



# Interactive Learning Media Anatomy of 3D Human Skull Using Augmented Reality

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## abstract

Anatomy is the study of the structure of the body and the relationship of its parts to one another. Studying human anatomy is mandatory for students of the Faculty of Medicine, especially Medical Education. Based on the results of a preliminary study conducted by the author on students of the Faculty of Medicine, some students stated that they did not understand studying human anatomy only by reading anatomy books such as Sobotta's Atlas of Human Anatomy, Yokochi's Color Atlas of Anatomy, practicum modules. This gave rise to the idea to design an android-based smartphone application using Augmented Reality technology for interactive learning media. Making AR smartphone applications using Unity and Vuforia software with C# programming language. The result of this research is to develop an interactive learning media application of a 3D human skull using augmented reality technology. Interactive learning media provide convenience for students in studying the anatomy of the human skull.

## abstrak

Anatomi adalah studi tentang struktur tubuh dan hubungan bagian-bagiannya satu sama lain. Mempelajari anatomi manusia merupakan kewajiban bagi mahasiswa Fakultas Kedokteran, khususnya Pendidikan Dokter. Berdasarkan hasil studi awal yang dilakukan penulis terhadap mahasiswa Fakultas Kedokteran, beberapa mahasiswa menyatakan bahwa mereka tidak mengerti mempelajari anatomi manusia hanya dengan membaca buku-buku anatomi seperti Atlas Anatomi Manusia Sobotta, Atlas Anatomi Warna Yokochi, modul praktikum. Hal tersebut memunculkan ide untuk merancang sebuah aplikasi smartphone berbasis android dengan menggunakan teknologi Augmented Reality sebagai media pembelajaran interaktif. Pembuatan aplikasi smartphone AR menggunakan software Unity dan Vuforia dengan bahasa pemrograman C#. Hasil dari penelitian ini adalah mengembangkan aplikasi media pembelajaran interaktif tengkorak manusia 3D dengan menggunakan teknologi augmented reality. Media pembelajaran interaktif memberikan kemudahan bagi siswa dalam mempelajari anatomi tengkorak manusia.

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## 1. Introduction

Studying human anatomy is essential for medical students, but many face challenges in understanding the subject solely through reading anatomy books and practical modules. In a preliminary study conducted among students of the Faculty of Medicine, it was found that the human skull is a challenging area to study due to the lack of a 3D model. However, the use of Augmented Reality (AR) technology can potentially revolutionize the way students learn human anatomy. AR provides a unique interface experience, allowing users to explore 3D objects in a realistic way and interact with them. In previous research, AR has been successfully used as a learning medium for human anatomy objects. This research aims to develop an interactive learning media using AR technology for learning the anatomy of the human skull on smartphones, with the hope of making the subject more accessible and attractive to students.

The anatomy of the human body is something that must be studied by students of the Faculty of Medicine, especially Medical Education [13]. Based on the results of a preliminary study conducted by the author on students of the Faculty of Medicine, some students stated that they did not understand human anatomy only by reading anatomy books such as Sobotta's Atlas of Human Anatomy, Yokochi's Color Atlas of Anatomy, practical modules [9]. Based on a preliminary study conducted on students of the Faculty of Medicine, some students chose skulls for parts that were difficult to study in human bone anatomy learning and there was no 3D skull model [15] this can certainly support the study of human bone anatomy, especially the skull if there is an application of interactive learning media on skull anatomy with 3D-shaped objects [16].

Augmented Reality (AR) is a technology that provides a unique interface experience. Users can see the real world through the camera combined with virtual objects that blend with the surrounding environment with AR [14]. Augmented Reality technology has the potential to be developed as a learning medium. The advantage of AR applications for learning purposes is that AR inspires and motivates users to explore and control from different perspectives [16]. AR can help users explore 3D

objects from a 2D image or text contained in a book. With AR, information appears directly like physical objects in the real world, so it will add to a more realistic experience, and can allow users to interact and be interested in book content, thus helping users who have problems to understand the text-based learning materials used when learning this [3].

In previous research using Augmented Reality technology as a learning media with human anatomy objects. Designing AR applications for learning the anatomy of the human body that runs in a web browser on a PC, the application is equipped with anatomical explanations and anatomical positions [5]. This research conducted an interactive learning media using Augmented Reality technology for learning the anatomy of the human skull, so it is hoped that the results of the research can be used to provide convenience for students in studying the anatomy of the human skull more attractively by using Augmented Reality technology on smartphones.

## 2. Method

At this stage, the AR application began to be designed by creating a 3D skull object using Autodesk 123D Catch and Blender software, after the 3D object was completed, the next stage was making the Augmented Reality application.

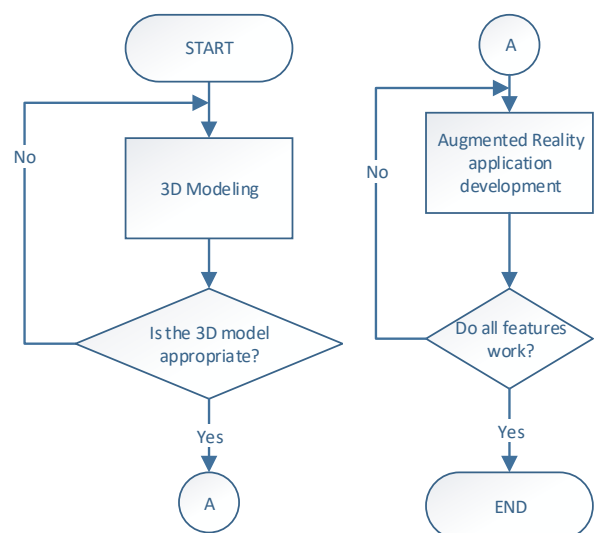


Figure 1. Research Flowchart

This research conducted an interactive learning media using Augmented Reality technology which is applied

to learning the anatomy of the human skull. This application is an alternative media for learning the anatomy of the human skull, so it is expected to be able to support anatomy lecture activities at the Faculty of Medicine.

### *Vuforia*

Vuforia is a cutting-edge software technology that enables developers to create augmented reality experiences with ease. It is built on a foundation of advanced computer vision algorithms that are specialized in image recognition, which makes it possible to detect and track objects in the real world and overlay digital content on top of them. With a rich set of features and capabilities, Vuforia provides developers with a powerful toolset for building immersive AR applications that can be deployed across a wide range of devices, including iOS and Android smartphones and tablets, as well as the Unity3D development platform [12]. Whether you're looking to create games, educational tools, or marketing experiences, Vuforia has everything you need to bring your ideas to life in the exciting world of augmented reality.

### *Unity*

Unity is a powerful and versatile game development platform that is widely used in the gaming industry. It provides developers with a range of tools and features that enable them to create high-quality, multi-platform games that can run on a variety of devices, including desktops, consoles, and mobile devices. In addition to game development, Unity can also be used to create 3D animations and other interactive content [12]. One of the key strengths of Unity is its ease of use. The editor interface is designed to be user-friendly and intuitive, allowing developers to quickly and easily create complex game worlds without requiring extensive programming skills. Moreover, Unity offers extensive support for professional applications, which makes it possible to seamlessly integrate with other software tools that developers may be using.

Another advantage of Unity is its support for the C# programming language, which is a powerful and widely-used language in the software development industry. This enables developers to create complex game mechanics and functionality using a familiar and well-supported programming language. Overall,

Unity is an excellent choice for anyone looking to create high-quality games or 3D animations with ease and efficiency.

### *Interview*

Respondents will be interviewed about the interface, information, and features available in the application to get any comments and suggestions when using the application. An overview of the interactions of the learning media application system is shown in Figure 2.

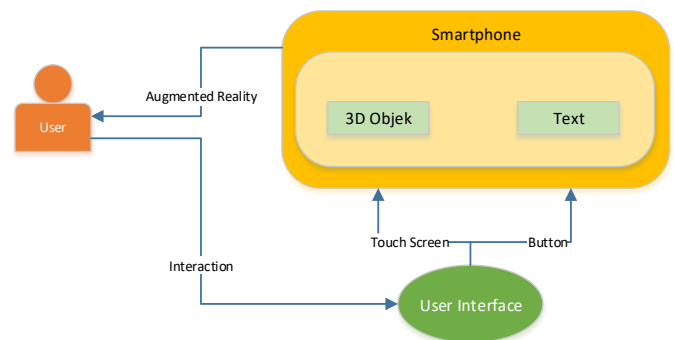


Figure 2. User Interaction with the System

Users can interact with the application interface via a smartphone, by touching the touch screen and buttons to interact with information on the application, such as 3D objects and text. In this study, an interactive learning media for the anatomy of the 3D human skull using augmented reality technology was developed. The first stage of the research was to create a 3D skull object using Autodesk 123D Catch and Blender software. Once the 3D object was completed, the next stage was to develop an augmented reality application using Vuforia and Unity software. Vuforia was used to develop the image recognition and tracking feature while Unity was used to create the interactive interface of the application.

Vuforia was selected as the primary software for this study because it provides advanced computer vision algorithms that are specialized in image recognition, which is crucial for the application to detect and track the 3D skull object. With Vuforia, it is possible to overlay digital content on top of real-world objects, allowing users to interact with the 3D skull model in a more immersive way. Unity was chosen to develop the interactive interface of the application because of its versatility and ease of use. Unity provides a range of tools and features that enable developers to create

high-quality interactive content, including games, animations, and educational tools. Unity's support for the C# programming language also makes it possible to create complex interactive features using a familiar and well-supported programming language. To evaluate the effectiveness of the interactive learning media, respondents were interviewed to gather feedback on the interface, information, and features available in the application. Users can interact with the application interface via a smartphone, by touching the touch screen and buttons to interact with information on the application, such as 3D objects and text. Overall, the study demonstrated the potential of using augmented reality and interactive learning media to enhance anatomy lecture activities at the Faculty of Medicine.

### 3. Result and Discussion

#### 3D Object

The creation of a 3D skull object (cranium) goes through several stages, namely scanning photos of skull objects using a camera, after that photos of skull objects are entered into Autodesk 123D Catch software to be converted into 3D objects, then the 3D object editing process is carried out using Blender software. The stages of making 3D objects can be seen in Figure 3.

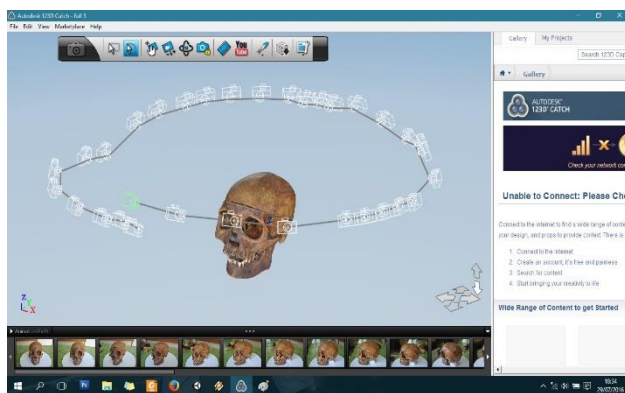


Figure 3. 3D skull object Autodesk 123D Catch

Furthermore, the converted 3D object is carried out by the editing process using Blender software. At this stage, the 3D object is added in the form of a pointer to the anatomy section along with the name of the part (Figure 4).

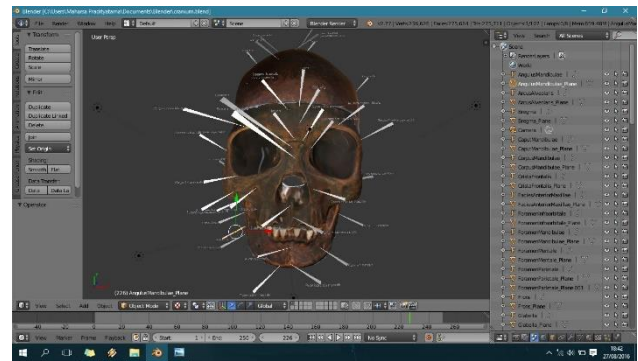


Figure 4. 3D objects editing process in Blender

#### User Interface

The user interface in this application consists of a splash screen display, main menu, sub-menus, and the display when an action is executed.

##### 1) Starting Application

The application when first opened by the user will display a splash screen and go directly to the main menu page.

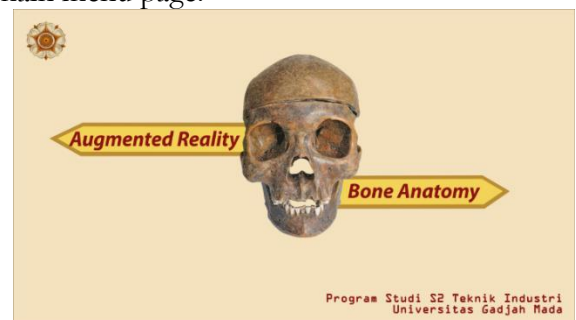


Figure 5. Splash Screen

##### 2) Main Menu

Displaying the main menu page, there are 3 buttons, namely the start button to move to the augmented reality page, the about button to move to the about page, the quit button to exit the application.

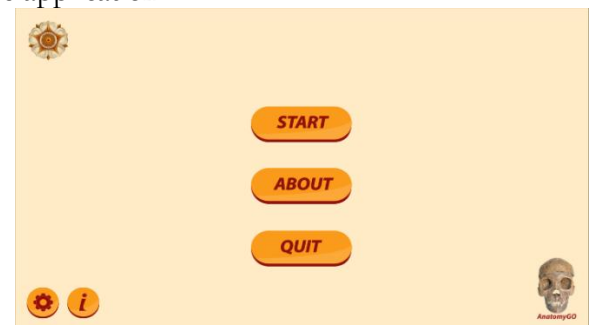


Figure 6. Main Menu



## 3) About Application

Displays an about page that contains brief instructions for using the application.

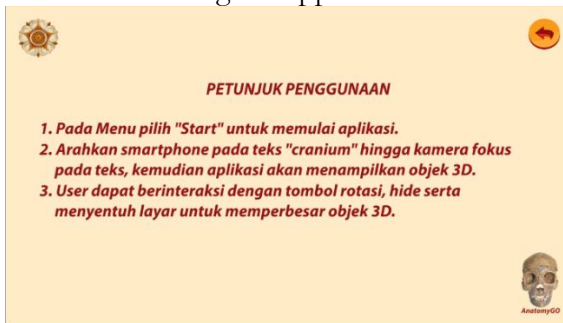


Figure 7. About Application

## 4) Application Guideline

Displays an info page that contains instructions for the buttons found in the application.

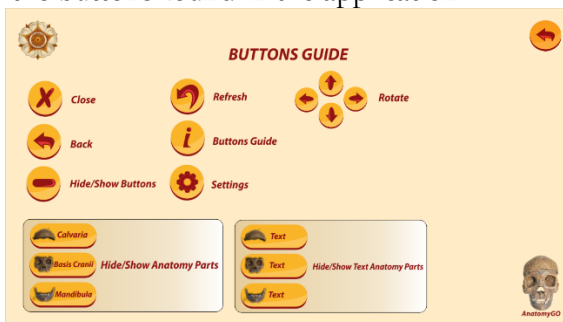


Figure 8. Application Guideline

## 5) Augmented Reality

Displays an augmented reality page that contains a rotation button to rotate an object, a back button to return to the main menu page, a hidden button to show and hide parts of a 3D object.

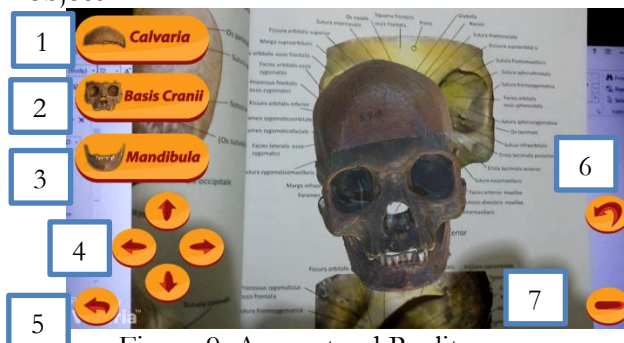


Figure 9. Augmetend Reality

Button Information:

1. Show/hide the calvaria section.
2. Show/hide the base of the cranium.
3. Show/hide the mandible.
4. Rotate the 3D object.

5. Return to the main menu.

6. Refresh.

7. Show/hide all buttons

### Interview

The results of interviews with respondents obtained positive comments on the application:

1. 3D objects in the application provide a realistic design of skull anatomy.
2. Application developed is simple and easy to use, this application is a good innovation for learning skull anatomy.

## 4. Conclusion

This research has succeeded in developing an interactive learning media application using Augmented Reality technology for learning the anatomy of the human skull. Based on the results and discussion of the research, it can be concluded that this application can provide information and an attractive learning experience for skull anatomy using Augmented Reality technology. This research can only run on the Android platform, so it can be developed on other platforms, such as IOS and Windows. 3D objects that are displayed cover all parts of the bone, and can be expanded to other parts of the human anatomy such as organs in the human body.

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