Inspection of 3-D model of Human body using Augmented Reality

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Abstract : To fully grasp complex concepts like the heart, the digestive system, and other challenging systems, it is essential for medical students to rely on visual representations alongside written materials. Currently, students who wish to study the anatomy of different organs must rely on visual representations as their primary means of comprehension in addition to written resources. An software called AR , in Anatomy allows students to examine the human body and learn how it functions. Users of this programme are able to zoom in and out, rotate, and view the anatomy of various human body parts. The programme also provides labelling for minor components. The student's ability to remember newly acquired knowledge is improved through AR. Because these diagrams are printed in 2D on books and are quite intricate, it is exceedingly challenging to envision them. With our APP, The capacity of students to visualise these representations quickly and efficiently.

Keywords — Augmented Reality, AR Core, labelling , Anatomy, Human Body Parts , Cloud, APP .

1. Introduction

The aim of this project is to investigate the potential of augmented reality (AR) technology in improving and enriching learning experiences . With the use of AR, students will study anatomy in order to memorise bodily organs and analyse this material in the context of how the body functions. A significant challenge in this undertaking is to visualise the three- dimensional linkages between distinct organs and their interdependent functions. The proposed method in the study aims to assist and direct students by presenting them with augmented reality (AR) images that provide a systematic learning approach to anatomical details. The effectiveness of using AR technology as a learning tool for understanding anatomical concepts is the main focus of this research.

2. Related Work

Students that study anatomy will be able to comprehend and retain a wealth of information on the range of bodily processes to contextualise this. Visualizing the relationships between various organs in three dimensions and their interconnected functions is a significant obstacle in our quest . This study introduces a structured educational framework that enhances students' understanding of the subject matter by offering them a virtual reality representation of the anatomical information

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K. R. Madhavi et al. (eds.), *Proceedings of the International Conference on Computational Innovations and Emerging Trends (ICCIET 2024)*, Advances in Computer Science Research 112,
https://doi.org/10.2991/978-94-6463-471-6_100

under examination . This development aims to support students in their understanding of anatomical facts through the use of virtual reality technology. This study examines if haptics may provide equal access to more immersive augmented reality experiences while being an effective tool for understanding anatomy (AR). This study aims to investigate how Augmented Reality (AR) and haptics technology can improve productive learning settings. Technology-aided learning often offers flexible usability. It is projected that intuitive immersive approaches, including augmented reality with haptics, can create learning environments that are more exciting and efficient. [1][2][3]

Human body anatomy is a crucial element in the study of genetics that should be studied after junior high school. There are numerous teaching tools in the form of mannequins (puppets) for literature and anatomy, but they are insufficient for assisting students in understanding the human body's anatomy. A technology known as augmented reality (AR) allows for the interactive blending of the real environment with a virtual one. The objective of this thesis is to create an augmented reality learning application that enhances students' comprehension of the human body, making it more accessible and engaging. This research aims to help students grasp human anatomy by utilizing a combination of 3D model interaction, textbooks, and mannequins. To evaluate the application's impact, a prototype is developed and data is collected using a quantitative analysis method. The development process adheres to the waterfall methodology, encompassing stages that include planning (comprising data collection and analysis), architectural design (encompassing interaction design and diagram development), implementation, and testing. The primary outcome of this study is a web- based augmented reality framework that facilitates the study of human body anatomy, incorporating 3D objects, organ explanations, and their respective locations. [4][5][6]

Understanding human body anatomy can be challenging for students as converting a 2D image into a 3D representation poses difficulties. This project aims to address this issue by developing a virtual reality-based learning system. By utilizing 3D renderings, Through this approach, students can readily grasp the intricate details of human anatomy . The framework employs the Mobile Computing Application Augmented Reality Identifier technology, where a marker is captured through photography and matched with images in the database after being segmented. The integration of the SQLite database and the Floating Euphoria System was performed for this analysis. The virtual anatomy device allows interactive exploration of the entire body or specific regions. The effectiveness of the virtual reality anatomy system was assessed by engaging both high school students and medical students in the evaluation of the program. The results indicate that the implementation of virtual reality visualization in the human anatomy learning system enhances students' comprehension of the human body. [7][8][9]

This study presents a novel approach for teaching anatomy to high school students using an interactive virtual reality technique based on depth cameras. Specifically, the Microsoft Kinect depth camera is utilized to overlay 3D models of human anatomy onto a person's body in real-time. This system does not require the use of targets or markers for mapping, allowing users to visualize the distribution of bones, muscles, and organs within their own bodies. Augmented reality (AR) is a technology that enables the coexistence of real-world objects and digital counterparts in the same space. The Microsoft Kinect's depth sensor comprises both an RGB camera and an infrared laser depth camera, enabling precise measurement of the distances between various body parts and the identification of joints within a three- dimensional (3D) space . This capability enables full-body 3D motion recording. Recent advancements in computing and the availability of affordable depth cameras have significantly improved the real-time visual processing of AR technology, overcoming past challenges related to poor lighting conditions and slow mathematical processing. [10][11][12].This article provides an overview of augmented reality (AR) by discussing its fundamental principles and core concepts. It explores the various sectors and current applications where AR is being utilized. The article aims to provide a comprehensive overview of the features and capabilities of augmented reality. Additionally, it touches upon potential future directions in the field of AR [13][14].The notion of augmented reality (AR) is gaining popularity and has several applications. This study looks at the results of a poll that was specifically created to gauge how easily proposed features will be adopted in mobile outdoor AR applications. This poll was created to provide a clearer assessment of consumer preferences for outdoor AR situations. The preference level was determined using product indicators pertaining to various current and pertinent models. The study covers the survey results on the preference level in relation to the targeted questions and offers a systematic framework for on how AR technology is being adopted [15][16][17],Augmented reality (AR) is an increasingly popular and rapidly advancing technology that allows the integration of 3D virtual objects into the real-world environment, enhancing the overall experience. This technology offers exciting and captivating applications. While AR is commonly implemented using smartphones and interactive media, its utilization in relation to the human body remains relatively limited. The Cardiac Learning Recognition (CLD) project aims to assist medical students in comprehending interactive learning materials, specifically focusing on the anatomy of the [18][19][20] human heart and providing more comprehensive details compared to traditional teaching methods. To achieve this, virtual reality has been developed as a visual technology approach to incorporate the intricate structure of the human heart.

3.Proposed System

Incremental Development Model

The project's methodology is the incremental development paradigm. Due to the system's numerous functionalities, this model is the best software development strategy for this project. In general, this system's capabilities (requirements) are initially flawed, broken down into multiple pieces that can be built and delivered in stages. As a result, it is simpler to gradually change the various needs. The system's fundamental features are created first, after which more functions are gradually added to raise the system's capability levels. The phases of overview description (planning), specification (requirement), development, and validation make up the incremental development paradigm. Development and validation are done simultaneously for the phases of specification.

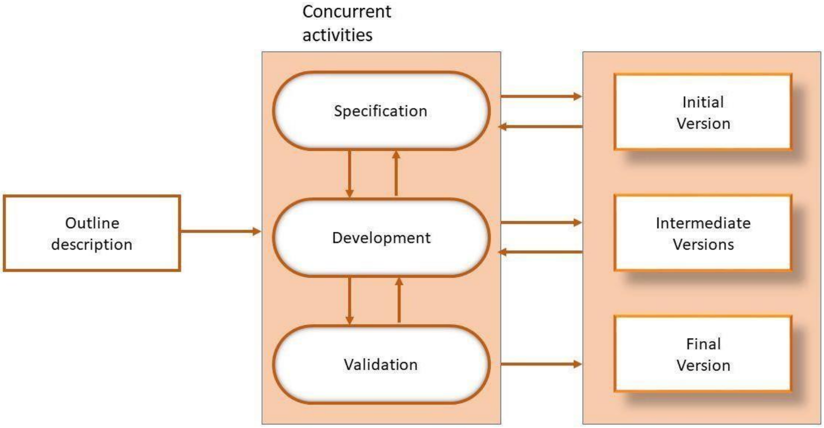


Figure 1: Incremental Development Model

Outline Description

The planning phase, also known as the outline description phase, is when the incremental development model starts. In this stage, the analysis and outlines of the user requirements are established . Studying a number of journals or research papers, as well as conducting user interviews, are used to gather the requirements for creating and implementing an augmented reality application for understanding human anatomy. The requirements that have been gathered must then be reviewed and described in order to understand what the users are expecting from this learning application.Many system architecture patterns are selected to develop for this system in this phase based on the chosen features in the system.At this step, each system increment is coded individually after selecting the appropriate architecture patterns for each system increase. As a result, at the conclusion of this phase, all features and functionalities are present, and the application system is capable of meeting the criteria.Iteratively, each system increase is validated one at a time. The full system is then deployed at this stage once the successful system increments have been combined. Final validation of the finished system is done at the last stage of the incremental development process. The last system is then ready to be released onto the market. To fulfil the needs of users in the future, the system will nevertheless be maintained.In this, two hardware components are employed: a computer and an Android smartphone. The computer is utilized for tasks involving the creation of 3D model objects derived from MRI and CT datasets, which encompass processes such as visualization and segmentation. Additionally, it is used to integrate augmented reality (AR) technology into these 3D model objects. Subsequently, the augmented reality application designed for the study of human anatomy is tested and deployed on a mobile device.

Anatomical Plane

Three planes are used to describe how to scan and take pictures of the human body's anatomy, correspondingly.

1. The body component is divided into front and rear sections by the coronal (frontal) plane, which is vertical.
2. The body component is divided into top and bottom halves by an axial (horizontal/transverse) plane.
3. The sagittal plane is a vertical plane that separates the body into left and right portions

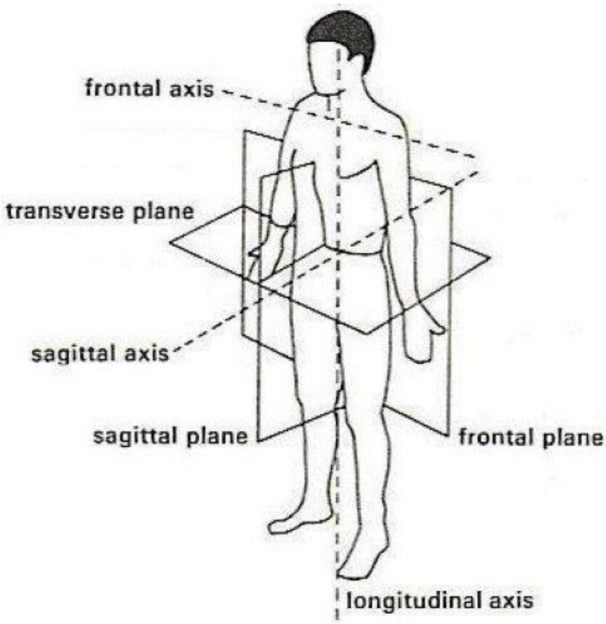


Figure 2: anatomical plane

Unity with Vuforia

This uses Unity and the Vuforia Augmented Reality SDK as its software.The Unity engine, in conjunction with the Vuforia engine SDK, is employed to facilitate the integration of a 3D model of the human body into a virtual environment and improve interaction with augmented reality (AR) objects. The project has reached a stage where the AR body structure is successfully showcased on the Unity testing platform, albeit without any operational functionalities implemented yet.

Marker scan module

The user must be prompted by the application to snap a photo of the visual marker.The marker images from the programme must be downloadable by the user.Using the camera on the mobile device, the programme must find the marker image.

AR displaying module

Only the correct and distinct visual marker image shall elicit a reaction from the programme.Just the appropriate AR object on the appropriate proper marker image shall be displayed by the application.After the marker has been detected using fingertip motions, the application must enable user interaction with the AR item displayed on the mobile device's screen.The programme must show augmented reality (AR) objects in the real-time surroundings that mobile devices' cameras are tracking.The programme must display to users the textures and 360-degree views of AR items.After the user clicks a button, the programme will display an AR object that can rotate itself.

Labelling or pop out window module

The user will see the physiologically naming labels for each section of the anatomy in the application.The programme must display specific anatomy part information in a pop-out window to explain and describe the relevant portion to the user.

System Architecture

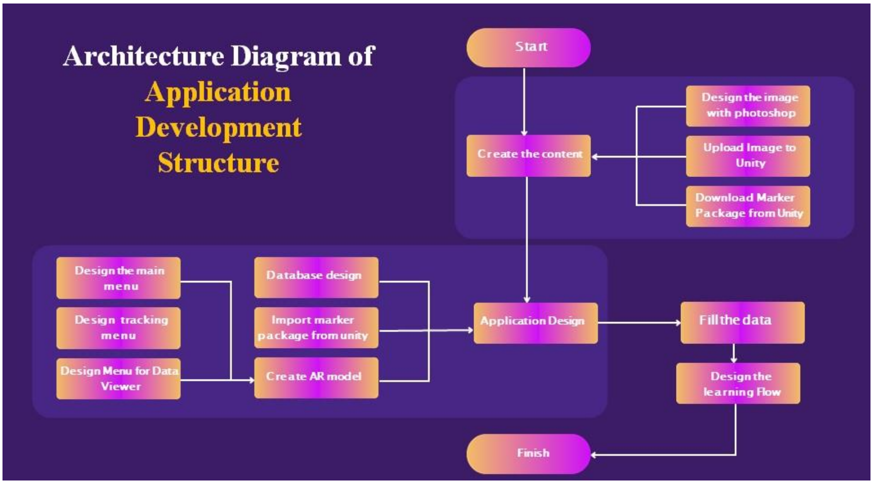


Figure 3: Architecture Diagram of ADS

The use case diagram provided illustrates the functionality of an augmented reality application designed for learning human anatomy. The user has the option to download a marker image and then employ the mobile device's camera to scan and detect the marker using the AR software. Upon successful detection of the marker photo, the user can view the augmented reality object displayed on the screen. By utilizing finger gestures, the user can interact with the AR object and explore the 3D anatomy from various angles within the virtual world. Additional information and detailed explanations about specific anatomical structures can be accessed by using the user function and description buttons. Lastly, the user has the ability to exit or terminate the application as desired.

4 Results Analysis

The satisfaction of users with the program was evaluated through an attitude survey. The survey employed a Likert scale with a range from 1 (indicating strong disagreement) to 5 (indicating strong agreement). The survey consisted of questions categorized into five areas, each comprising three questions . We computed the mean average for every category by analyzing the survey responses ,by aggregating the individual responses to each question.

A total of 60 individuals completed the questionnaire, with 30 having a high school education, particularly in science-related subjects, and the other 30 possessing at least a Tier 1 university degree, primarily in fields related to human anatomy study.

The results of the study are presented in Figure 3 and Table 1.

Table 1: Findings from the Human Anatomy Evaluation

Q	Instructional aids	Mean	Avg
1	I find the "AR-based anatomy learning app" to be extremely fascinating.	4.05	3.997
2	In my view, the "AR-enabled anatomy learning app" offers significant advantages when it comes to educational resources on human anatomy.	4.07	
3	From my perspective, the "AR-based anatomy learning app" is versatile and can be applied to a wide range of subjects.	3.87	
Q	**Interaction design**	**Mean**	**Avg**
4	The concept of the "AR-enabled anatomy learning app" is highly fascinating to me .	3.95	3.98
5	In my opinion, the design of "AR-based anatomy learning apps" with markers is more captivating compared to static visuals	4	
6	In my view, the design and implementation of markers in the "AR-based anatomy learning app" allow for the presentation of diverse application functions.	4	
Q	**Media capabilities**	**Mean**	**Avg**
7	In my opinion, "AR-based anatomy learning apps" that utilize markers offer greater advantages in comprehending the anatomy of the human body.	4.13	4.097
8	I am of the opinion that "AR-based anatomy learning apps" incorporating markers provide enhanced benefits for gaining a more detailed understanding of the human body's anatomy.	4.08	
9	The "anatomy learning application with AR" and marker, in my opinion, make it easier to comprehend the human body's anatomical structure.	4.08	
Q	**Interactive function**	**Mean**	**Avg**
10	The capability of "anatomy learning application with AR" to view a description of each organ is, in my opinion, highly beneficial and fascinating.	4.08	4.163
11	The ability of the "anatomy learning application with AR" to rotate a 3D model, in my opinion, greatly obliterates anatomical observation.	4.18	
12	I believe that "anatomy learning application with AR"'s function to magnify 3D models is quite unsettling to view anatomical details.	4.23	
Q	**Feasibility**	**Mean**	**Avg**
13	I consider using the "anatomy learning application with AR" to learn in anatomy class to be really terrifying.	4.12	4.050
14	The use of "anatomy learning applications with AR" is something I'm particularly interested in.	3.88	
15	In general, "anatomy learning applications with AR" significantly facilitated learning.	4.15	
#	**The overall average**	**4.058**	

The average values for each category were computed based on the responses of the participants. In Table 1, 'Avg' indicates the mean average within respective categories, 'Q' denotes survey questions, and 'Mean' represents the average value for every question.

By analyzing on the data presented, the instructional aids category received an average value of 3.997, indicating a generally positive sentiment among participants regarding the instructional aids available in the application. However, some participants suggested that the application could be further enhanced by placing a stronger emphasis on 3D models for visualization rather than academic articles.

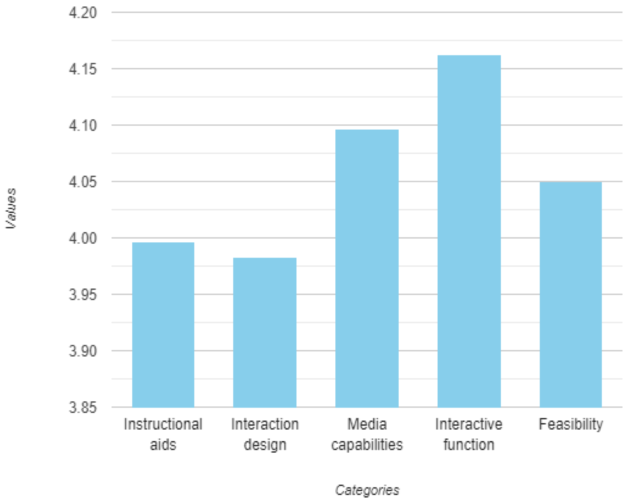
The Interaction design category yielded an average value of 3.983, suggesting that participants generally found the design favorable. Nonetheless, a subset of respondents noted that the text size was too small, leading to readability challenges.

In the media capabilities category, an average value of 4.097 was observed. This suggests that participants generally found the 3D models and presented images to be satisfactory but expressed a desire for more content.

Participants highly rated the interactive features, with an average score of 4.163. This suggests they found the touch capabilities and dynamic model exploration particularly engaging and well-suited to their needs.

Finally, the feasibility category received an average value of 4.05. While some users reported confusion in using the application, the majority of respondents found it highly useful.

The total average presented in Table 1 is 4.058, indicating that the majority of respondents agreed or strongly agreed that the program helped them learn about human anatomy and that all



evaluation categories met their needs.

Figure 4: Comparing the avg value across categories

Figure 3 illustrates a comparison of various aspects analyzed on user ratings. The graph highlights that the application's interactive functionality received the highest ratings, followed by feasibility and multimedia elements. This underscores the value of augmented reality (AR) anatomy learning apps in providing students with accessible and engaging media capabilities. Consequently, students can actively engage with the app by selecting their preferred anatomy model, adjusting the zoom for more detailed information, and rotating the model. However, it's worth noting that the utilization of AR within the program is not adequately explained, resulting in lower ratings for interaction designs and instructional aids.Additionally, the perceived lack of comprehensive anatomical learning content contributes to interaction design confusion among respondents. To address these issues and enhance the educational resources related to the interactive 3D human anatomy model, this research aims to develop a program that includes detailed instructions on its usage. This approach will make it more user-friendly and effective. Furthermore, the incorporation of voice narration into the program's development can be beneficial for conveying specific information about anatomical structures and user interaction features.

5 Conclusion

All secondary school students in the science stream are required to take biology, and the 2D illustrations in textbooks make it difficult to completely comprehend the complex intricacies of the human anatomy. Although anatomical mannequins are available for students to use as a reference, access is only permitted during class time with a teacher's approval. Students are not permitted to use anatomical mannequins at home. In addition, some students have trouble comprehending the 2D illustrations of the human anatomy. The suggested solution is to create an AR application with 3D visualisation and segmentation from a dataset of MRI and CT scans. using current technology, such AR or VR, to apply and replace the conventional approach of teaching and learning for pupils. Learning with augmented reality technology not only offers a different manner of instruction, but also aids in more effective and efficient learning . By providing a more realistic sense of a 3D model with intricate components on it, learning complex human anatomy via augmented reality aids students who find it difficult to comprehend the 2D representations of the human body. Also, it offers convenience for people who wish to learn at any time or place using only a mobile device rather than lugging about bulky textbooks if the student wants to review and study right away. In addition to using AR technology, 3D models made from MRI and CT scan datasets using MITK software are also used since they are more precise and accurate than AR models made artificially by graphical design tools. Medical 3D visualisation and body part segmentation from MRI and CT datasets were utilised to construct the AR model for this proposed AR application for studying human anatomy.

The purpose of the proposed system is to provide a different approach to understanding human anatomy using augmented reality technology and a more accurate 3D model created from medical visualisation and datasets segmented from MRIs and CT scans. By carrying out this project, every student may become more aware of the advantages and benefits of using augmented reality technology to aid their study. As a result, it will subtly enhance their understanding of current technologies. Finally, thanks to the 3D models being created from actual medical datasets, students will learn anatomy in a more realistic and accurate way.

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