

Design and Development of an Android-Based Augmented Reality Application for Simulating Men's Hairstyles Based on Face Shape

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Abstract

Selecting a hairstyle without considering face shape, combined with the limitations of two-dimensional reference materials, can make it difficult for customers to visualize the final result. This study aims to design and develop an Android-based Augmented Reality application for Grezfa Barbershop that interactively simulates men's hairstyles based on face shape. The research employs the Research and Development method using the Borg and Gall model, encompassing stages such as information gathering, planning, initial product development, testing, revision, and finally, dissemination and limited implementation. Data were collected through observation, interviews, questionnaires, documentation, and literature review. The application was developed using Unity 3D and Blender, while the Viola-Jones method was utilized to detect the user's facial area via the Android device's camera. The system is designed to classify face shapes into four categories: oval, round, square, and oblong. Each category offers three hairstyle options, resulting in a total of twelve low-poly 3D hairstyle models within the application. Planned testing includes functional application testing; detection testing across variations in lighting, distance, face angle, accessories, and movement; and usability assessment using the System Usability Scale with 30 male customers. The expected outcome is an application capable of providing stable, interactive, and user-friendly hairstyle simulations. The application is expected to assist customers in selecting more suitable hairstyles, minimize the gap between expectations and actual results, enhance the quality of consultations between customers and barbers, and support digital service innovation at Grezfa Barbershop. Beyond its practical benefits, this research is also intended to serve as a reference for the development of interactive visual applications based on computer vision and Augmented Reality for similar services.

Keywords: *Augmented Reality, Android, Viola-Jones, Face Shape, Hairstyle*

1. Introduction

The development of information and communication technology in the current digital era has significantly influenced various aspects of human life. Technology is no longer limited to supporting communication and information needs but has also been widely utilized in education, business, entertainment, healthcare, beauty, and personal appearance. One form of technological advancement increasingly used in these fields is interactive visual technology, which enables users to obtain a visual representation of a product or service before making a decision. One interactive visual technology that continues to develop is Augmented Reality (AR). AR integrates two-dimensional or three-dimensional virtual objects into a real-world environment and displays them in real time [1]. Through devices such as smartphones, users can view digital objects as though they were present in their actual surroundings. Compared with conventional media, AR provides a more engaging, informative, and interactive visual experience. This capability makes AR particularly relevant for applications that require users to visualize changes in personal appearance before they are applied in real life.

The need for such technology can also be identified in barbershop services, including at Grezfa Barbershop, which is the subject of this study. Customers often require visual references before deciding on a desired haircut style. However, the consultation media commonly used, such as two-dimensional images, catalogs, and static hairstyle examples, cannot directly display how a particular hairstyle will appear on the customer's face. Consequently, customers may experience difficulty in imagining the final haircut result and determining whether the selected hairstyle is suitable for their face shape. Although several previous studies have examined the application of Augmented Reality for hairstyle simulation, further development is needed for an Android-based application specifically designed to simulate men's haircut styles based on face shape. Therefore, this study develops an Android-based Augmented Reality application that allows users to virtually preview men's haircut styles according to their facial characteristics. The application is expected to help customers select more suitable

hairstyles, provide an interactive visual preview before the haircut process, reduce the risk of dissatisfaction with the final result, and support digital service innovation at Grezfa Barbershop.

2. Literary Studies

2.1. Augmented Reality

Augmented Reality, or AR, is a technology that combines virtual objects with the real-world environment in real-time [2]. This technology allows users to view digital objects as if they were present in the real world through specific devices, such as smartphone cameras. The displayed virtual objects can take the form of two-dimensional images, three-dimensional objects, animations, text, or other visual elements. Augmented Reality possesses three key characteristics: combining the real world with the virtual world, operating interactively in real-time, and displaying virtual objects in three dimensions. These characteristics distinguish AR from Virtual Reality technology. While Virtual Reality immerses the user entirely in a virtual world, Augmented Reality retains the real-world environment and overlays digital objects onto it. In this study, Augmented Reality serves as the primary technology for displaying simulations of men's hairstyles. Using an Android device's camera, users can view virtual hairstyles superimposed on their own faces. Thus, AR acts as a visual aid, giving users a preview before they decide on a specific hairstyle [3].

2.2. Augmented Reality berbasis Android

Android provides a range of application development tools that can be used to build apps for various Android devices [4]. Support for cameras, graphics, sensors, and user interfaces makes Android well-suited for interactive, visually-oriented applications. In the context of AR applications, Android enables users to run simulations conveniently on their smartphones without the need for specialized hardware. The second characteristic is real-time interactivity. AR systems can provide immediate responses to camera movements, changes in object positions, or user actions. According to Azuma (1997), real-time capability is a crucial element of AR because virtual objects must be able to adapt instantly to real-world conditions. In hair simulation applications, this characteristic is vital because the hairstyle model must track the user's face position as the user moves.

The third characteristic is the use of two-dimensional or three-dimensional virtual objects. Virtual objects in AR can be tailored to the application's requirements. In this study, the virtual object used is a men's hairstyle model. The object must be displayed in a position aligned with the user's face so that the simulation result appears natural and is easily understood.[5].

2.3. Platform pengembangan Augmented Reality

Augmented Reality development platforms are software, frameworks, or Software Development Kits that provide functionality for accessing the camera, performing object tracking, processing the positions of real-world objects, and rendering virtual objects in real-time. The choice of platform must be tailored to the object being tracked, the target operating system, the type of camera, and the characteristics of the virtual objects to be displayed. ARCore was selected due to the availability of the Augmented Faces feature, which can detect and track a user's face via the front-facing camera. This feature provides information regarding the face's center position, orientation, specific facial landmarks, and the 3D face mesh structure. This information is used to position a 3D hairstyle model on the user's head and to update its position and rotation as the user moves their head [6].

2.4. Metode Tracking pada Augmented Reality

Tracking is the process performed by an AR system to determine the position, orientation, or movement of real-world objects. This process is crucial because it determines the positional accuracy of the displayed virtual objects. If the tracking process is unstable, virtual objects may drift, fail to follow movements, or appear misaligned with the real-world environment. In this study, the Augmented Reality platform employed is Google ARCore, utilized via AR Foundation within Unity 3D. Unity 3D serves as the application development and 3D hairstyle model management environment, while AR Foundation acts as the interface layer between the Unity application and the Augmented Reality services on Android devices. The Google ARCore XR Plugin is used to provide AR functionality on Android devices. . The choice of ARCore is based on the availability of the Augmented Faces feature, which can detect and track the user's face using the front-facing camera. This feature provides data regarding the face's center position, orientation, specific facial regions, and the 3D face mesh structure. This information is used to position the 3D hairstyle model on the user's head and to update its position and rotation as the user moves their head. [7].

2.5. Tracking Methods in Augmented Reality

Tracking is a process performed by an AR system to determine the position, orientation, or movement of real-world objects. The tracking process is crucial because it determines the positional accuracy of the displayed virtual objects. If the tracking process is unstable, virtual objects may drift, fail to follow movement, or appear misaligned with the real-world environment. In general, tracking methods in Augmented Reality can be categorized into marker-based tracking and markerless tracking. Marker-based tracking utilizes specific markers such as images, codes, or distinct patterns to trigger the appearance of virtual objects. Conversely, markerless tracking does not require specific markers but instead leverages features of the environment, surfaces, location, or the user's body or face. According to Putri et al. (2020), in AR hairstyle applications, face tracking plays a vital role in ensuring that hairstyles are displayed in the correct position. For this study, the relevant tracking method is markerless tracking specifically, face tracking. This is because the application being developed does

not use physical markers; instead, it directly detects the user's face via the camera. By employing face tracking, the application can position virtual hairstyles directly onto the user's head or face [8].

3. Research Method

3.1 Research Location

This study was conducted at Grezfa Barbershop, which served as the site for data collection and application testing. This location was selected due to its alignment with the research subject specifically, men's haircutting services—where innovation is needed to assist customers in choosing a hairstyle that suits their face shape.

3.4. Research Flow

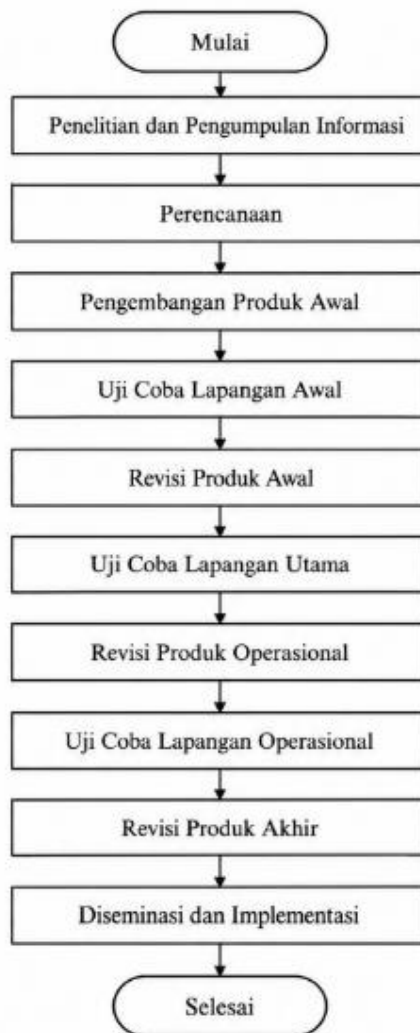


Fig. 1: Research Flow

The research flowchart illustrates that the study was conducted systematically using the Borg and Gall Research and Development model. Each stage is sequentially linked, as the outcome of one stage serves as the foundation for the next. The research process began with information gathering to identify problems, user needs, and the existing conditions at Grezfa Barbershop. The information obtained then served as the basis for formulating the application development plan.

During the planning stage, the researcher established development objectives, system requirements, application features, hardware specifications, a testing plan, and the target user base. The planning outcomes were subsequently implemented during the initial product development phase. In this stage, the researcher developed the interface design, system modeling, and components for face detection, face shape classification, hairstyle recommendations, and an Android-based Augmented Reality simulation.

The initial product was then subjected to preliminary field testing. This trial aimed to verify that the application's core functions operated as designed and to identify any errors or shortcomings. The results of the preliminary field test served as the basis for revising the initial product. Thus, there is a direct link between the testing and revision stages, as the deficiencies identified during testing provided the input for refining the application.

Following the revision of the initial product, the research proceeded to a main field trial involving a broader user base. This stage aimed to assess functionality, ease of use, system stability, and the application's alignment with the needs of Grezfa Barbershop customers. Data

obtained from the main field trial informed the revision of the operational product. These revisions focused on refining features, the user interface, navigation, the accuracy of hairstyle placement, and overall application performance.

The refined operational product subsequently underwent an operational field trial. Testing was conducted under usage conditions closely resembling the actual environment at Grezfa Barbershop. This stage aimed to determine whether the application could effectively serve as a consultation tool between customers and barbers. Findings from the operational field trial provided the basis for the final product revision. Once the final product revision was complete, the application entered the dissemination and implementation phase. At this stage, the application was deemed suitable for limited implementation at Grezfa Barbershop and was documented in the research report. Thus, the relationship between the stages of the research process was both continuous and evaluative; each testing outcome served as the basis for revision, while each revision resulted in an improved product prior to the subsequent testing phase.

4. Results And Discussion

4.1. Home Page

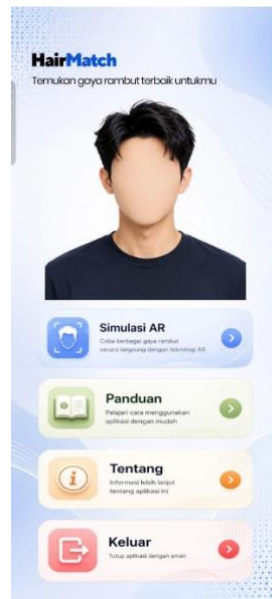


Fig. 2: Home Page

The main page serves as the initial interface of the HairMatch application and acts as the central navigation hub for users. This page displays the application's identity, an illustration of a hairstyle simulation, and several menu options: AR Simulation, Guide, About, and Exit. The AR Simulation menu allows users to virtually try out hairstyles; the Guide menu provides instructions on using the app; the About menu displays information regarding the application; and the Exit menu is used to close the app.

4.2. User manual



Fig. 3: User Manual

The User Guide page provides information on how to use the AR simulation feature in the HairMatch app. The guide covers the entire process, starting from selecting the AR Simulation menu, positioning the face in front of the camera, and maintaining that position during image capture, through to the system's analysis of the face shape. Once the analysis is complete, the app suggests suitable hairstyles. Users can then view the simulation results and save them to their device's gallery. This page also offers usage tips to ensure more accurate face analysis results.

4.3. About page



Fig. 4: About page

The "About" page provides information regarding Grezfa Barbershop and the application developed. This page features a brief profile of Grezfa Barbershop, an explanation of the application's functions, the technologies employed, the detectable face shapes, and the objectives behind the application's development. Developed using Unity, the application analyzes the user's face shape and provides recommendations for suitable hairstyles. The face shapes recognized by the system include oval, round, square, and oblong.

4.4. Exit page



Fig. 5. Exit Page

The Exit Confirmation page appears after the user selects the "Exit" option on the main screen of the HairMatch app. This page serves to verify the user's decision before the application closes. Users can select the "No" button to cancel the exit process and return to the previous screen, or select the "Yes" button to confirm and close the application.

5. Conclusion

Based on the interface design, the HairMatch application features a simple and structured layout. The main page serves as a navigation hub connecting users to the AR Simulation, Guide, About, and Exit menus. The Guide page provides instructions on using the application, covering steps such as face positioning, face shape analysis, obtaining hairstyle recommendations, and saving simulation results. The About page presents information regarding Grezfa Barbershop, the application's purpose, the technology employed, and the analyzable face shape categories. Meanwhile, the Exit Confirmation page ensures the application is not closed accidentally. Overall, each page has been designed to align with specific functions and user needs. The arrangement of menus, information, illustrations, and navigation buttons is intended to facilitate ease of use and help customers visualize hairstyles that suit their face shapes prior to getting a haircut. This aligns with the research objective: to design an Android-based Augmented Reality application that serves as a hairstyle simulation and consultation tool for Grezfa Barbershop customers.

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