations such as the application of information systems in transaction management, data exchange, promotion through various media, online sales, designing company profiles, making packaging labels, designing advertisements for publication, and product packaging. One of which is car variations business.

Although many car variation workshops have opened, based on the results of the author's observations as a worker in a car variation workshop, there are still many people who are unfamiliar with the hobby of car variations and existing car accessories products, while according to the results of research [2] product knowledge, which is a collection of various information about products such as: product categories, brands, features, prices, and so on. has a direct impact on the level of purchase desire of customers. Therefore, attractive media and promotional methods are needed so that product knowledge can reach customers and increase the possibility of transactions. Therefore, the author conducts this research with the aim of applying markerless augmented reality to the e-catalog application of car variations as a way to promote car variation products in an attractive and interactive way, through the application of AR in the e-catalog application, application users can see 3d models of products that have been provided in the application through their respective cellphone cameras, existing 3d models can be rotated and scaled to make it easier for users to see the visualization of the desired product.

Natural feature tracking method is used to facilitate the detection of pattern features on the surface that will be mapped to the coordinate point later [3], then used as a marker for placing 3D objects. In this research, especially

* Corresponding author

because it uses Vuforia as a development kit for AR, the natural feature tracking method is used in the form of Ground Plane Stage, quoted from the official Vuforia web (<https://library.vuforia.com/ground-plane/introduction-ground-plane-unity>) where the camera will capture images in the real environment then use Plane Finder Behavior in finding the appropriate Plane or surface.

II. METHODS

A. MDLC (Multimedia Development Life Cycle)

MDLC method is an application design method used in the research that has been done, as for the components in the MDLC method [4] are the following:

1) *Concept*

At the concept stage, there are several points that can be determined as the basis for designing applications/programs, such as the type of multimedia application (presentation, animation, interactive, etc.), the estimated size of the application, the target audience of the application, and the output of the application.

2) *Design*

This stage is carried out to determine the specifications, materials needed and appearance of the application. The results of the design will be used as the basis of the next process so that if there are changes or additions do not change the basic concept of the application too far.

3) *Material Collection*

This stage is carried out to collect materials that will be used in making applications, materials in the form of displays, product images, and 3D models. Material collection is done by making the required assets yourself and searching from the internet.

4) *Merging/Building*

This stage is carried out to implement the design that has been determined and the materials that have been collected into the form of applications.

5) *Testing and Evaluation*

This stage is done to test the application that has been made to see if the application is functioning properly, in this research black box testing are used to determine application system functionality.

6) *Distribution*

After the application is tested, the next is the distribution of the application, in this case google drive is used as a media sharing .apk application because it is free.

Below is a cycle graph of mdlc processes:

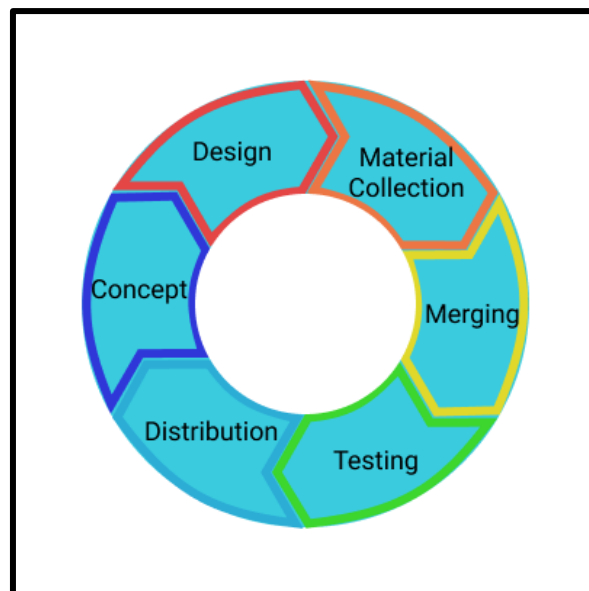


Fig. 1 MDLC Cycle Graph

B. Augmented Reality

Augmented Reality (AR) is a branch of technological knowledge that places 2D and 3D virtual objects into a real environment. In its development, AR technology allows users to interact directly with virtual objects in real-time [5]. Augmented Reality (AR) is a technology that combines objects made using computers, either in the form of two-dimensional or three-dimensional images or objects, into the user's immediate environment [6]. The objects

shown by AR help users form a new understanding and allow them to see the interaction between the objects that appear with the real environment. Augmented Reality has 2 tracking features, namely marker-based and markerless, the following is an explanation of each concept:

1) Marker-Based Tracking

Marker is a unique pattern that can be detected by the camera so that AR applications can recognize the pattern and display 3D objects according to the detected pattern [7]. Photos or images that have unique patterns can be used as markers. The way this identifier works uses marker recognition techniques or fiducial markers.

2) Markerless

Markerless feature is without the use of photos or images as special markers that determine the place to appear 2D or 3D objects [8]. In the markerless feature, the AR camera repeats techniques such as: tracking face, object, motion, and GPS as a technique for detecting places or areas to appear objects. [9] Markerless techniques strong selling point is not just cool visualization but the fact that everyone have smartphone nowadays, [10] AR also increasingly found in the business sector where applications offer visualization of products to be sold and branding, as well as the entertainment industry sector in the form of game applications such as pokemon go, pikmin bloom, and others.

In this research, the tracking method used is markerless because it can display 3D objects without having to use markers [11]. The application of markerless is also broader because it can use sensors on Android such as Gyroscope, GPS, and Magnetometer.

C. Unity

Unity 3D is a game engine or software created to create game applications, which are equipped with an IDE (Integrated Development Environment) so that unity does not require development software such as Delphi or Ms Visual C++ in the process of making applications, because Unity has a built-in code editor and compiler in it. Visuals on unity [12] are made with high-level visuals aimed at OpenGL and directX. Asset file types that can be used in Unity are very numerous, especially file types that are commonly used in various graphics applications such as Adobe Suite.

D. Vuforia SDK

Vuforia Engine [13] is the most widely used library in developing augmented reality applications, with compatibility for many brands of phones, tablets, and glasses. Developers can add various augmented reality functions contained in the Vuforia library to their Android, iOS, and UWP applications to create AR experiences that interact realistically with objects and the environment. The Vuforia Engine Library is equipped with complete and up-to-date documentation for creating AR applications using the features contained in the library. Various overviews of the features and tutorials are continuously updated along with the updates made by Vuforia Engine.

E. Natural Feature Tracking

Natural Feature Tracking is used as a tracking method that has been loaded in the Vuforia SDK, quoted from a book written by [14] titled "Augmented Reality: Principles and Practice", we can use natural feature tracking to determine the camera pose from observations in the image without completing the environment with markers. Instead of creating a digital model first and then filling the physical environment with physical markers that have been matched on the digital model, natural feature tracking is done in stages: First, a suitable digital model is reconstructed by scanning the physical environment, the tracking area is matched at runtime with observations from the camera.

In its application in the Vuforia library, the method natural feature tracking used is in form of Ground Stage Plane function, quoted from [15] Vuforia's Ground Plane functions in detecting the surface that you want to use as a place to place virtual 3D objects, through mobile phones, the application will process the features captured on the horizontal surface and determine whether the surface can be used as a 3D object spawn area, as seen from fig. 2 below, apart from the ground plane, Vuforia library also features a mid air stage function which works very similar to the ground plane which allows placing objects in the air. In the Ground Stage Plane there is a Plane Finder function, Plane Finder contains 3 sub-functions, namely: Anchor Input Listener, serves as an input listener from the user, such as tap screen; Plane Finder Behaviour, serves to find a suitable surface to place content; and Content Positioning Behaviour, serves to control the placement of content on the Ground Plane such as scaling, rotation and position of objects.

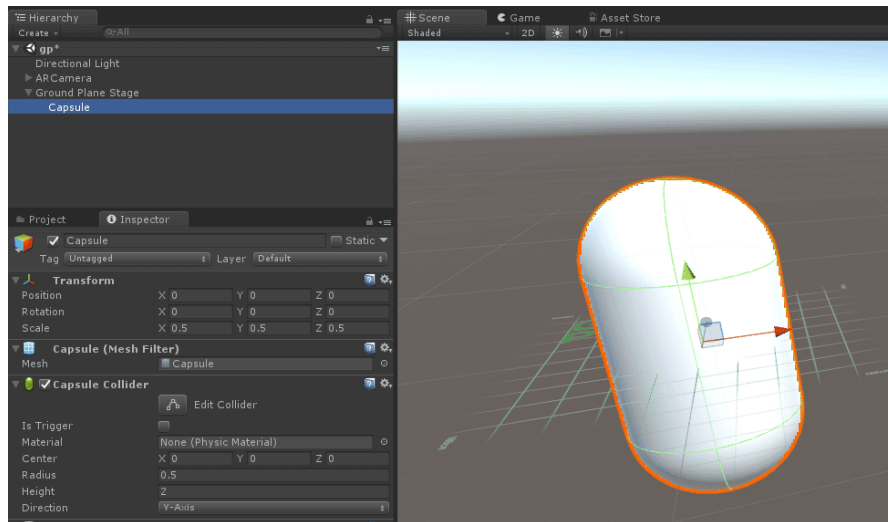


Fig. 2 Ground Plane Stage in Unity Editor

F. Black box testing

Black box testing is a software testing technique that focuses on the specification of functions that exist in the software being developed [16]. Black box testing is usually done to identify interface display functionality, interface errors or failures, data structure errors, performance errors, and initialization and termination errors in the program.

III. RESULTS

A. Flowchart

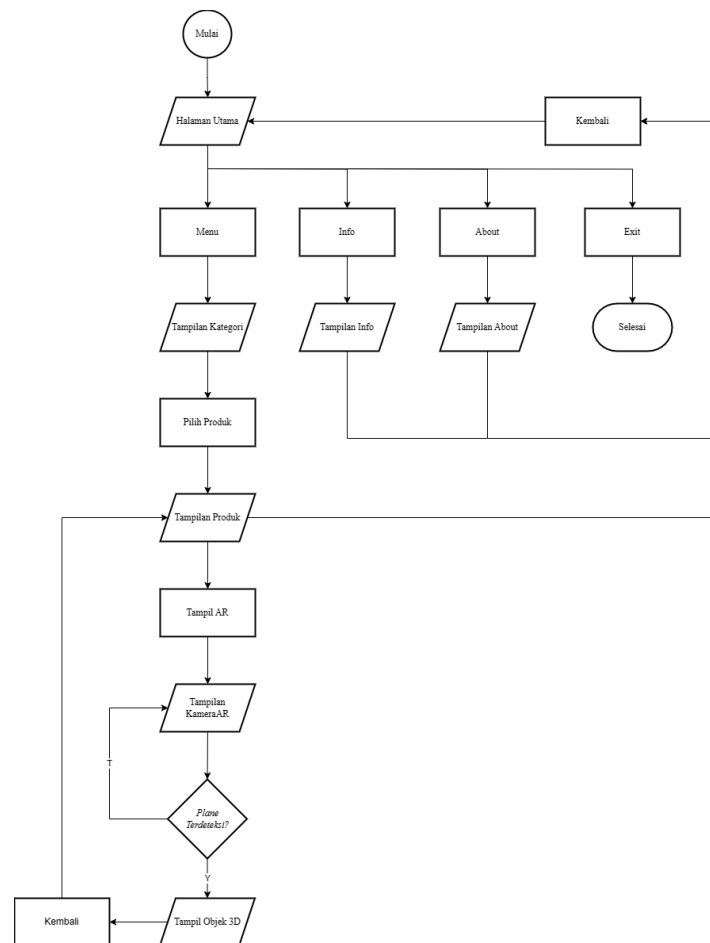


Fig. 3 Flowchart of Application

Based on figure 2, the following is a description of the flow:

- 1) Splashscreen display when the application is opened
- 2) The application will ask for permission to use the camera
- 3) Main Menu display with 4 buttons: menu, info, about, and exit
- 4) The info button will move the display to the information page
- 5) Button about will move the display to the about page
- 6) The back button on the info and about view will move the view back to the main menu
- 7) Button Menu will move the display to the category menu
- 8) The category menu display has 4 contents in the form of a scrollview. Scrollview can be controlled by swipe or next and prev buttons. The back button will switch the display back to the main menu
- 9) The product button will change to the respective product display
- 10) In the product view there is an AR button to change to the AR view, the back button will move the view back to the category menu.
- 11) In the AR display the camera will start detecting the surface that is considered suitable for placing content
- 12) When the appropriate surface is detected the plane finder symbol will appear on the screen.
- 13) The user enters input in the form of a tap on the screen to bring up a 3D object according to the previously selected product
- 14) The back button on the AR display will move the display back to the product display
- 15) The exit button on the main menu will close and end the application session

B. Application Display

The following are description of each displays that are present in the application currently, paired with the respective screenshots of displays (1-3 on Fig. 4 and 4-6 on Fig. 5) starting from the left:

1) Main Page

The main page contains 4 buttons, the menu button will display the category menu, info displays the information page, about displays the page about the application maker and exit closes the application.

2) Information Page

This page contains information on the use of augmented reality features in a simple way to users so that users can use AR features smoothly.

3) About Page

About page contains information about the application creator.

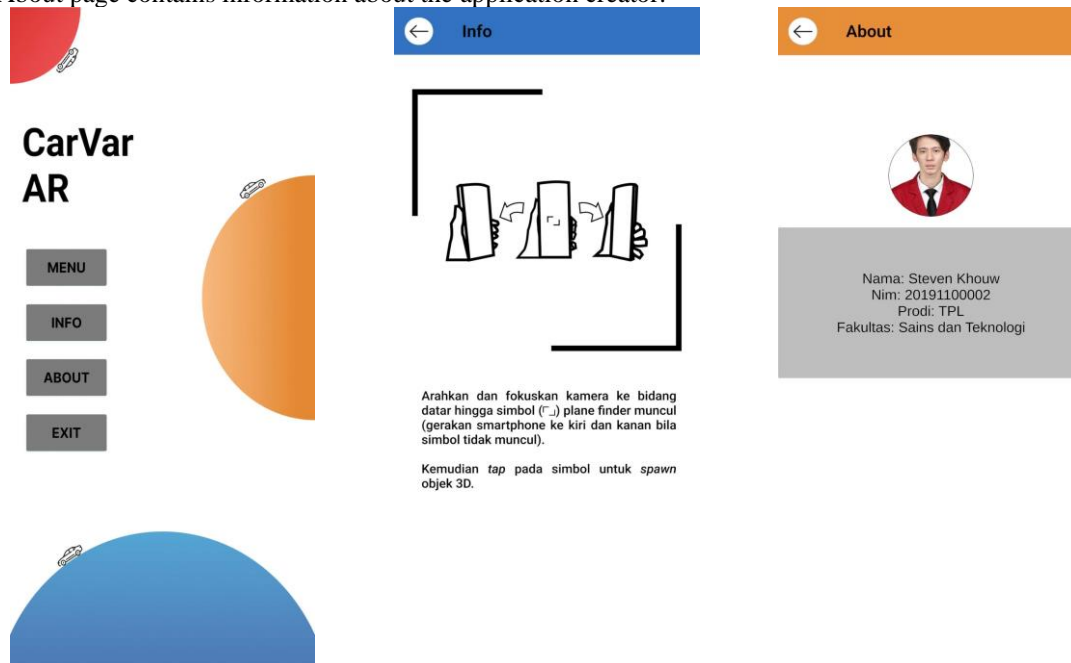


Fig. 4 Application Display 1(Main, Information and About Page)

4) Category Page

The Category page contains buttons that will take users to their respective product pages. Navigation of the category page can be done by swipe or using the buttons provided on the left and right, center of the screen.

5) *Product Page*

This page contains examples of product images, the navigation is the same as the category menu, below which there is product information text and an AR button to display the AR display. Below is an image of the Tweeter product display.

6) *Augmented Reality Display*

The AR display opens the camera and performs surface detection, if the appropriate surface is detected, a plane finder symbol will appear, the user can then tap the screen to bring up 3D objects on the screen.

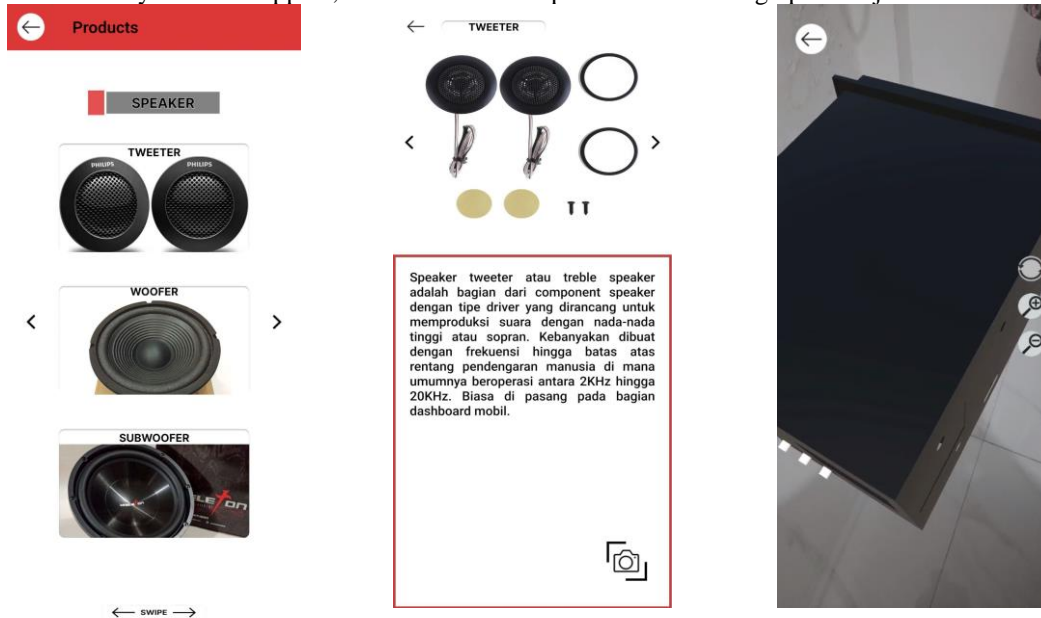


Fig. 5 Application Display 2 (Category, Product and Augmented Reality Page)

C. *User Acceptance Test*

1) *Questionnaire*

User Acceptance Test testing is carried out to get feedback from users regarding the user interface and user experience of the application, methods used in this research are questionnaire and black box testing, responses are gathered from 9 people, 3 of these respondents are coworker in writers car variation shop and 6 random people who were asked to test the application, table 1 below contains the results obtained from user responses in filling out questionnaires online via google forms.

TABLE 1
TABLE OF QUESTIONNAIRE RESPONSE DISTRIBUTION

No	Sections	Good	Enough	Lacking
1	Menu Display	9	-	-
2	Clarity of information	6	3	-
3	Product Display	9	-	-
4	Product Explanation	4	5	-
5	Augmented Reality Display	8	1	-
6	Ease of use of Application	9	-	-
7	Overall Application Attractiveness	8	1	-
8	Appropriateness of application development	9	-	-

From the responses gathered it can be interpreted that respondents have positive sentiments regarding the development of augmented reality application for car variation catalogue, the app itself of course has limitations and rooms for improvements due to currently still in development stage.

2) *Black box testing*

Black box testing is done to test whether the buttons functions according to its purpose in the design, the following is a table of Black box testing results that have been done:

TABLE 2
BLACK BOX TESTING RESULTS

Num.	Menu/Buttons	Expected Result	Status
1	Main Page	Appears after splashscreen	Valid
2	Button menu	Display category page	Valid
3	Button info	Display information page	Valid
4	Button about	Display about page	Valid
5	Button exit	Exit the application	Valid
6	Button back(info, about, category)	Back to main page	Valid
7	Button back (product display)	Back to category page	Valid
8	Button back (AR Display)	Back to product page	Valid
9	Button next/prev menu category and product display	Change scrollview's content	Valid
10	Button for products	Change display to respective product's page	Valid
11	Button AR products	Change display to AR camera display of each respective products	Valid

From the results of black box testing that has been carried out, it is known that the application can run smoothly in accordance with what is expected and planned from design phase.

IV. DISCUSSION

Based on the tests that have been done, it is concluded that markerless Augmented Reality works well with car variation catalogue application, the response that were gathered also implies that the application is easy to use, decently interesting and attractive, although lacking in description or explanation of products currently available, also worth to further developed. The app is still lacking in many places, for example display and quality of product information and the amount of products currently available in app, detailed explanation of products and probably access to external sources, market or e-commerce as a feature included in the application, these lacking point was caused by several things, firstly time, since the application was made from scratch, it needed more time to design and construct wireframe of the application as well as preparing the assets used, furthermore car variation products rarely have ready-to-use models, so improvement to similar models needed. For further development and research about this topic it is expected to have better preparation for the assets needed and maybe the use of framework available to not only speed up the process of making the application also to enhance the ui display and user experience within the app, it is also possible to incorporate the application with other feature such as mixed reality or in-app purchases to further elevate the value of the application.

V. CONCLUSIONS

From the results of this research titled “Application of Markerless Augmented Reality on E-Catalog of Car Variations Using the Natural Feature Tracking Method”, it is concluded that the application successfully runs and can show images and product information according to the initial design, Augmented Reality features are successfully applied to the e-catalog application of car variation products with the Vuforia SDK, the car variation e-catalog application that has been made is easy to use according to the results of the questionnaire and 88% of respondents are interested in the use of catalog applications and further application development.

REFERENCES

- [1] E. S. Rini and N. W. S. Arini, “Pemanfaatan Teknologi Informasi sebagai Media Promosi Produk Hasil Kerajinan Dynler (Dainy Leather),” 2019. [Online]. Available: www.kuka.co.id
- [2] R. Ricardo, “BUILDING PURCHASE INTENTION: COMPANY IMAGE, PRODUCT KNOWLEDGE AND PRICE PERCEPTION,” vol. 2, no. 6, 2021, doi: 10.31933/dijdbm.v2i26.
- [3] S. Ulfah, D. R. Ramdania, U. Fatoni, K. Mukhtar, H. Tajiri, and A. Sarbini, “Augmented reality using Natural Feature Tracking (NFT) method for learning media of makharijul huruf,” *IOP Conf Ser Mater Sci Eng*, vol. 874, no. 1, Jul. 2020, doi: 10.1088/1757-899X/874/1/012019.
- [4] A. Febriyandani and I. Diana Sholihati, “Algoritma Fast Corner Detection dan Natural Feature Tracking Media Tumbuhan Berbasis Augmented Reality,” *Jurnal Teknik Informatika dan Sistem Informasi*, vol. 8, no. 3, 2021, [Online]. Available: <http://jurnal.mdp.ac.id>
- [5] D. Deslianti and Sumarsih, “Implementasi Metode Image Tracking Vuforia Pada Pengenalan Hewan Menggunakan Augmented Reality Berbasis Android,” *JSAI*, vol. 2, 2019, [Online]. Available: <http://www.jurnal.umb.ac.id/index.php/JSAI>
- [6] D. Renaldi and E. Satrio Aziz, “The Design of Basic Computer Networking Simulation Learning using Multimedia Development Life Cycle Method based on Augmented Reality at SMKN 1 Tangerang,” 2021. [Online]. Available: <http://bsti.ubd.ac.id/e-jurnal>
- [7] K. S. Wibowo, Fauziah, and I. D. Sholihati, “Augmented Reality Dalam Visualisasi Katalog Penjualan Toko Aneka Furniture Berbasis Android Menggunakan Algoritma Fast Corner Detection,” *Jurnal Teknik Informatika dan Sistem Informasi*, vol. 8, no. 3, 2021, [Online]. Available: <http://jurnal.mdp.ac.id>
- [8] S. I. W. Putra, “IMPLEMENTASI TEKNOLOGI MARKERLESS AUGMENTED REALITY MENGGUNAKAN METODE ALGORITMA FAST CORNER DETECTION BERBASIS ANDROID (STUDI KASUS MULTIMEDIA BUKU INTERAKTIF KEBUDAYAAN LOKAL KALIMANTAN BARAT),” 2019.
- [9] Monsterar, “Augmented Reality Dalam Bisnis.” Accessed: Oct. 20, 2023. [Online]. Available: <https://monsterar.net/2021/03/29/augmented-reality-dalam-bisnis/>
- [10] INSTIKI, “Canggihnya Teknologi VR & AR di Dunia Bisnis.” Accessed: Oct. 20, 2023. [Online]. Available: <https://instiki.ac.id/2022/04/28/canggihnya-teknologi-vr-ar-di-dunia-bisnis/>
- [11] A. A. Mubarak, W. Setiawan, and Y. Wibisono, “UPINav : Aplikasi Markerless Augmented Reality untuk Media Informasi UPI Berbasis Android,” 2020. [Online]. Available: <https://ejournal.upi.edu/index.php/JATIKOM>
- [12] Rafarendra Ardhi Harlanto, “Berkenalan dengan Fitur-Fitur Unity 3D.” Accessed: Nov. 22, 2022. [Online]. Available: <https://www.gamelab.id/news/211-berkenalan-dengan-fitur-fitur-unity-3d>
- [13] library.vuforia.com, “Getting Started.” Accessed: May 15, 2023. [Online]. Available: <https://library.vuforia.com/>
- [14] D. Schmalstieg and T. Hollerer, *Augmented Reality: Principles and Practice*. Addison-Wesley Professional, 2016.
- [15] Vuforia, “Vuforia Ground Plane Stage.” Accessed: Sep. 20, 2023. [Online]. Available: <https://library.vuforia.com/ground-plane/introduction-ground-plane-unity>
- [16] N. W. Rahadi and C. Vikasari, “Penguujian Software Aplikasi Perawatan Barang Milik Negara Menggunakan Metode Black Box Testing Equivalence Partitions,” *Infotekmesin*, vol. 11, no. 1, pp. 57–61, Jan. 2020, doi: 10.35970/infotekmesin.v11i1.124.