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MediVis 3D: Interactive 3D Medical Anatomy and Learning Tool

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ABSTRACT: MediVis 3D is a sophisticated learning platform that aims to transform the interaction between medical students and professionals with human anatomy. By harnessing the capabilities of 3D visualization technologies, this software offers an interactive and immersive space to navigate anatomical structures in fine detail. Constructed using Blender for 3D modeling and backed by easy-to-use user interfaces, MediVis 3D enables users to rotate, zoom, dissect, and annotate anatomical models, facilitating greater understanding and retention of intricate ideas.

The system closes the gap between textbook learning and practical experience by mimicking real-life anatomy in an imaginary environment. It enables layered exploration of organs, tissues, and systems, with embedded quizzes and guided modules to support active learning. The tool is especially useful in remote learning environments and for institutions with limited access to physical specimens.

This project report delivers the design, development process, system architecture, and use cases of MediVis 3D, as well as its impact on medical education. With its integration of pedagogy and technology, MediVis 3D hopes to improve the quality, accessibility, and efficacy of anatomy learning during the digital age.

KEYWORDS: Anatomy visualization AI in medical learning, Remote learning tools, Digital medical education

I. INTRODUCTION

With the increasing worldwide trend towards digital and remote learning, especially in medicine where conventional cadaver-based learning is subject to logistical, ethical, and budgetary constraints, the demand for affordable, interactive, and efficient digital tools is now greater than ever. MediVis 3D is an advanced virtual anatomy learning tool created in response to this need, leveraging Blender's power for high-fidelity anatomical modelling and tools such as Three.js and WebGL to support real-time, browser-based 3D interaction without the necessity for downloads. In contrast to most static anatomy applications, MediVis 3D focuses on modular learning and provides topic-oriented units with augmented layered anatomical views, clinical cases, walkthroughs with narrations, and in-built evaluations that are beneficial for learners from basic healthcare education to high-level surgical training. The system ensures cross-device use, is bandwidth-friendly, and includes inclusive features like multilinguality, customization of interface parameters, and support for screen readers. Built to be LMS-compatible (e.g., Moodle, Canvas), it features tools for teachers to build and monitor individualized learning paths while students are able to participate in collaborative sessions, interactive quizzes, and annotate 3D models for greater comprehension. MediVis 3D is a major leap in democratizing medical education by bringing high-quality visuals, pedagogical organization, and technical accessibility together in one unified learning environment.

II. LITERATURE SURVEY

Digital technologies being incorporated into medical education has become much more prominent over the past couple of decades, fueled by advancements in computing power, visualization tools, and a growing need for flexible, scalable learning solutions. Anatomy education based on cadavers, even though it is considered to be the gold standard,

has difficulties in the form of being very costly to maintain, ethical drawbacks, and being not very accessible in resource-poor settings (McMenamin et al., 2018). As a reaction, various studies have examined the effectiveness of virtual anatomy tools and proposed that 3D digital models have the ability to greatly improve spatial knowledge and retention over static textbooks or 2D diagrams (Yammine & Violato, 2015).

Some commercial and educational projects, like Visible Body, Anatomy Table, and Complete Anatomy, have shown the potential of 3D visualization in anatomy learning. But the constraints of being expensive, hardware-dependent, and less interactive still hinder their broad use, particularly in the developing world (Estai & Bunt, 2016). Open-source software such as Blender has become increasingly used in the educational environment because they are easily customizable and can generate high-fidelity models without the limitations imposed by proprietary restrictions (Hughes et al., 2021). Moreover, web rendering technology like WebGL and Three.js has empowered lightweight, browser-supported 3D applications that are available on all platforms without needing to be installed, making it more accessible to learners of differing technology capabilities.

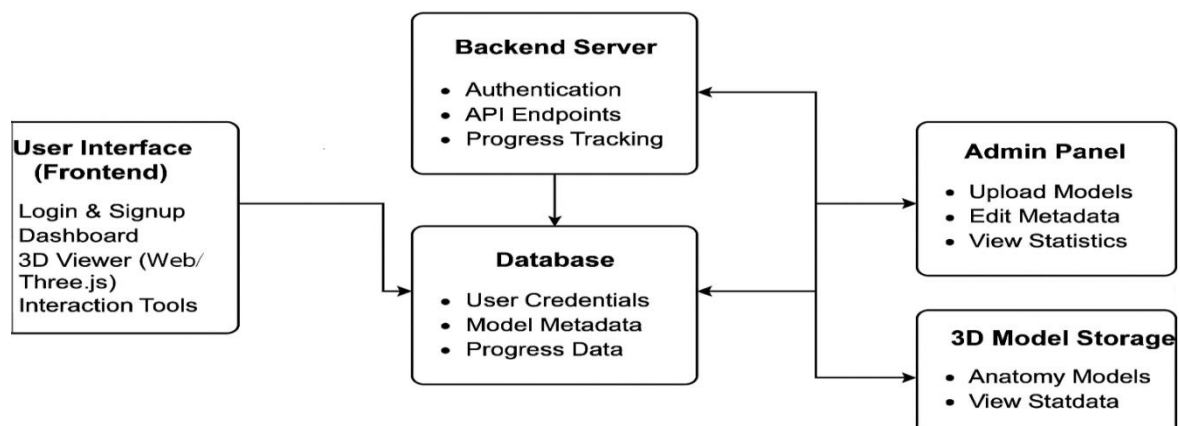
Pedagogically, the move towards modular, self-directed learning facilitated by virtual platforms has been found to enhance learner motivation and retention of knowledge. Virtual anatomy environments that are embedded with clinical scenarios and evaluation offer a more integrated and context-based learning experience (Nicholson et al., 2006). In addition, accessibility features like multi-language support, customisable UI/UX, and screen-reader support are increasingly identified as integral aspects of inclusive digital education (Seale, 2013).

The need for solutions that combine these developments into one accessible, interactive solution resulted in the idea of MediVis 3D. Created with cross-platform compatibility, modules that can be customized, LMS integration, and interactivity with layered anatomy, MediVis 3D fills the shortcomings of current systems by providing high-quality visualization in balance with accessibility and pedagogical richness. This literature-driven basis underlies its function as a next-generation learning tool that democratizes the education of anatomy in both face-to-face and distance learning environments.

III. METHODOLOGY

The design of MediVis 3D was based on an iterative and modular approach, integrating software engineering best practices and user-centered design principles. The process began with a thorough requirement analysis involving domain specialists and prospective users like medical students and teachers. Functional modules were determined and ranked upon which it was based.

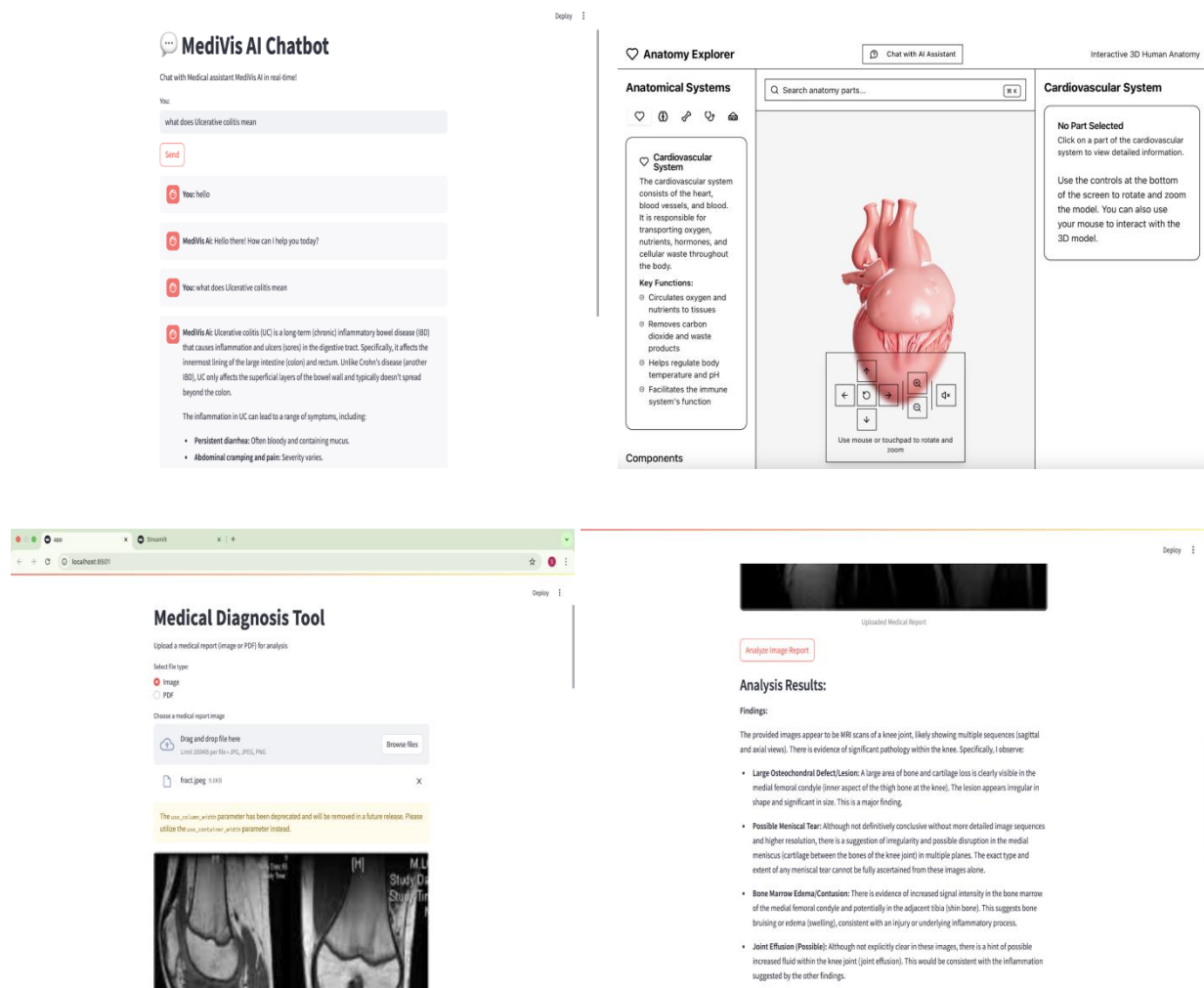
The system was developed based on a component-based architecture, guaranteeing modularity and scalability. Backend development involved the use of Django (Python) for handling user authentication, content management, and API processing. A MySQL relational database was used for storing and retrieving user data and anatomical content.



At the frontend, JavaScript, CSS, and HTML were utilized to create a responsive and intuitive UI. The Three.js/WebGL framework was utilized for rendering anatomical models of high accuracy in order to support real-time 3D interaction. These models were exported in light forms such as .glb or .gltf after being optimized for web display through the use of Blender.

During development, Agile methodologies were applied, with regular testing and feedback loops from the users. User validation sessions, integration tests, and unit tests were used to make the system robust, accurate, and usable. At last, the application was deployed and tested on various platforms and browsers to ensure compatibility and performance.

IV. EXPERIMENTAL RESULTS



V. CONCLUSION

MediVis 3D offers a novel platform that integrates cutting-edge 3D visualization technologies with interactive learning tools to facilitate better comprehension of human anatomy. The system allows students and medical enthusiasts to navigate intricate anatomical structures in a more intuitive, interactive, and immersive manner than through conventional textbooks or static models.

By its interactive usability, 3D rendering technology, and content management functionality, MediVis 3D reduces the theoretical-learning-to-realizing-practical-insights gap to a near negligible level. Individuals can sign in, browse fully detailed 3D anatomy models, adjust, explore, and monitor their progress. Administrators can add, organize 3D content and keep the portal up to date and dynamic.

The project illustrates the potential of 3D technologies like WebGL and Blender integration in enhancing digital learning tools in the medical sector to a great extent. The system's clean design and modular architecture also render the system open and scalable for integration with new technologies.

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