Innovative Hospital Exploration and the Evolving Role of Virtual Reality Tours in the Learning Process of Medical Students during Clinical Clerkship

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Abstract. One of the stages in the process of implementing clinical clerkship is the activity of visiting hospital facilities. The medical students are divided into groups and visit various clinical facilities that are available. The process of physical visits requires time and expenses. Additionally, the crowded condition of the clinic facilities often poses a problem when trying to find a suitable visiting time. For this reason, a new method is needed that is efficient and cost-effective, which can facilitate this activity. The purpose of this research is to design a virtual reality-based virtual tour of a hospital. With this technology, students will still be able to experience virtual tours of healthcare facilities that are comparable to or even as good as physical tours. Since it is virtual-based, there will be no issue with visit time as it can be done anytime. This research will utilize the Multimedia Development Life Cycle (MDLC) development model. There are a total of six steps in its development, namely Concept, Design, Material Collection, Assembly, Testing, and Distribution. The hospital's virtual reality tour facility has been constructed effectively after all the stages of the MDLC approach have been completed. The test results indicate that all functional requirements have successfully met expectations. Users can utilize virtual reality headsets for a more immersive experience. The concept of a virtual tour of hospital facilities based on virtual reality has been successfully developed. The presence of virtual tours will facilitate medical education students during their clinical clerkship to observe the available facilities without being limited by time.

Keywords: hospital tour, clinical clerkship, virtual reality

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INTRODUCTION

The implementation of clinical clerkship is a crucial stage in the medical education system. This process is an important moment when aspiring medical students transition from theoretical learning to gaining practical experience [1]. During this transformative journey, there are several components, and one of them involves visiting hospital facilities. This activity is important because it enables medical students to gain a comprehensive understanding of the actual processes involved in healthcare. In the traditional approach to clinical education, students are typically organized into groups and assigned to visit different clinical facilities. These facilities function as the crucibles of medical practice, where students observe the practical application of theoretical knowledge in real-life scenarios. However, the traditional practice of conducting in-person visits is not without its difficulties, which poses a dilemma that requires a thoughtful and subtle approach. First and foremost, the process of conducting physical visits requires a substantial investment of both time and resources. During times of high demand, the hospital clinic services may experience a high volume of activities. Management and students frequently encounter difficulties in coordinating their schedules to align with the operational hours of the clinical facilities. Participating in this time-consuming endeavor not only places an additional burden but also stretches the already limited resources of educational institutions. Moreover, the cost of these in-person visits should not be disregarded. The costs related to transportation, accommodation, and other logistical factors.

Given these challenges, it is evident that there is a clear necessity for a paradigm shift. This shift should involve the adoption of a new approach that surpasses the constraints of conventional clinical clerkship implementation. The request is for a method that is not only efficient but also cost-effective, relieving the burdens placed on both students and educational institutions. The experience during the Covid-19 pandemic, where there were physical contact restrictions, was a valuable lesson that we need to prepare alternative processes with less physical contact [2].

The advancement of information technology enables us to develop technologies that can assist in that matter. The incorporation of contemporary technological tools offers the potential to transform the manner in which medical students interact with clinical facilities. Virtual clinical experiences, which are facilitated through innovative platforms, provide a feasible alternative to in-person visits [3]. This transformative approach utilizes the potential of digital connectivity to bridge the divide between theory and practice, without being limited by time and space constraints.

There are numerous benefits to virtual hospital tours. One of the most significant advantages is found in its inherent flexibility. In contrast to traditional in-person visits, virtual experiences have the advantage of not being bound by operational hours [4]. This means that students can engage with clinical facilities visit whenever it is convenient for them. This flexibility not only empowers students to balance their educational pursuits with other commitments but also addresses the perennial challenge of finding suitable visiting times amidst the chaotic schedules of clinical facilities. Furthermore, the significance of the cost-effectiveness of virtual hospital tours cannot be emphasized enough. The financial barriers that hinder access to practical experiences are eliminated, as students no longer struggle with the economic burdens associated with physical visits. The elimination of travel and accommodation expenses

democratizes access to quality medical education. This ensures that every aspiring medical professional, regardless of their financial background, can benefit from immersive clinical experiences.

In order to address these concerns, a potential solution could be to adopt a hybrid approach that leverages the advantages of both virtual and physical experiences. The thoughtful incorporation of virtual platforms into the current structure of hospital or clinical tours enables students to take advantage of the flexibility and cost-effectiveness of virtual experiences. The advancement of virtual reality technology enables the creation of virtual visits to healthcare facilities. The purpose of this research is to design a virtual reality-based virtual tour of a hospital.

Virtual reality (VR) refers to a technologically simulated experience that utilizes pose tracking and 3D near-eye displays in order to provide users with an immersive sensation of being present within a virtual world. Virtual tours using VR technology have emerged as a new and innovative way to explore and experience remote places and educational institutions. VR technology allows users to create their own customized reality and provides a realistic and immersive experience. It has been applied in various industries such as education, tourism, and hospitality. VR virtual tours have been found to enhance visualization, understanding, and learning quality in students [5]. Kishor et al discusses the concept of using extended reality, specifically virtual reality, to create a virtual tour of a college campus with a voice assistant service based on IoT technology. Leshchuk et al discusses the use of virtual tours in education, specifically using VR technologies. It explores the advantages, disadvantages, and skills that can be developed through virtual tours. It also provides instructions on creating virtual tours using the Panotour Pro program [6].

In other works, Firmansyah et al discusses the use of virtual reality technology for virtual tour training, which aims to promote school media and shape visiting patterns [7]. While Shuta et al presents a Web-based multi-user Virtual Reality system for a virtual tour of remote places, supporting 360-degree images and live 360-degree videos [8]. The exploration of virtual tourism and the potential of virtual reality (VR) to enhance the tourism industry is presented by Polishchuk et al. It mentions the use of VR technologies to immerse people in a virtual environment that recreates touristic destinations and experiences. However, it does not specifically mention the concept of a virtual tour using virtual reality [9]. Ferbangkara et al also explore the usability of the Lampung Heritage Virtual Reality Tour, which is a virtual reality tool for educating about Lampung's historical heritage [10]. The work of Arago et al also show that the development of a virtual tour system using virtual reality technology to offer an immersive user experience of selected tourist spots in Manila [11].

In the field of healthcare, VR tours have recently emerged as an innovative tool in the learning process of medical students during their clinical clerkship (Nguyen et al., 2023). Virtual reality (VR)-based learning modules have demonstrated their efficacy in enhancing pharmacology knowledge among medical students, as evidenced by previous studies [14]. Moreover, these modules have garnered positive feedback from undergraduate medical students. Virtual clerkship curricula in anesthesiology have effectively integrated video-recorded simulation-based scenarios to offer trainees a simulated clinical experience [15]. The paper concluded that the virtual format provides a valuable and informative learning experience. Roni work shows that most undergraduate medical students are receptive to VR as a learning tool [13]. The

COVID-19 pandemic has expedited the implementation of virtual platforms for medical education, encompassing the utilization of virtual reality (VR) technology [16]. The work by Tyastuti et al even advise community medicine clerkship modules need to be redesigned for the COVID-19 pandemic. The work concluded that modifications and variations in learning methods and coordination are necessary [17].

Based on the aforementioned related works, the utilization of virtual reality holds immense promise in revolutionizing the delivery of medical education. This is because it provides a platform for dynamic and adaptive learning experiences. The utilization of virtual induction programs, specifically through the implementation of video tours, has been discovered to significantly improve the confidence and orientation of medical students within hospital settings. The evolving role of virtual reality tours in medical education shows promise, as it offers immersive and experiential learning opportunities for students during their clinical clerkship.

SUBJECT AND METHOD

his research will utilize the Multimedia Development Life Cycle (MDLC) development model depicted in Figure 1 [18], [19]. This method offers a well-organized framework that aims to assist multimedia developers in navigating the intricate process of developing interactive and captivating multimedia content. This type of material may encompass a blend of textual information, visual graphics, auditory elements, video clips, animated sequences, and various other interactive components. The Multimedia Development Life Cycle (MDLC) plays an essential role in ensuring the successful execution of multimedia projects that align with the intended objectives and user expectations.

There are a total of six steps in its development, namely Concept, Design, Material Collection, Assembly, Testing, and Distribution [18]. The Concept phase is the initial stage of the project, where goals and audience are defined. Design involves the creation of a comprehensive project blueprint. The Material Collection is responsible for gathering the necessary assets, such as text, graphics, and media. Assembly incorporates these elements through the utilization of authoring tools and programming. Testing ensures the functionality of a system or product by identifying and addressing any potential issues or problems. Finally, Distribution releases the multimedia project through a variety of channels. These stages collectively serve as a guide for the systematic development, ensuring both quality and effective delivery to the target audience through an iterative process.

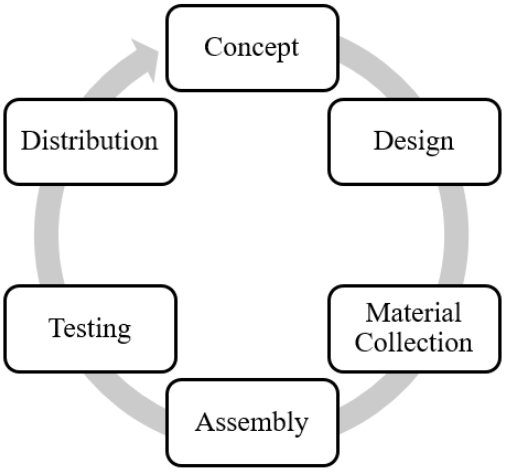

Figure 1: Multimedia Development Life Cycle (MDLC)

RESULT AND DISCUSSION

Concept

In the Concept phase, there is a plan to create a virtual tour media for hospital facilities based on virtual reality. The main objective is to improve medical education through delivering a fully immersive experience for students learning medicine. The target audience comprises of medical students and healthcare professionals who are looking for a thorough understanding of hospital environments. Feasibility is evaluated by taking into account technological requirements, budget limitations, and the potential for collaboration with hospitals. The scope has been defined, which outlines the specific hospital areas that will be included. This ensures that the project remains focused and manageable. Collaborating with stakeholders, such as hospital and university management, medical students and VR developers, ensures that a wide range of perspectives are taken into account. The conceptual framework is of greatest significance as it defines the essential characteristics and interactive components, including 360-degree views, informational overlays, and interactive simulations. The Concept phase plays an essential part in ensuring that the VR project is in line with educational objectives. After discussing with every stakeholder involved, it has been agreed upon that there are two levels of user role for this system, namely administrators and users shown in Table 1.

Table 1: User role and requirement.

Role	Requirement
Administrator	The administrator is able to manage the virtual tour effectively by adding spots, reducing them, and updating the system.
User	Users can view the virtual tour that has been developed.

Design

During the complicated design phase of developing a virtual hospital tour for medical education, a thorough analysis is conducted. This analysis explores various aspects such as visual aesthetics, user interface design, information architecture, navigation strategies, interactive elements, and the alignment of storyboarding with educational objectives. Visual aesthetics serve as a canvas for innovation, as designers properly create an immersive and visually captivating environment that goes beyond simple simulation. Their goal is to elevate medical education to unparalleled levels.

The design of the user interface takes center stage, requiring a seamless blend of functionality and user engagement. The strategic positioning of interactive elements and the development of an intuitive interface are intended to empower users to effortlessly navigate the virtual hospital tour. At the same time, information architecture is carefully organized, ensuring that the flow of medical information is logical and easy to navigate within the virtual realm. Storyboarding serves as a dynamic blueprint, aligning the narrative flow of the virtual tour with educational objectives. The visual roadmap serves as a guide for the progression of the experience. It helps refine the structure and pacing to ensure that each interaction contributes meaningfully to the overarching educational goals. The design phase, in essence, involves a meticulous orchestration of creativity and purpose.

Material Collection

During the Material Collection phase, an image-taking activity is conducted at each predetermined location. A 360-degree image is a photograph with a 2:1 aspect ratio. The length of the X-axis is twice that of the Y-axis, resulting in an equirectangular shape for the photo. It is essentially a 360-degree fully immersive photograph. The capturing of a 360 Equirectangular Image is carried out by team members using a 360 camera depicted in Figure 2. Another camera is also used to capture images that will be used as icons for each location. The results of the graphic that is collected in this phase will be analyzed and stitched in the subsequent phase. The photo shoot is scheduled during non-peak hours at the pre-determined location to ensure optimal photo taking and minimal disruption to the clinic's activities.

Figure 2: 360 Equirectangular panoramic image taking

Assembly

The subsequent stage is Assembly, which involves the connection (stitching) of the collected images to produce a wide panoramic image and its integration into the virtual tour application. The assembly phase for a virtual hospital tour in medical education is a complex process with multiple facets. The process includes integrating multimedia assets, programming interactivity, implementing user controls, fine-tuning visual and audio elements, creating interactive simulations, iteratively refining, and integrating assessment mechanisms. This phase plays an essential role in converting the gathered materials into a unified and engaging educational experience that aligns with the overall objectives of the hospital virtual tour in relation to medical education during clinical clerkship. The sample of original 360 equirectangular image, taken from the 360 camera depicted in Figure 3, was processed as shown in Figure 4.

Figure 3: 360 Equirectangular image

Figure 4: The result of processing a 360 equirectangular image

4.5 Testing

The Phase Testing is conducted to test the virtual tour system that has been created, ensuring that every feature functions as intended. After conducting testing on the created virtual tour system, all navigation menus within the system are functioning properly. According to black-box testing shown in Table 2, all features are working properly. This system can be used as a virtual tour medium for students during clinical clerkship to convey information about existing health facilities. Through this virtual tour system, students can see the health-care facilities that the hospital has, such as clinic rooms, administration areas, laboratories, and other common facilities.

Table 2: Testing scenario and results

No.	Scenario	Expected Results	Result
	Functional Feature		
1	Explore virtual hospital locations.	User visit hospital spot in *Virtual Reality*	Pass
2	Access information regarding virtual hospital facilities.	Information displayed on hospital facilities spot	Pass
3	Choose a virtual hospital location using the location panel..	User teleport to a chosen location.	Pass
	Non Functional		
4	Can make a selection by using the view option, specifically through Gaze Control.	Processed in 1,5 seconds	Pass
5	User may use stereoscopic display	Display in stereoscopic	Pass
6	Place switching can occur instantly. (Teleport)	Teleportation	Pass
7	Can return to the home menu from any screen	Home menu button and functional	Pass
8	Can exit the application	Exit button and functional	Pass

Distribution

Once the virtual tour has been refined and is ready for deployment, the next step is to consider strategies for widespread dissemination. This task entails determining the most efficient channels and platforms for reaching medical students and management. One potential distribution avenue could be online platforms, which would ensure convenient access for students in various locations. The presentation of each location is in the form of a 360-degree panoramic photo depicted in Figure 5.

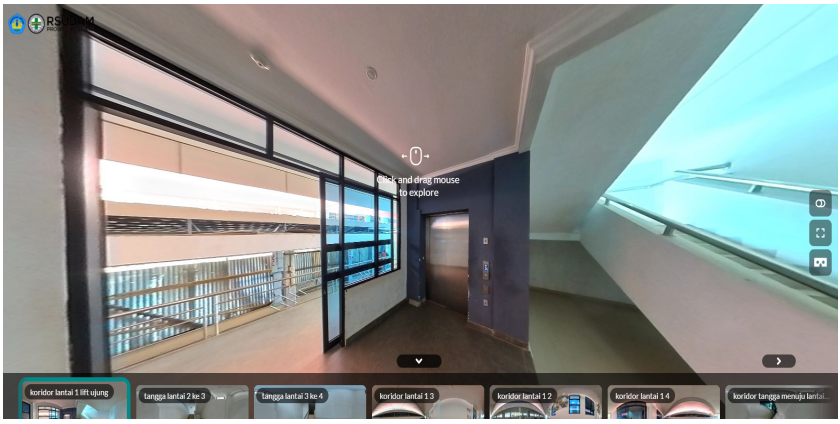

Figure 5. Web-based 360 Hospital Virtual tour

The Distribution phase also takes into account the technical requirements for end-users, ensuring compatibility with a wide range of VR devices. Clear documentation and support mechanisms have been established to assist users in accessing and navigating the virtual hospital tour effortlessly. Figure 6 depicts the final product that was delivered to the medical students, who are the users.

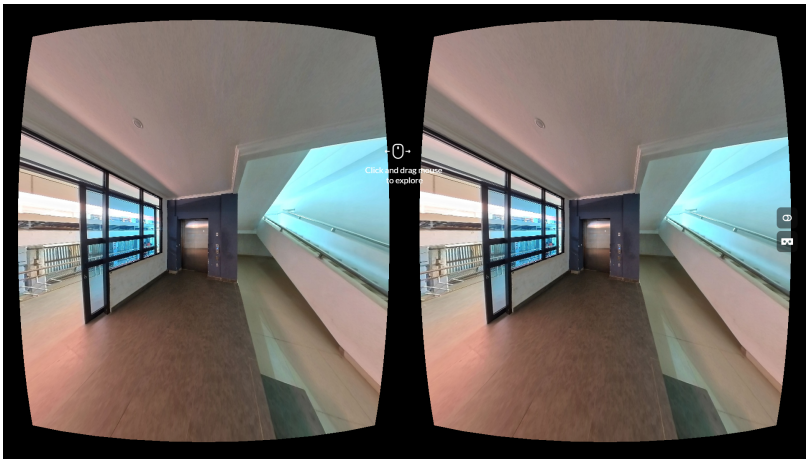

Figure 6. Final product of hospital tour by using VR

CONCLUSIONS

The concept of a virtual tour of hospital facilities based on virtual reality has been successfully developed. According to black-box testing, all features are working properly. The presence of virtual tours will facilitate medical education students during

their clinical clerkship to observe the available facilities without being limited by time. Users can access the virtual tour either through web access on a computer device or by using a VR device.

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