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360-Degree Panoramic Visualization
in Archaeological Documentation:
An Interactive Learning Tool

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Abstract. Tourism is one of the aspects of producing foreign exchange from the non-oil and gas economic sector for tourist attractions. One of them is documenting cultural heritage as a form of archaeological preservation. Therefore, adequate and complete data collection in spatial or three-dimensional (3D) attributes is required to detect artifacts, eco-facts, monuments, or wall reliefs. Therefore, as a form of cultural heritage preservation, a system is needed to document antiquities with 3D (three-dimensional) modeling, using a panoramic photography approach to interactive visualization to provide information about archaeology and as a medium for interactive learning. Create a space to use the virtual panorama to preserve historical sites. This research uses a qualitative research methodology of Design and Create, and the test carried out is black box testing focused on the software's functional needs. The result of this study is an archaeological 3D document application with web-based 360-degree panoramic visualization. The advantage of this system is that it makes information more accessible to the public and becomes an interactive medium for identifying historical objects so that users can experience exploring and appreciating ancient objects in detail from all sides.

Keywords: Archaeology · 3D (Three Dimensional) · Virtual Panoramic · Web · Tourism

1 Introduction

Indonesia has cultural wealth because of the many tribes and cultures that are part of the nation's unity. The wealth can be seen in the archaeological sites that protect 4,444 cultural relics of the past. The sites contain stone tools, bone tools, wood, sculptures, pottery, inscriptions, caves, architecture, and other objects from past human activities [1]. Archaeological sites are an essential component in reconstructing the culture of the past, so a reasonable effort must be made to preserve recorded history. One of them is the documentation of cultural heritage as a form of archaeological relics.

VR is a technology designed to allow users to interact with environments derived from computer simulations in cyberspace, giving users of this technology a sense of being in that environment [2, 3]. Its development in the world of photography offers what is known as VRP (Virtual Reality Photography). VRP is a technology used to take wide-angle photos interactively. The problem for the tourism industry is that the format of presenting information is presented only in text and images and does not touch the field of virtual reality [4]. This technology can be used as a medium to advertise tourist attractions, education, public facilities, etc. This study aims to conduct a literature review and fill in the gaps in the literature review to present information on the website [5].

Conservation means an action to protect against harm or damage, maintain or treat something from interference, destruction, or wear and tear [6]. In addition, conservation, according to archaeology, is an effort to preserve archaeological objects to prevent or overcome the problem of damage or weathering to prolong their life [7].

Efforts to preserve historical objects involve concrete actions to care for artifacts, eco-facts, monuments, and other structures that hold valuable stories of human life in the past [8]. These objects are vulnerable to degradation and deformation due to natural activities such as earthquakes, floods, storms, and weather such as wind and rain. Therefore, preservation efforts involve taking action to protect and improve the condition of these structures and surfaces to prevent their loss over time. Archaeological relics whose condition has been severely damaged cannot be quickly restored. In addition, many archaeological objects are still authentic, so a massive restoration can be done but cannot restore the details that have been lost [9]. So it is necessary to record excellent and complete data in spatial or 3-dimensional attributes for recording an artifact, eco face, monument or wall relief, and others [10].

Recording data in archaeology is essential for comprehensively reconstructing historical objects that offer a glimpse into the human experience of the past. Historical relics, such as artifacts, Eco-facts, and monuments, hold significant cultural and historical value, providing insights into past civilizations. Despite their potential significance, many of these relics receive less attention from the public, as evidenced by a lack of interest in visiting museums.

Referring to the existing conditions, the lack of good recording qualities of archaeological objects and the lack of interest in archaeological objects can be concluded. Therefore, creating a system that can document the 3D modeling of archaeological objects as a form of cultural heritage preservation and become a medium for information and interactive learning about archaeology is necessary [11].

This 3D modeling technology has been applied in archaeological research, such as the reconstruction of artifacts and the virtual reproduction of a historical site. In addition, several materials have been made with the same method, such as stone, bone, to ceramics. However, the existence of a panoramic photography approach for interactive visualization opens up a space for the use of Virtual Panoramic in the preservation of historical sites. The reconstruction of the historical relics using photogrammetry techniques and 3D models is then displayed using 360 Degree Panoramic visualizations [12]. The archaeological documentation system using 360 Degree Panoramic visualization makes it easier for the public to access historical information. So that with the above features,

users can feel the experience of exploration and appreciate an archaeological object in detail from all sides.

Virtual reality photography is an interactive and immersive visual medium commonly used to create panoramas and video objects. A panorama is an image that displays a wide angle of view [13]. Virtual reality photography captures a 360-degree view of the scene, creating a spherical representation that gives users the impression of being physically present in the location photographed. These images can be edited using computer software to create a VR Panorama, which can be viewed using an interactive user interface application. This technology allows users to explore and experience locations and environments in a way that closely resembles reality. The result can be clicked and rotated horizontally or vertically as if the user is given the actual environment. VR Panorama is developing rapidly and has become a popular visual technology because VR Panorama can provide a new experience for users by displaying different points of view in viewing panoramic photos; VR Panorama can give users an interactive state.

A website is a digital platform that connects documents both locally and remotely. The documents on a website are commonly referred to as web pages, and links within these pages allow users to navigate between pages stored on the same server or on servers located worldwide using hypertext [14]. Users utilize web browsers such as Netscape Navigator, Internet Explorer, Mozilla Firefox, and Google Chrome to access and view web pages. PHP is an open-source web server-side programming language. It is integrated into HTML and located on a web server (Scripting). PHP scripts are used to create dynamic web pages [15]. Dynamic means that the page is created when the client requests it, which keeps the information updated at all times. All PHP scripts are executed on the server where they are hosted [16].

This research focused on virtual reality applications. This application is a medium for Archaeological Documentation at the Makassar Archaeological Center. The visualization scope is in the form of artifacts and Eco-facts in the Makassar Archaeological Center. Shooting archaeological objects using photogrammetry and object reconstruction techniques to produce a photorealistic 3-dimensional model. The app uses a panoramic photography approach and image stitching techniques for interactive, web-based visualization. This system provides information to the general public regarding archaeological objects. The web-based system documents archaeological objects using a 360-degree panoramic view displayed horizontally. Shooting using photogrammetry techniques and reconstruction of 3D models of archaeological objects displayed using 360 panoramic visualizations with image stitching techniques server (Server-Side HTML Embedded).

2 Method

The study's author employed a qualitative research method, emphasizing the research subject's meaning and process analysis. Qualitative research utilizes theoretical frameworks to guide the research focus and is often conducted in natural settings to ensure that the findings are grounded in reality. The location chosen for the study was the Makassar Archaeological Center, the primary data collection and analysis site.

This research uses a scientific research approach, which is an approach based on science and technology. The data source used to design and build this system comes
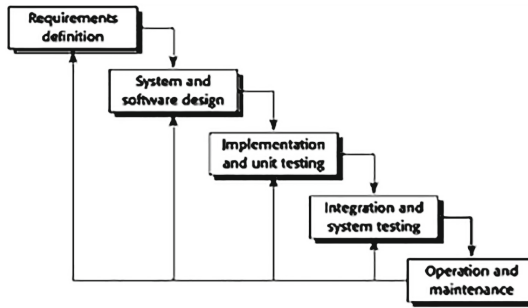
Fig. 1. Waterfall Model

from artifact and eco-fac data owned by researchers from the Makassar Archaeological Center. This research uses literature data sources related to the theory of application creation, where the researcher only takes data sources and references related to the research carried out by the author. Data sources are also obtained from sites that provide information about the author's research object.

Data management analysis is divided into two types, namely quantitative analysis methods and qualitative analysis methods. This quantitative analysis method uses statistical data and numbers that are very fast in obtaining research data. The qualitative analysis method is in the form of several records that use many data as comparison material to obtain accurate data. In this study, the author used a qualitative data collection method by looking directly at the processes and problems within the scope of the area to find problems and interview directly related parties in the environment under study.

The method used for designing the application is the Waterfall model. This model takes a systematic and sequential approach, starting from identifying the system needs and progressing through the stages of analysis, design, coding, testing/verification, and maintenance. It is called the Waterfall model because each stage must wait for the previous stage to be completed before moving forward, and they are executed sequentially. For instance, the design stage cannot begin until the requirement stage has been completed [17, 18]. This approach ensures that each stage is completed thoroughly and properly before moving on to the next stage (Figs. 1, 2, 3, 4, 5 and 6).

3   Results and Discussion

3.1   Panoramic Design

The 360 Makassar Archaeological Center interface is designed using Kolor Panotour Pro 2.5 Software to create several features and connect the panorama. Panoramic design is a technique used to create immersive visual experiences that allow users to view a 360-degree panorama of a location or scene. Kolor Panotour Pro 2.5 software is famous for photographers and designers to create panoramic designs.

Kolor Panotour Pro 2.5, users can create interactive virtual tours and panoramas that can be viewed on desktop computers, mobile devices, and VR headsets. The software offers a wide range of features and tools to help users create high-quality panoramas,

Fig. 2. Panoramic Design

including the ability to import and stitch together multiple images, customize the layout and design of the panorama, and add interactive elements such as hotspots, audio, and video.

One of the key advantages of using Kolor Panotour Pro 2.5 is its user-friendly interface and intuitive design. Users can easily create panoramic designs without programming knowledge or technical skills. The software also provides a range of templates and presets to help users get started quickly and efficiently [19].

Another advantage of Kolor Panotour Pro 2.5 is its compatibility with various devices and platforms. Panoramic designs created with the software can be viewed on desktop and mobile browsers and VR headsets such as Oculus Rift, HTC Vive, and Google Cardboard.

3.2 System Implementation

3.2.1 Interface Home

Interface Home is the initial display of an application or program that aims to give a first impression and a brief introduction to the application to the user. This display contains several elements such as logos, application titles, descriptions, and navigation to other pages in the application.

In the application mentioned in the sentence, the home interface has an additional feature: a button to start a tour at the Makassar archeological center. This feature may provide interactive and educative experiences to users who want to explore the Makassar archeology center. With this virtual tour feature, users can see and learn more about Makassar archeological sites in depth without coming to their physical location.

In addition, this virtual tour feature can also attract users to use the application because these features provide a different added value from similar applications. With this virtual tour feature, it is expected that users will be more interested and comfortable using the application and helping increase the popularity of the application.
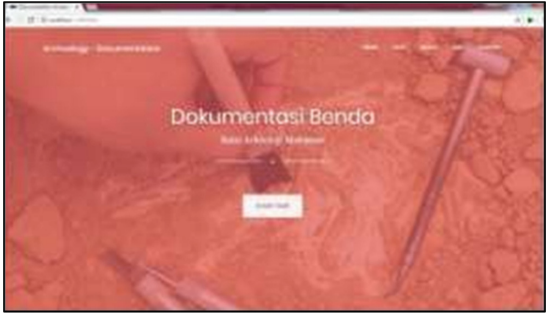
Fig. 3. Interface Home

Fig. 4. Interface Peta

Fig. 5. Interface Virtual Tour

This page contains a map of the Makassar Archaeological Center on the virtual tour map menu.

3.2.2 Interface Virtual Tour

This page contains the initial display of a virtual tour consisting of a panorama of the Makassar archeological center, equipped with a controlling menu, map, information icon, and three-dimensional information about archeological objects.

Panorama seen on this page is usually made with VR technology or 360-degree photo that allows users to see the environment around the Makassar Archeological Center from a different perspective. The controlling menu on this page provides access to essential features such as navigation, zoom, and rotation of views so that users can choose to see particular objects and environments from different perspectives.

The map on this page provides information about the location of archeological objects at the Makassar Archeology Center. Users can click the object on the map to get more information about the object. The information icon on this page provides more detailed information about archeological objects at the Makassar archeological center, such as history, description, and photos.

In addition, this page also provides three-dimensional information about archeological objects. This information can be accessed through the controlling menu or information icon and allows users to see archeological objects from all possible angles, even from a perspective that is difficult to access physically. With this three-dimensional information, users can learn more about archeological objects and understand how the object is related to Makassar's history and culture.

This page has a menu displaying information about archaeological objects in 3D. Virtual reality photography is an interactive visual tool for creating panoramas and video objects. A panorama is an image that presents a wide-angle view of a location. With virtual reality photography, a 360-degree view can be captured, providing a spherical representation of the scene that gives users the impression of actually being in the location photographed. These images can be edited using computer software to create a VR Panorama, which can be viewed using an interactive user interface application.

The result can be clicked and rotated horizontally or vertically as if the user is given the actual environment. VR Panorama is developing rapidly and has become a popular visual technology because VR Panorama can provide a new experience for users by displaying different points of view in viewing panoramic photos; VR Panorama can give
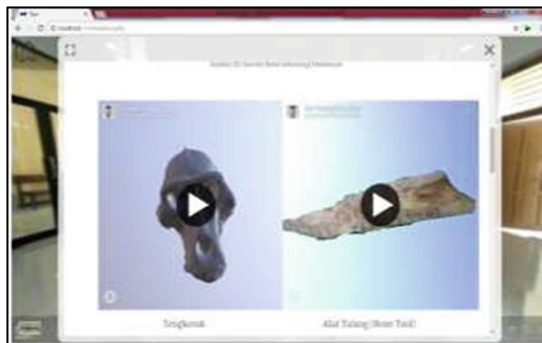

Fig. 6. Object Archeology

users an interactive state. Functional testing of this application aims to ensure that the software created is as expected. Based on the respondents' value, 82% of 20 agreed that this application provides information such as location pictures, archaeological objects, and location plans at the Makassar Archaeological Center.

4   Conclusion

This application can make it easier for the public to access historical information using Virtual Tour technology so that with the above features, users can experience exploring and appreciating an archaeological object in detail from all sides. The application of the photogrammetry method to reconstruct archaeological objects using a 360-degree panoramic visualization displayed horizontally.

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