Research Article

Augmented Reality-Based Car Showroom Application as a Promotional Media at Alya Motor Car Showroom

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Abstract: In today's fast-paced world, transportation is crucial in facilitating the movement of people and goods. As a popular means of land transportation, automobiles have continuously evolved with advanced technologies to enhance fuel efficiency and driving safety. Established in 2014, Alya Motor has served hundreds of customers using social media platforms for marketing. However, innovative marketing strategies are essential to enhance the shopping experience, especially amidst declining purchasing power. This research aims to design, implement, and test a car showroom application based on Augmented Reality (AR) as a promotional medium for Alya Motor. An Android application was developed using Blender, Unity 3D, and Vuforia to offer an interactive car viewing experience. The research followed the Multimedia Development Life Cycle (MDLC) methodology, ensuring a user-centric approach. The application was successfully tested, achieving an 86% acceptance rate in User Acceptance Testing (UAT). The AR-based application significantly improves the promotional strategy by providing potential buyers with an engaging and effective shopping experience.

Keywords: Augmented Reality; Car Promotion; User Experience; Multimedia Development Life Cycle; Android Application

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1. Introduction

Nowadays, transportation is an essential element in human life and is used to facilitate the movement of people and goods. Cars, as one of the popular means of land transportation, can transport large loads for personal and commercial purposes [1]. With constantly evolving technology, cars have changed the transportation paradigm to improve fuel efficiency and driving safety [2]. Cars are one of the vehicles that have great opportunities in the business world. Alya Motor car showroom, established in 2014, serves hundreds of buyers with marketing strategies through social media such as OLX, Facebook, and Instagram. However, innovation is needed to improve potential buyers' shopping experience, especially amid declining purchasing power. Augmented reality as a promotional medium can be an effective solution to increase traction and sales. Effective marketing includes product understanding, unique characteristics, and the right promotional strategy. Promotion is vital to increase sales and purchasing power, shaping consumer perceptions of quality and service [3].

To increase purchasing power, unique and creative marketing media is required. Augmented Reality (AR) is a technology that combines virtual elements with the physical environment, allowing potential buyers to view cars interactively through a smartphone. In the context of car showrooms, AR allows potential buyers to view and interact with car models virtually through their devices, such as smartphones. AR enhances the shopping experience and helps in more informational decision-making. AR allows users to see the virtual world firsthand, deepening their understanding of the features and characteristics of the car before visiting the car showroom [4].

Based on the background description above, the problem formulation raised in this study is how to design, implement, and test the Augmented Reality-Based Car Showroom Application as Promotional Media at the Alya Motor Car Showroom. This research is limited to making augmented reality-based car showroom applications as promotional media at the Alya Motor car showroom using Blender version 4.1.1, Unity 3D version 6000.0.8f1, and Vuforia version 10.24 software. This application is only available for the Android platform. The place of the research object is carried out in the Alya motor car showroom environment. The application can only be accessed using an Android Smartphone.

This research aims to design, implement, and know the results of testing augmented reality-based car showroom applications as a promotional medium at the Alya motor car showroom. The benefits of this research are that it will increase purchasing power and become an effective and attractive promotional medium for prospective buyers or the public. This research applies a development methodology consisting of several stages: design, material collecting, assembly, and testing. The software includes Blender to model 3D objects, Adobe Photoshop and Illustrator for UI/UX and Marker design, and Unity 3D for application development. Observations and interviews were conducted to identify user needs and current conditions, which became the basis for developing an effective and attractive augmented reality-based car showroom application.

2. Theory

Equipment Transportation equipment is an important means of transporting people and goods. Transportation is moving passengers and goods with a focus on movement [5]. Transportation includes five components: people, goods, vehicles, roads, and managers [1]. Transportation tools emphasize the importance of movement in moving from one place to another, and transportation has become a common use in everyday life. Furthermore, A car is a four-wheeled land transportation device driven by an engine. It is designed for highways and transports people and goods. Cars are used in business, personal use, and advertising [6]. They usually use gasoline as fuel [2]. Cars' physical aspects and specifications continue to develop every year, and they are one of the vehicles that are often used on the streets. Moreover, a car showroom is a space for exhibiting various car models, allowing potential buyers to see and evaluate cars. Showrooms serve to meet customer needs and increase sales [7]. Showrooms are designed to attract consumers [8]. Car showrooms are a very important aspect of marketing and selling cars. Moreover, Promotion is a marketing method for increasing recognition, interest, and sales of products or services. It is a dynamic communication tool for attracting buyers and introducing products [9]. The promotion aims to inspire and motivate consumers to buy [10]. Promotion is important in marketing a product to attract interest and increase purchasing power.

Furthermore, Augmented Reality, or AR for short, is a technology that combines real and virtual world elements in real-time. AR allows interaction with an environment simulated by a computer [11]. AR combines two or three-dimensional virtual objects with the real world [12]. AR's goal is for user interaction with virtual environments to be done directly and realistically. This technology works by projecting digital information, such as images, videos, or other data, into the user's view through smartphones, tablets, or special AR glasses. Thus, users can see and interact with digital elements that appear as if they are in the real world. AR also utilizes sensors and algorithms to detect and track the user's position and movement so that virtual objects can be precisely placed and responsive to environmental changes. The technology has a wide range of applications, from entertainment and gaming to education to industry and healthcare, all of which aim to enhance the user experience and provide richer, more contextualized information. Moreover, Blender is free and open-source 3D creation software for artists, designers, and animators. Blender supports modeling, rigging, animation, simulation, rendering, compositing, motion tracking, video editing, and game creation [13]. Blender is designed to create visual movies, 3D animations, and special effects [14]. Blender is an application for designing 3D object models, and its advantages with its open-source nature.

Unity 3D is a software platform for creating three-dimensional applications, games, simulations, and architectural visualizations. Unity 3D is a multi-platform game development application with an easy-to-use interface [15]. Unity 3D can be used to create video games, architectural visualizations, and three-dimensional animations [16]. Unity 3D has excellent flexibility as a game engine for various creative purposes. Moreover, Vuforia is a powerful software development kit (SDK) incorporating augmented reality technology into applications and games. It enables the real and effective creation of 3D virtual objects, is compatible with iOS and Android, and integrates with the Unity Game Engine. Vuforia excels in image recognition and tracking [17]. It is an innovative SDK for creating advanced augmented reality applications [18]. In augmented reality applications, Vuforia is used for image recognition and tracking on markers.

Furthermore, The C# programming language is a versatile, object-oriented programming language for desktop, mobile, and game development applications. C# is an important part of the .NET framework and is often used for web and cloud software [19]. The C# programming language is used in Unity 3D for scripting, allowing easy manipulation of objects [20]. The use of C# is very important in the development of augmented reality applications. Moreover, User Acceptance Testing (UAT) User Acceptance Testing (UAT) is an important phase in software development, where end users or representatives test the application to ensure the system meets needs and expectations. UAT is the last phase of software testing, which aims to ensure software functions and tasks match user requirements and usage scenarios [21]. UAT focuses on verifying functional and nonfunctional requirements so developers can ensure the product or software changes are accepted and used effectively by users before the official launch. The following is the UAT calculation formula as the equation 1. Formula Calculate acceptance percentage, and the average feature formula can be seen in Equation 2.

$$Percentage\ of\ Revenue = \left(\frac{Number\ of\ Users\ who\ stated\ the\ Feature\ is\ Appropriate}{Total\ number\ of\ users}\right) x\ 100\ \% \quad (1)$$

$$Average\ Feature\ Match = \left(\frac{Number\ of\ Users\ who\ stated\ the\ Feature\ is\ Appropriate\ x\ Total\ Fiture\ tested}{Total\ number\ of\ users}\right) \quad (2)$$

Furthermore, Flowcharts are tools that combine aspects of maps and flow charts to depict the movement of objects, enabling the analysis of movement patterns, spatial distribution, and the development of location-based strategies. A flowchart is a visual representation of a process or sequence of steps, usually drawn horizontally to show how the activities or steps are combined into a whole [22]. Flowcharts are used to understand workflows, identify problems, or design systems, with special symbols defining each step in the process. Moreover, Black Box Testing is a method that allows users to operate a system without needing to understand how it works. In augmented reality, it ensures a real visual experience without requiring knowledge of the program code. The advantage of black box testing is that it tests from the user's point of view so that the results may vary. Black box testing focuses on functional specifications without regard to internal design and code, ensuring the software's functions, inputs, and outputs conform to specifications [23].

Finally, Some related research that supports the background of this problem includes Research by Nia Ekawati and Alvin Peterson Salamena using Sugeno's fuzzy logic method to determine the selling price of used cars, showing that this sophisticated approach is effective in setting prices based on vehicle conditions [24]. Research by Anderies, Adidarma, Rendy et al. explored the application of Augmented Reality (AR) technology in the property industry, showing that AR can improve property sales efficiency by allowing users to view properties interactively through mobile devices [25]. Finally, research by Arif Firmansyah Hidayat and Nindria Untarini shows that sales promotion and product quality significantly influence the purchase decision of Wuling Confero cars in Surabaya, which increases consumer attractiveness and purchase decisions [26].

3. Method

This research uses the MDLC (Multimedia et al.) methodology because of its advantages in developing augmented reality applications. MDLC pays attention to the user experience, starting with concept analysis and collecting relevant content material. The MDLC methodology has six stages: concept, design, content material collection, incorporation, testing, and distribution. Another advantage of MDLC is that it helps reduce the risk of media damage and creates an interesting experience in augmented reality applications for product promotion. The following is a description of each stage of the process in the MDLC model in this study. MDLC is shown in Figure 1.

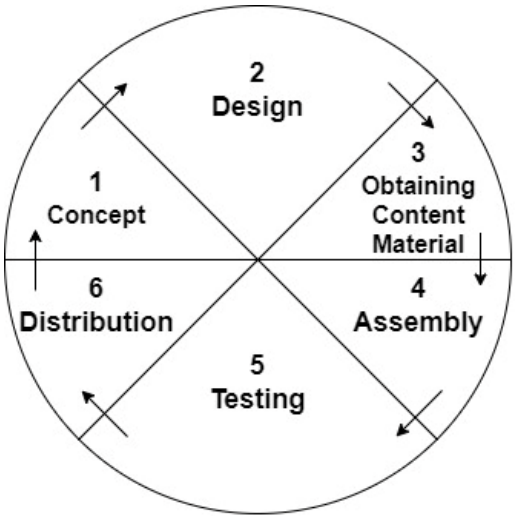

Figure 1. MDLC (Multimedia Development Life Cycle)

Furthermore, The parameters of the MDLC cycle are described as follows: 1. Concept This initial stage is the stage for identifying needs, collecting ideas, and conceptualizing augmented reality application projects. At this stage, researchers collect information from car showroom owners through interviews about how promotions are usually carried out and the cars' selection in car showrooms. 2. Design At this stage, researchers carry out the visual and functional design of the system in the augmented reality application to be created, such as creating markers, designing user interfaces (UI / UX), and making 3D models of cars and interiors. The tools used in this stage are Adobe Photoshop, Adobe Illustrator, and Blender. 3. Obtaining Content Material: At this stage, researchers collect all the materials and materials that will be used in making augmented reality applications, such as text and images. The content material collected must be free of copyright or researchers who create their own. The content taken is based on observations at the car showroom.

Moreover, 4. At this stage, researchers combine all the elements based on the initial design plan. Researchers use Unity 3D for augmented reality application development and use the Vuforia plugin for markers. Therefore, each element created and designed will become a complete application after being combined. 5. Testing The testing stage ensures the quality and functionality of the augmented reality application runs well and according to user needs. Testing involves black box testing and User Acceptance Test (UAT) methods, which will involve car showroom owners or prospective buyers. Finally, 6. At this final stage, the product or augmented reality application will be distributed to users as an APK for Android devices. Researchers also provide guidelines for prospective buyers and car showroom owners on using augmented reality applications.

Furthermore, this augmented reality-based car showroom application is designed to give customers an interactive experience exploring car models in real-time. It aims to increase buyers' attraction to viewing cars. The following is a description of the system that will run, as shown in Figure 2.

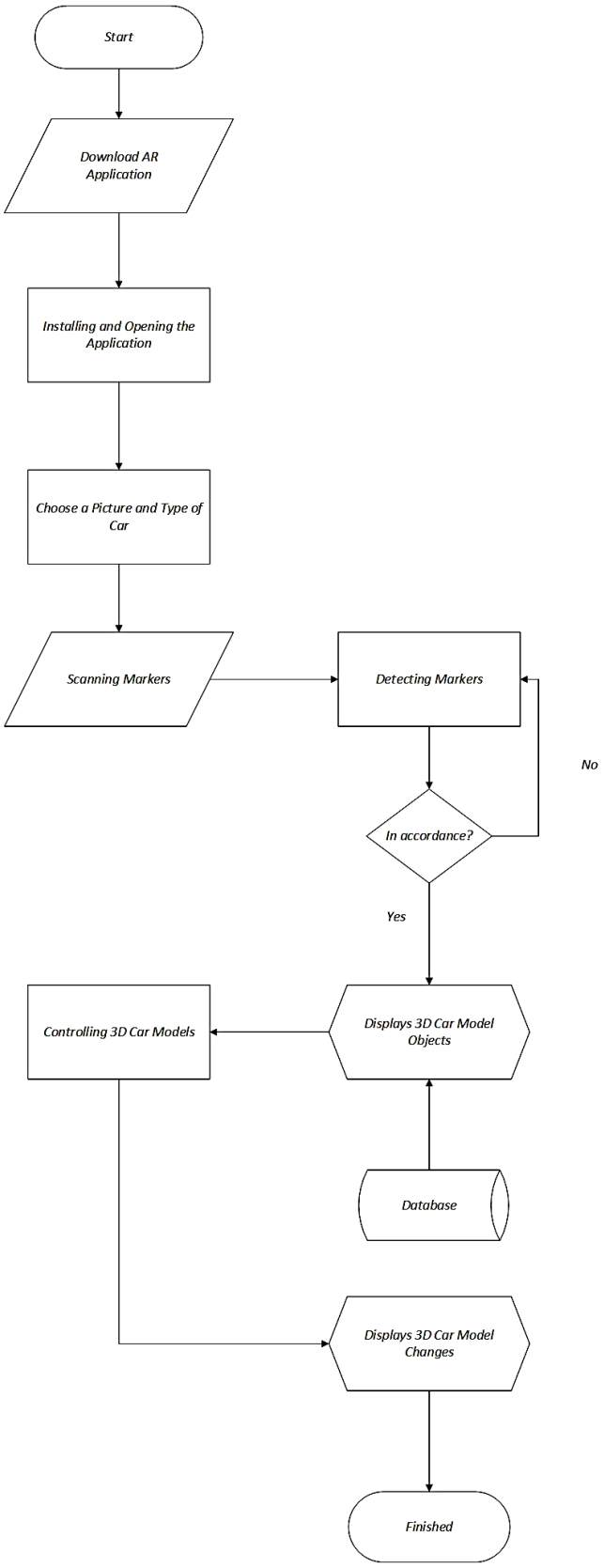

Figure 2. Flowchart of Running System

The car showroom app will use augmented reality (AR) technology to display 3D objects in real-time, offering innovative promotions for car showrooms. With marker-based methods and object-tracking techniques from the Vuforia SDK Library, the app will quickly detect objects based on target features. The app's main focus is the customer, allowing them to see the interior and exterior of the car in real time. This application is designed to enhance the shopping experience by implementing attractive interactive visualizations. In Figure 2, the flowchart of the running system depicts how the AR application processes input from the marker to display the 3D car model interactively to the user. The following is a description of each Augmented Reality (AR) based car showroom application system that will run:

a) The process begins. b) The user downloads the AR application first. c) The user installs and opens the AR application d) The user displays the image and type of car to be selected. e) The user scans the marker so the system can scan the marker to detect objects. f) Next, the system checks whether the marker has been detected. 1) If No, the system returns to the marker scanning step. 2) If yes, the system will appear, and the 3D model object will proceed to the next step. g) The 3D model object that appears will be retrieved based on the marker registered in the Vuforia database. h) The user can control the 3D model based on the detected marker. i) The user can make the necessary changes to the 3D model, and the system will display the changes to the car's 3D object. and j) Finish: The process is completed.

4. Result and Discussion

This research produces promotional media in the form of an application with augmented reality features designed to be a unique and creative means of promotion. This application is expected to help Alya Motor's car showroom conduct promotions using augmented reality technology as an innovative and attractive promotional medium. The results of the research and discussion are described in several sections.

4.1 3D Model-making process

Step 1. 3D Model Making In the early stages of developing augmented reality (AR) applications for car showrooms, researchers used the Blender version 4.1 application to create 3D models of cars and their interiors. The process began with creating the car's exterior, including the body's shape, wheels, and other details. Next, researchers enriched the model with an interior with seats, dashboards, and other relevant elements. With this model, the AR app can realistically display the car in a virtual environment, allowing users to view the interior and exterior details as if inside the actual car.

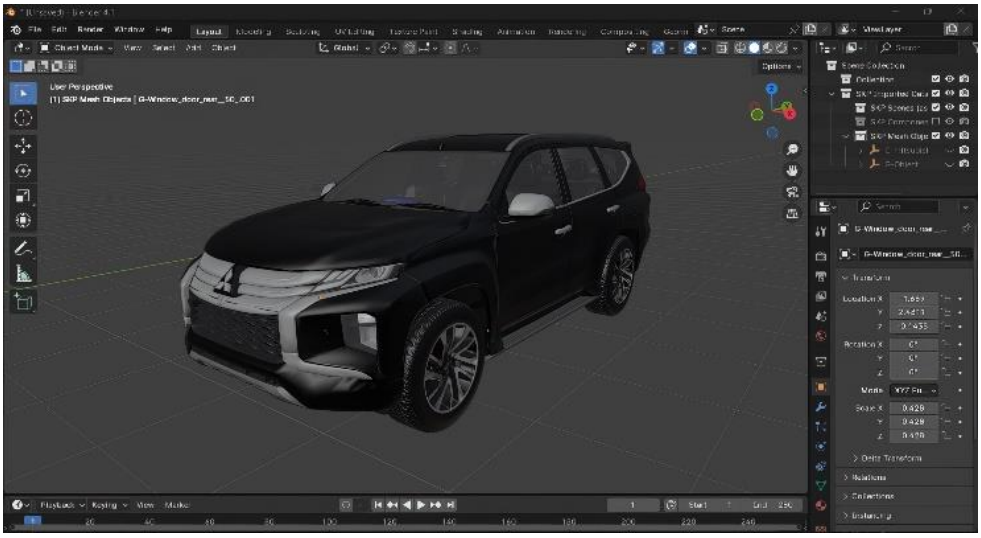

Figure 3. 3D Car Exterior Blender 4.1 Creation

Figure 4. 3D Car Interior Blender 4.1 Creation

Step 2. Making AR Applications and Application Menus In the next stage, researchers use the Unity3D game engine version 6000.0.8f1 to develop AR applications. The steps researchers take to develop applications are combining elements, including markers and 3D car models; setting up application displays, including the user interface (UI); creating interactions with 3-D objects, such as rotating and zooming in on models; and testing and maintaining applications.

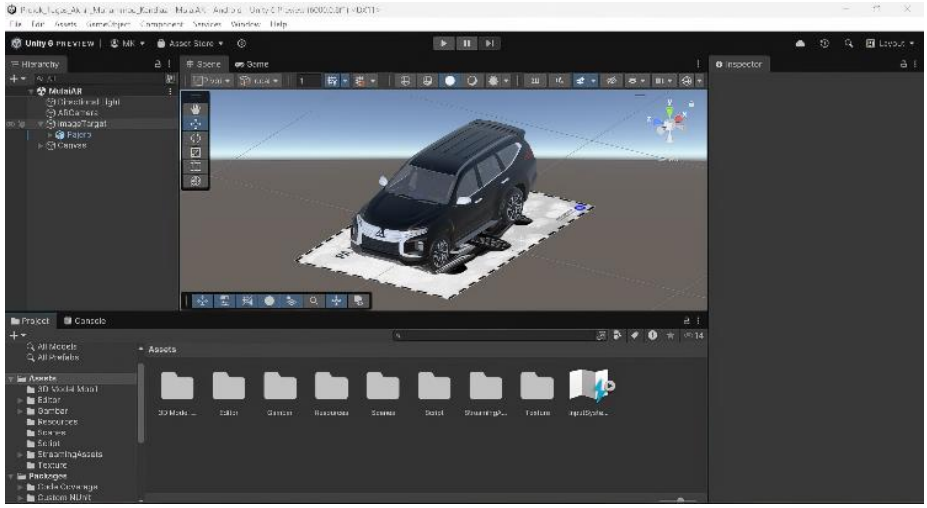

Figure 5. Unification of car 3D model with Unity Marker

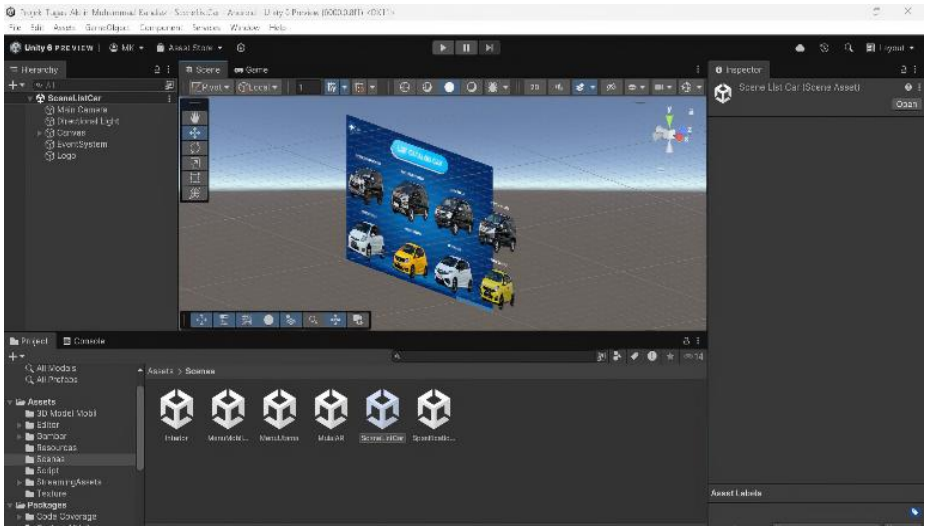

Figure 6. Unity Car List Menu Creation

4.2 Application Development Results

Application Main Page Display On This initial display is a display when a new user opens the application; the user can select the scan marker menu to directly open the camera and read the marker to view AR or select the List Car menu, which will then be directed to the car catalog page display containing several cars.

Figure 7. App Main View

Furthermore, the display of the list car page On this page, when the user selects the list car menu from the initial display menu, the display will show a variety of cars in the catalog. Users must select one of the cars to be directed to the next page.

Figure 8. Display of List Car Page

Furthermore, Car Page Display, This page display is when the user selects one of the cars on the list car page display, which will then be directed to the car display page, as shown in Figure 4 below. On this display, users can choose the car's color and interior menu and select the car specification menu, which will be directed to the next page.

Figure 10. Car Page Display

Furthermore, Car Interior Page, View This page view is when the user selects the interior view page; it will be directed to the car interior page view. On this page view, users can see the contents of the car interior by sliding or swiping with their hands and can rotate the camera to see the entire interior.

Figure 11. Car Interior Page View

Moreover, Car Specification, Page Display This display is when the user selects a car specification on the car display page; the car specification display will be shown in Figure 12. In this display, users can see the contents and images of the car's specifications.

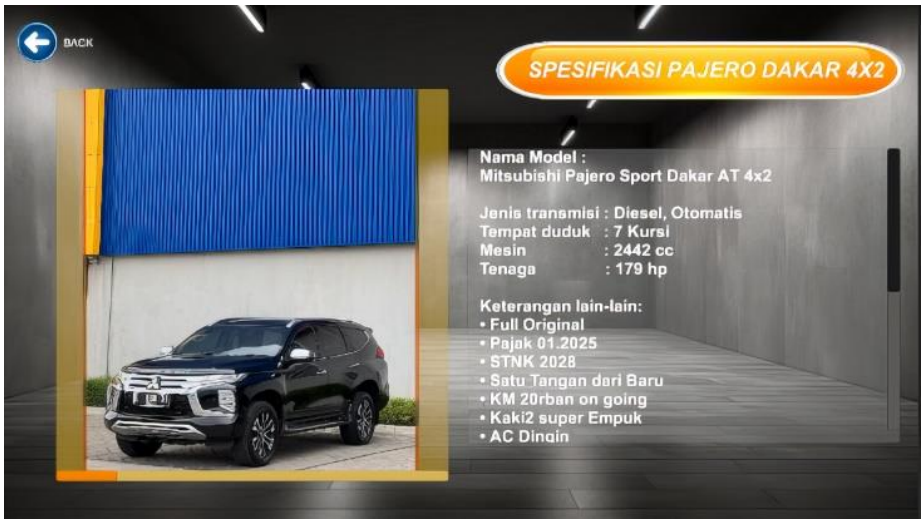

Figure 12. Car Specification Page Display

Figure 13. AR Camera Scene Page Display

Figure 14. AR Camera Size Display

Furthermore, Car marker design is a marker design used for markers that trigger the appearance of three-dimensional car objects, this marker is designed using Adobe Photoshop and Adobe Illustrator. Marker data will be stored in the database in Vuforia, the higher the stars in Vuforia or the better the image, the effect on the application in the augmented reality application will be the faster the appearance of the three-dimensional car model design according to the marker image stored in the database.

Figure 15. Marker Image Design

4.3 Discussion

Discussion Based on the results of black box testing which shows that all application functions run as well as expected, as well as the results of User Acceptance Test (UAT) testing which reached a percentage of 85%, it can be concluded that this augmented reality-based promotional media application has been successful in achieving a good level of acceptance. The main features, such as viewing the car catalog starting from the exterior and interior of the car, rotating the three-dimensional model object, as well as the use of augmented reality as an interactive media from the AR display, changing the color of the car, and viewing the contents of the car specifications thus creating an innovative and effective promotional experience in the Alya Motor car showroom. Thus, this application is ready to be used in the Alya Motor car showroom environment, to provide a new experience in conducting promotional media using augmented reality as a breakthrough in innovative and effective ways to increase purchasing power in the car showroom. The following are details of the UAT calculations tested along with the black box testing table tested.

Table 1. UAT calculation

UAT Aspects	Rated
Number of users who tested the app	20 Users
Total features tested	7 features
Number of users who stated the feature is appropriate	17 users (85%)
Average matching features per user	5.95 features

Calculation Details Number of users who tested the app: 20 users Number of users who declared the features suitable: 17 users Acceptance percentage: Percentage = (17/20)×100%=85% Average features matched per user (with a total of 7 features tested): Average features matched = ((17×7)/20)=5.95 features With 17 users out of 20 users stating features matched, we achieved an acceptance percentage of 85%.

Table 2. Black Box Button Testing on Each Menu

Components Tested	Action	Expected Output	Output Displayed	Results
Button Scan Marker	Click	Display AR Page	Display AR Page	As per
Button List Car	Click	Display the Car Catalog Page	Display the Car Catalog Page	As per
Car Button	Click	Display 3d Car Model	Display 3d Car Model	As per
Button Interior View	Click	Display 3d Interior Model	Display 3d Interior Model	As per
Button Car Color	Click	Changing Car Color	Changing Car Color	As per
Specification Button Car	Click	Display the Car Specification Page	Display the Car Specification Page	As per
Button Back	Click	Display Previous Page	Display Previous Page	As per

Here are some data that can be used for the causes of some things that are felt to be lacking by users who state the application is not suitable:
a) When scanning markers, sometimes 3D cars appear less quickly; the cause is that the camera must focus on markers with bright enough light. b) The application feels lag and heavy; the cause is inadequate smartphone specifications. c) Users feel that the application interface is less intuitive or difficult to use; the cause is that there is no guide display in the application.

5. Conclusion and Suggestion

Based on the research and testing results, researchers can conclude that the Augmented Reality (AR) based car showroom application developed for the Alya Motor Car Showroom has successfully met the expected objectives. Black box testing shows that all application functions run as expected, including key features such as a) Displaying AR pages, b) Displaying car catalogs, c) Displaying 3D models of cars and their interiors, d) Changing car colors, e) Displaying car specifications In addition, the results of User Acceptance Test (UAT) testing reached a percentage of 85%, which indicates that users will receive this application. This application provides an interactive and innovative experience in car promotion and is expected to increase attractiveness and sales at the Alya Motor showroom.

The development of technology makes many innovations in promoting an item. Augmented reality is one of the technologies that many people can utilize, and it is useful in conducting a promotion. Researchers have suggestions for steps so this research can develop again in the coming years: a) Take steps to expand the application platform for IOS and Web AR in addition to Android. b) Add the latest features and functionality, such as seeing AR engine parts. c) Conduct further studies on whether the effectiveness of augmented reality applications can be developed further apart from the impact of increasing purchasing power. d) Make application improvements, from integrating new technologies that will appear, to improving the appearance of the application interface, and changing the rendering of 3D car models. It is hoped that with the suggestions that researchers have expressed in the future, this research can continue to develop as information technology develops.

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