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Implementation of Virtual Reality (VR) Technology in the North Sumatra Museum Virtual Tour to Enhance Visitor Interactivity

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Museums, as cultural preservation institutions, play a strategic role in conveying historical values to the public; however, they face challenges related to access, distance, and the time spent by visitors. The purpose of this research is to create interactive and easily accessible digital media for teaching and promoting the North Sumatra State Museum thru a 360° Virtual Tour. This research uses the Multimedia Development Life Cycle (MDLC) method, which includes the phases of concept, design, material gathering, creation, testing, and distribution. The 3DVista Virtual Tour application is used to develop virtual tours that utilize 360° panoramic photos, videos, audio, and interactive hotspots to visually and informatively convey information about museum collections. The research results show that the virtual tour created can make the space of the North Sumatra State Museum an immersive and interactive experience. The results of system testing using the Black Box Testing method show that all important system features, including inter-room navigation, information hotspots, panorama control, and multimedia display, can operate well and stably. Therefore, this virtual tour is expected to serve as an alternative way to learn history, support cultural preservation, and increase public interest, especially among young people, in the North Sumatra State Museum.
Keywords: : Virtual Tour, Museum Negeri Sumatera Utara, 3DVista, Panorama 360°, MDLC

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1. Introduction

The rapid development of information and communication technology has provided various conveniences in various aspects of life, including in the fields of education, tourism, and cultural preservation. One innovation that has emerged from this technological advancement is the virtual tour, a digitally simulated tour experience that allows users to visit specific places without having to be physically present. One implementation of this technology that is now becoming increasingly popular is the virtual museum tour[1], [2]. Over time, the rapid growth of information technology has led to new technologies that make human activities easier, such as virtual tour or panorama tour technology[3][4], [5]. A virtual tour is a realistic replica of a place, allowing viewers to feel as if they are there simply by looking at a collection of panoramic photos. A panorama, also called panoramic, is an image with a wider field of view than a regular pictur[6].VR technology can be used for many things. One of them is virtual tours, which allow users to see locations in a realistic way thru images and videos, including 360-degree views, making it feel as if they are actually there[7][8]. With virtual reality (VR) and augmented reality (AR) technology, visitors can explore the North Sumatra Museum's collection, read information, and understand history thru immersive visual displays[9][10]. Virtual tours not only expand the museum's audience reach but are also capable of attracting the interest of younger generations who are more familiar with the digital world[11][12].

Museums are important institutions that serve as places for preservation, education, and recreation. However, not all communities have easy access to visit museums in person, whether due to limitations of

distance, cost, or time, which restrict people's mobility[13], [14]. In this context, the North Sumatra Museum Virtual Tour emerges as an alternative solution, offering an educational and informative experience to the wider public thru digital media[15]. The North Sumatra Provincial State Museum was inaugurated on April 19, 1982, by the Minister of Education and Culture, Dr. Daoed Yoesoef. However, the first collection of the State Museum was placed in the form of a makara by Ir. Soekarno, the first President of the Republic of Indonesia, in 1954. On a plot of land spanning 10,468 square meters, this museum is known as the Statue Building. The main building of the museum is shaped like a traditional North Sumatran house. At the front of the roof, there are ornaments originating from the Batak Toba, Simalungun, Karo, Mandailing, Pakpak, and Nias tribes. The State Museum of North Sumatra Province is categorized as a general museum based on its collection[16]. Most of its collection comes from North Sumatra and consists of cultural heritage artifacts from prehistoric times to the Islamic era, classical Hindu-Buddhist periods, and modern struggles[17].

This research resulted in a 360° Virtual Tour website for the North Sumatra Museum, which can be accessed via computer devices or VR headsets[18]. This website enhances user interactivity and provides a new experience in getting to know the collections and history of the North Sumatra Museum[19]. Thus, the application of Virtual Reality technology in this virtual tour will help in cultural preservation, learning media, and serve as a promotional tool for the North Sumatra Museum. This virtual tour will attract more young people to learn more about the North Sumatra State Museum[20].

2. Methods

This research uses the MDLC (Multimedia Development Life Cycle) method. The MDLC (Multimedia Development Life Cycle) method is one of the most commonly used methods in the process of developing interactive multimedia applications because it allows for a systematic, structured, and flexible approach to handling various multimedia elements, such as text, images, audio, video, animation, and other interactive elements, all of which can be integrated into a Virtual Reality (VR)-based application[21], [22]. The MDLC method has six stages as follows: Concept, Design, Material Collecting, Assembly, Testing, and Distribution.

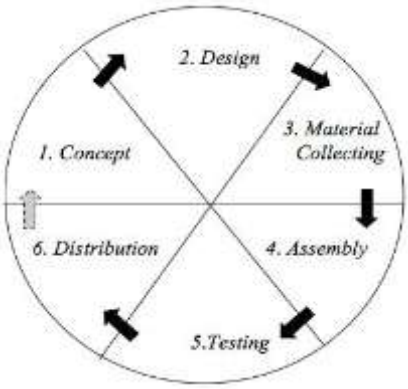

Figure 1: Metode Mulitmedia Development Life Cycle (MDLC)

Here is a brief explanation of each stage of the MDLC that will be used in this study:

1. Concept
   This stage is the beginning of the design process, where the basic concept for the virtual tour of the North Sumatra Museum will be created. This includes initial planning, identifying goals, and the main features that will be included in the virtual tour of the North Sumatra Museum.
2. Design

The design phase begins after the idea is developed. This includes user interface (UI) design, navigation structure, content layout, and the overall plan for the virtual tour of the North Sumatra Museum. The design also includes selecting the technology to be used in development.

3. Material Collecting
   At this stage, gathering the materials to be used in the virtual tour, such as 360 images, videos, descriptions, and information available at the North Sumatra Museum, with all the materials collected forming the basis of the virtual tour content.
4. Assembly
   After the material has been collected, the virtual tour creation phase begins. This involves a special application for creating the virtual tour, using the 3DVista Virtual Tour application. By combining the 360 photos already taken at the North Sumatra State Museum, they are integrated to form the same flow from the entrance to the rooms within the North Sumatra State Museum, by creating panorama points, content integration, and interactive elements such as navigation buttons.
5. Testing
   This stage is when the virtual tour application is thoroughly tested to ensure all created components are functioning correctly. This testing involves verifying the functionality and interactivity of the virtual tour, the quality of the images and videos input into the virtual tour, and the compatibility of the virtual tour across various devices.
6. Distribution
   Once the virtual tour has been tested and meets the desired quality standards, this distribution phase begins, and the virtual tour will be published. The virtual tour application will be promoted to potential users thru web platforms, mobile platforms, or other appropriate methods.

3. Results And Discussion

Design

During this planning phase, a needs analysis, interface design, and the creation of a virtual navigation flow were conducted, allowing users to interactively explore each space. This phase was also used to develop the concept and structure of the virtual tour system that met the needs of the Medan State Museum's users. In the modeling process carried out, Navigation is the structure or flow of a program that functions to help organize all the opening elements of the application. The navigation structure used by the author is a mixed/composite navigation structure.

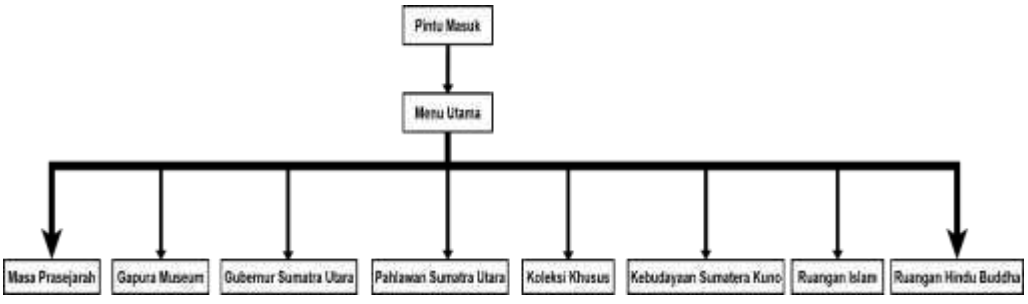

Figure 2: North Sumatra Museum VR Navigation Structure

System Design

In the process of developing a virtual tour, system design is an important stage because it serves as the foundation for building the application's structure, workflow, and interactive elements. In this study, the

system was designed using the 3DVista Virtual Tour application, which offers complete features for creating 360° panorama-based virtual tours, hotspot integration, audio, and other interactive features.

3DVista Virtual Tour is desktop-based software that can be used to design, develop, and publish virtual tours based on 360° images or 360° videos. This application is highly sought after in the fields of digital documentation, museums, tourism, and educational research.

Figure 3: 360° Photo Processing

Figure 3 above shows the processing of 360° photos taken with an Insta360 camera, using the Insta360 Studio application to import the images into a panorama and adjust the width of the panoramic photo. The next application used is 3Dvista. Here, the initial steps involve arranging photos according to the created concept, adding hotspots and navigation to the virtual tour, and incorporating video material to be used in one of the museum rooms.

Figure 4: Process of Creating a 360° Virtual Tour

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Figure 5: Visual Interface Virtual Tour

Figure 5 above shows the interface of the virtual tour. In the upper left and right corners, there are buttons shaped like the "i" logo. When clicked, these buttons display explanations corresponding to the main title at the top. On the left, there are several clickable menus that, when clicked, lead to rooms or panoramic images that match the selected menu. Additionally, there is a navigation button shaped like the "forward" logo, which can be clicked to go to the next room and connect between rooms. There is also a "play video" button in one of the rooms in the virtual tour, which when clicked, will bring up a video pop-up visual between the panoramic photos, as shown in (Figure 6), providing additional information to the user in video format.

Figure 6: Visual Play Video

Table 1. The testing results for this virtual tour system were obtained using Black Box Testing.

No	Fitur	Deskripsi Pengujian	Status Pengujian	Keterangan
1	360° Panoramic View	Testing whether the 360° panoramic view of the museum's front page can be displayed in its entirety and rotated in all directions.	Successful	The panorama appears clear and responsive.
2	Menu Navigasi Sidebar	Testing the side menu functions (Entrance, Prehistoric Period, Museum Gate, etc.) to switch between scenes.	Successful	Each menu directs to the appropriate scene.
3	Information Hotspot (Visitor Information)	Testing the information hotspot displaying museum visit information.	Successful	The information popup appears correctly.
4	Information Hotspot (Brief History)	Testing the hotspot displaying a brief history of the North Sumatra State Museum.	Successful	Information is displayed according to the content.
5	Navigation Shift Icon	Testing the arrow icon to move to another area within a single scene.	Successful	The location move went smoothly.
6	Control Camera Rotation	Testing the user's ability to rotate the panoramic viewpoint.	Successful	The camera can rotate 360° without lag.
7	Fullscreen button	Testing the full-screen function on a virtual tour.	Successful	Fullscreen mode is active and stable.
8	Reset View Button	Testing the function to return the viewpoint to its initial position.	Successful	The camera angle returns to its initial position.
9	Interface Responsiveness	Testing the display on various screen resolutions (PC & laptop).	Successful	The interface adjusts to the screen.
10	Loading Scene	Testing the transition time between scenes.	Successful	The scene transitions with normal loading time.
11	Artifact Information Icon	Testing the "i" icon on objects that display additional information.	Successful	The information appears without errors.
12	System Stability	Testing the system's stability when used continuously.	Successful	No crashes or freezes occurred.

4. Conclusion

The research conducted for the North Sumatra State Museum resulted in the utilization of 360° virtual tour technology to digitize the North Sumatra State Museum, making it part of the museum's promotion, assisting users who cannot visit the North Sumatra State Museum directly, and providing new learning materials and interests for teenagers in this era of digitalization. This website-based virtual tour application development uses the Multimedia Development Life Cycle (MDLC) method. System testing results using the Black Box Testing method show that all main virtual tour features—including inter-room

navigation, information hotspots, viewpoint control, and multimedia element integration—function well and meet user needs. During testing, no significant obstacles were found that would hinder the system's functionality. This virtual tour of the State Museum of Sumatra has been successfully visualized as a 360° virtual tour and can be accessed thru the website.

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