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Augmented Reality in E-Learning

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ABSTRACT—

Augmented Reality (AR) has gained significant prominence in the field of Human-Computer Interaction (HCI) in recent years. Its ability to superimpose interactive visuals onto real-world environments has found various applications in academia and research. Within the education sector, where textbooks remain the primary learning resource, AR has emerged as a valuable tool for students to delve into new subjects. AR facilitates interaction and exploration through specialized virtual scenes, enabling students to engage with a three-dimensional representation of the internal organ system using OpenCV and the Haar cascade algorithm. Students can visualize the human anatomy on themselves, enhancing their understanding and visualization of the internal system. Augmented reality has proven beneficial in aiding students' comprehension and visualization of the intricate workings of the human body.

Keywords—Augmented Reality (AR), OpenCV, Marker-less, e-learning, Haar Cascade.

I. Introduction

Augmented Reality (AR) is a rapidly advancing technology that has the potential to revolutionize multiple sectors, including education, healthcare, and research. In the field of education, AR has made significant strides by offering immersive and captivating experiences that enhance traditional learning methods. AR involves overlaying virtual images onto the real world, allowing users to observe and interact with dynamic virtual content in real-time. Unlike Virtual Reality, AR enables users to maintain awareness of their actual surroundings. Devices such as smart glasses, tablets, and smartphones can be utilized to experience AR. By blending the physical world with digital information, AR enhances the user's perception of reality. The main objective of an AR system is to supplement the real world with three-dimensional virtual objects that appear to coexist with the actual environment, enabling users to interact with them more seamlessly.

Educational institutions have shown significant interest in implementing AR technology to enrich classroom learning experiences. This technology has redefined traditional learning methods by providing students with immersive 3D visualizations, moving away from conventional pen-and-paper approaches. The combination of AR and Human-Computer Interaction (HCI) techniques enables educators to assess students' comprehension and evaluate the effectiveness of AR in the classroom. By incorporating an augmented reality application, we aim to enhance learning experiences beyond the confines of the classroom. Our proposed AR application includes an interactive, three-dimensional model of the human internal system, allowing students to understand and visualize this complex system while also memorizing the names of essential internal organs. In our study, students utilize webcams to interact with 3D schematics of the human internal system. By employing augmented reality as a supplementary tool for learning about the human internal system, students can capture real-time images and gain better visualization of conceptual information.

II. LITERATURE REVIEW

The AR application displays a three-dimensional skeleton model overlaid on the pages of a textbook when users point their mobile devices at the relevant pages. The 3D model of the skeleton, as well as the text displaying the names of the bones, was created using Autodesk 3ds Max. To integrate the model into a mobile application, the Unity game engine and the Vuforia Framework were employed. The software was trained to recognize the textbook page as a marker, enabling it to superimpose the 3D model accurately on top of the corresponding page once a picture of it was taken. [1].

The application offers several captivating and distinctive functionalities, including interactive alphabet sounds and navigation buttons for previous, next, and home screens. Users can utilize any smart device along with the application to scan a target image and access a three-dimensional representation of the alphabet. The software utilized in the development of this application includes Unity 3D, Vuforia, and Sketchup. Users can access the application on various smart devices such as mobile phones or tablets. However, it is important to note that direct navigation to a specific letter is not possible, and users must progress sequentially through the alphabet from the beginning. The application relies on a single target image for its functionality. [2].

A group consisting of 14 architecture students participated in a design assignment where they were given the option to utilize either ARtect or traditional 2D drawings. The authors of the study employed Unity 3D, a popular game development engine, and Vuforia, an AR software development kit, to create the ARtect prototype. Additionally, they utilized SketchUp and Blender to generate 3D models of buildings and spaces. However, it is important to note that the study did not directly compare ARtect with other AR tools or traditional methods of architectural education, which can be considered a limitation of the research.[3].

The web-based application offers instructors the ability to efficiently manage their lessons, including features for uploading, deleting, and modifying content. This particular web application is created using the PHP language. To check for duplicate images in the database, OpenCV in C++ is utilized. The EduAR approach is an Android-based smartphone application that leverages augmented reality technology to enhance lecture slides by adding extra content such as images, texts, and videos onto the original slides. The system consists of two components: a mobile application developed on the Android platform using the JAVA programming language, OpenCV, and MySQL, and a web application.[4].

ARGEO is a mobile app that utilizes augmented reality to merge the fields of volcanology and education, providing students with a comprehensive understanding of this complex subject. Designed as a teaching and learning tool, the app facilitates the exploration of volcano surfaces from various perspectives. Through clear labeling and an interactive 3D model, students can easily identify different features of volcanoes and the processes involved in their formation. The app, named ARGEO, can be found and downloaded from the Google Play Store. Its development involved the use of Unity3D, Vuforia, and the Firebase SDK. [5].

III. PROPOSED SYSTEM

Augmented Reality in e-learning is a Django application in aims to help students better visualize and grasp the concepts of human anatomy. The system has three modules namely, the Digestive system, the Respiratory system, and the Nervous system. The working of our AR application is shown in Fig 1. The user creates an account, and logs in to the application to use the Augmented Reality System that displays various human organs. This system overlays images of human organs on the students in the live video feed from the camera. The user can select any of these modules to see the augmented scenes of those organs on the system. Once the user selects a module the organs are displayed in a sequence and the user can toggle between them. The display window also has Wikipedia links and audio descriptions for the particular organs. The has a Multiple-Choice Questions module to check the student's knowledge regarding the respective human body system.

The system described utilizes a marker-less augmented reality (AR) approach, which means it can identify objects or unique characteristics of a scene without prior knowledge of the environment. Marker-less technology is currently popular due to its efficiency and ease of implementation. The implementation of this system involves the Django framework, OpenCV, pygame, and Tkinter. Django, a free and open-source web framework based on Python, follows the model-template-views (MTV) architectural design pattern. It emphasizes minimum coupling, rapid development, and the modularity of components. OpenCV, an open-source computer vision library, provides machine learning and computer vision functionalities and is freely available for use.

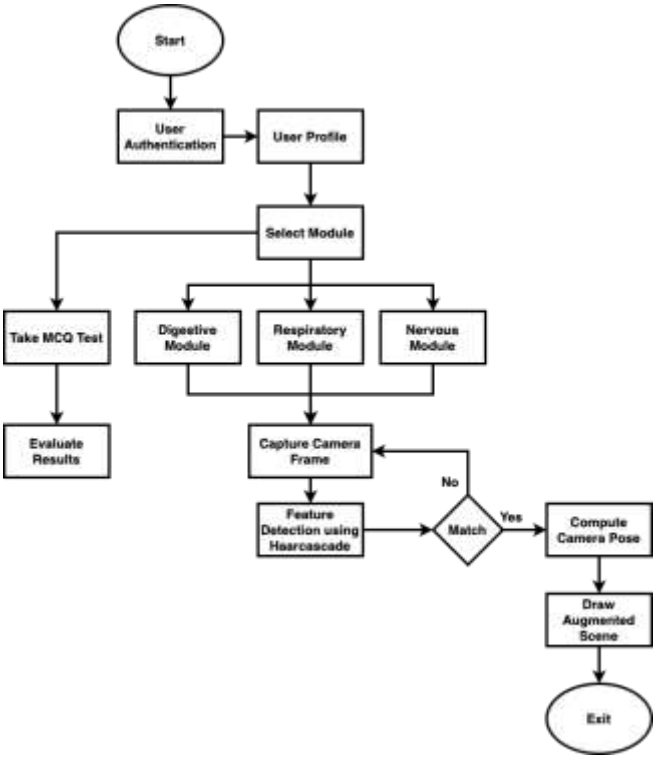

Fig 1. Workflow Diagram

The library offers a comprehensive collection of computer vision and machine learning approaches, blending both traditional and modern techniques. It boasts over 2500 optimized algorithms to support various tasks. Tkinter, a Python package, is employed for constructing graphical user interfaces (GUIs). It provides a range of tools and widgets for creating windows, buttons, labels, and other GUI components. Tkinter is a built-in module in Python, enabling developers to create interactive, cross-platform applications with ease. It is user-friendly and suitable for programmers at all skill levels.

For face detection, the algorithm employed is the Haar Cascade algorithm. It is a machine-learning-based approach that utilizes a cascade function trained with a large dataset comprising positive (face-based) and negative (non-face-based) images. The algorithm analyzes Haar features in XML format, including those for the Eyes, Frontal Face, Full Body, Upper Body, and Lower Body.

The Digestive module contains a digital simulation of the human digestive system that uses AR technology. The AR-based digestive system, a 3D model of the digestive system is created, including all the organs involved in the process of digestion. It allows users to see the internal structures of the digestive system, such as the mouth, stomach, small intestine, and large intestine. In addition to providing a visual representation of the digestive system, it also uses audio explanations to provide a more comprehensive understanding of how the digestive system works.

The Respiratory module allows users to see the internal structures of the respiratory system, such as nasal cavity, pharynx and lungs. The Nervous module contains a digital simulation of the human nervous system. A 3D model of the nervous system is created, including all the organs involved in the process. It allows users to see the internal structures of the nervous system, such as brain and central nervous system.

A. WORKING OF THE PROPOSED METHODOLOGY

a) Face Detection using a pre-trained classifier “haarcascade_frontalface_default.xml”.

b) Calculate the dimensions of the image of the digestive system based on the dimensions of the detected face.

c) Resizes the digestive system image to the calculated dimensions.

d) A loop starts over the pixels of the resized image and overlays it on the current frame based on the position of the detected face.

e) The function returns the modified frame with the Augmented image overlay.

IV. RESULT AND DISCUSSION

Students can use augmented reality to add digital information on top of real-world data. This article attempts to build a more effective educational environment by utilizing augmented reality. Fig 2 represents the augmented display of mouth. Fig 3 displays the augmented Pharynx and Fig 4 represents the augmented brain. According to the findings, augmented reality technologies are a positive step towards narrowing the knowledge gap between students and educators.

This AR application prototype enables students to become more acquainted with difficult concepts of human anatomy. The proposed system provides a new way of learning and understanding complex concepts of the human anatomy like the digestive system, respiratory system, and nervous system. This system is proposed for the enhancement of education at the rural level and to make education more interactive and engaging through the use of Augmented Reality.

Fig 2. Augmented Display of Mouth from the Digestive Module

Fig 3. Augmented Display of Nervous Module

Fig 4. Augmented Display of Pharynx from the Respiratory Module

V. CONCLUSION

In conclusion, the proposed system provides a new way of learning and understanding complex concepts. This technique is suggested to improve education in rural areas and employ augmented reality to make learning more interactive and interesting. This system also contains an MCQ quiz that analyses the understanding of the subject. Hence augmented reality technology bridges the gap between urban and rural education.

VI. FUTURE SCOPE

The use of augmented reality in e-learning courses for the neural, respiratory, and digestive systems has a bright future. Other organs of the human anatomy can be added to the system. The system can be further improved by adding augmented video models showing the processes of digestion and respiration. The concepts of other subjects and also be implemented to improve understanding. A mobile/wearable device integration using OpenCV and Haar Cascade algorithms will fundamentally alter how students interact with and comprehend these intricate systems, resulting in a more engaging, interactive, and productive learning environment.

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