IMMERSIVE MUSEUM NEGARA ARTIFACT EXPLORATION USING WEARABLE AUGMENTED REALITY TECHNOLOGY (HOLOHERITAGE)

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ABSTRAK

The integration of Augmented Reality (AR) technology into cultural heritage preservation has opened new avenues for immersive and interactive experiences. This study, titled "Immersive Museum Negara Artefact Exploration Using Wearable Augmented Reality Technology (HoloHeritage)" explores the potential of AR to enhance visitor engagement and learning at Museum Negara. By developing a prototype AR application, the research aims to provide users with a dynamic and interactive way to explore historical artefacts, bridging the gap between traditional museum exhibits and modern digital innovation. The research methodology involves the design and implementation of an AR-based platform that overlays digital information, such as 3D models, and historical context, onto physical artefacts. User testing is conducted to evaluate the effectiveness of the application in improving visitor understanding and engagement. Preliminary results indicate that AR technology significantly enhances the museum experience by making historical artefacts more accessible and engaging, particularly for younger audiences. In conclusion, this study demonstrates the transformative potential of AR technology in the realm of cultural heritage preservation. The HoloHeritage project not only enriches the visitor experience but also serves as a model for future applications of AR in museums worldwide. By leveraging AR, museums can create more immersive and educational environments, ensuring that cultural heritage remains relevant and accessible in the digital age.

ABSTRAK

Penyepaduan teknologi Augmented Reality (AR) ke dalam pemeliharaan warisan budaya telah membuka jalan baharu untuk pengalaman yang mendalam dan interaktif. Kajian ini, bertajuk "Penerokaan Artifak Muzium Negara Imersif Menggunakan Teknologi Realiti Diperkukuh (HoloHeritage)," meneroka potensi AR untuk meningkatkan penglibatan dan pembelajaran pelawat di Muzium Negara. Dengan membangunkan aplikasi AR prototaip, penyelidikan bertujuan untuk menyediakan pengguna dengan cara yang dinamik dan interaktif untuk meneroka artifak sejarah, merapatkan jurang antara pameran muzium tradisional dan inovasi digital moden. Metodologi penyelidikan melibatkan reka bentuk dan pelaksanaan platform berasaskan AR yang menindih maklumat digital, seperti model 3D dan konteks sejarah, pada artifak fizikal. Ujian pengguna dijalankan untuk menilai keberkesanan aplikasi dalam meningkatkan pemahaman dan penglibatan pelawat. Keputusan awal menunjukkan bahawa teknologi AR meningkatkan pengalaman muzium dengan ketara dengan menjadikan artifak sejarah lebih mudah diakses dan menarik, terutamanya untuk khalayak yang lebih muda. Kesimpulannya, kajian ini menunjukkan potensi transformatif teknologi AR dalam bidang pemeliharaan warisan budaya. Projek HoloHeritage bukan sahaja memperkaya pengalaman pelawat tetapi juga berfungsi sebagai model untuk aplikasi AR pada masa hadapan di muzium di seluruh dunia. Dengan memanfaatkan AR, muzium boleh mencipta persekitaran yang lebih mengasyikkan dan pendidikan, memastikan warisan budaya kekal relevan dan boleh diakses dalam era digital.

1.0 INTRODUCTION

In 2021, global augmented reality (AR) has the highest number of active users in the past four years, with more than 110 million active users, a year-on-year increase of 34% in 2020. In 2023, the last active user usage of augmented reality (AR) technology reached approximately 140 million users, a year-on-year increase of 27% from 2022. It is expected that global usage will reach 173 million users in 2024, a year-on-year increase of 23.6%, which will reach a new historical high and continue to rising (Mark、Adrian Clark、Gun Lee. (2015/3/30).

As of 2023, the use of augmented reality (AR) in games, home design, educational tools, tourism industry, and learning experience has increased significantly. Among them, the most widely used group of people is the development of the tourism industry. The number of global AR users will reach 173 million. About 37% of them will use AR technology while traveling.

Augmented reality (AR) technology has been integrated into our lives unconsciously, such as virtual tours of national parks and attractions (AR application of Yosemite National Park), AR navigation of tourist cities (Citymapper application), etc. It is expected that by 2024 In 2023, the scale of AR in the urban tourism market will grow from approximately US$15.52 billion to US$21.44 billion in 2023, with a compound annual growth rate (CAGR) of 38.1%.

Tim Cook (CEO of Apple) believes that "augmented reality is a big idea, just like smartphones. It will become technology accessible to everyone and almost become a part of people's daily lives." He predicts that in the future A large portion of the population will experience AR every day, just like eating three meals a day.

I think the development of augmented reality (AR) is very necessary. It is not only an important part of future technology, but also can significantly improve the user's interactive experience through the integration of digital information and the real world, driving economic and related industries. Development has significantly improved.

This software is an augmented reality (AR) cultural relic exploration experience software for the National Museum of Malaysia. I think if today's software can attract users, enhance the development of the National Museum of Malaysia, and drive people's love for Malaysia's ancient cultural relics, then this will be an excellent software.

2.0 LITERATURE REVIEW

As augmented reality (AR) technology matures, more and more AR is being applied to education and culture（Azuma 2024）, among which the emergence of markerless AR provides users with a newer and more comprehensive way of experience. This is particularly prominent in the introduction of AR technology in the exploration of cultural relics in museums, because the emergence of AR can break the limitations of time and space, directly superimpose the history, background information and 3D models of cultural relics on the real environment, and create a more immersive experience for visitors. This not only makes the museum content

more vivid, but also helps the audience to understand the background and cultural value of historical relics more deeply. In addition, through this more interactive display method, it can attract more attention from young groups and promote the dissemination and inheritance of cultural heritage.

In this section, we will discuss what augmented reality (AR) technology is, what is markerless AR technology in AR technology, and the application of markerless AR technology, and show the implementation and application of AR technology in modern museums. This chapter also lists three contemporary mainstream AR technology APP software, and compares the differences between the three contemporary mainstream software and their functions.

Augmented reality is a technology that superimposes digital information (such as images, videos, sounds, text, etc.) onto the real world, allowing users to perceive virtual content and the real world simultaneously in their real environment.（Arindam Dey &Mark Billinghurst 2024） AR technology uses computer vision, sensors, and positioning technology to identify the user's environment, and then projects the computer-generated content into the user's field of view, thereby enhancing their understanding of the real world.

Markerless AR is a technology in the field of augmented reality (AR) that does not rely on physical markers (such as QR codes, specific images) to locate and present virtual content. It mainly relies on the device's sensors, cameras, and computer vision technology to identify the surrounding environment and accurately superimpose virtual objects on the real world. Markerless AR is more flexible because it does not require the assistance of specific markers and can be used in open spaces, indoor and outdoor environments, so the application scenarios are more extensive（Hassan & Ismail 2024）.

Museum Augmented Reality (AR) is an innovative way to apply augmented reality technology to museum scenes, providing visitors with a more immersive visiting experience through the fusion of virtual and real. It uses smartphones, tablets or dedicated AR devices to superimpose digital information on physical exhibits or spaces, thereby enriching traditional exhibition content（Dünser & Billinghurst 2024).

3.0 METHODOLOGY

The mobile application uses the analysis, design, development, implementation, and evaluation (AD DIE) model, which can be applied in various teaching environments, especially for the learning design and development scenarios of multimedia programming majors. It can provide a structured framework to facilitate the development of augmented reality mobile applications.

Analysis: Understand specific requirements.
Design: Draw the application structure, user interface, and interactive elements. Given that AR applications require intuitive design, special attention should be paid to visual layout, user interaction processes, and virtual object design in real environments.
Development: Build actual AR applications, focusing on creating 3D, encoding interactive

elements, and ensuring compatibility with mobile devices.
Implementation: Test the application in an actual educational environment.
Assessment: Collect feedback from students and educators to improve the application.

The development of the HOLOHERITAGE system using C Sharp involved several structured phases, from requirements analysis to deployment and testing. This helped identify core functional requirements, such as the interactive features in the system, and the question-answering features of the Quiz in the system.

After clarifying the system functions, a detailed requirements specification was developed. The specification outlines the functional features such as support for multiple interaction modes, triggering interactions by clicking on objects, integrating voice, animation, video, answering mode, etc., and covers non-functional requirements such as cross-device compatibility.

4.0 RESULTS

The test implementation follows a series of specific steps. First, a test environment consistent with the production environment is established to ensure the accuracy and reliability of the test. Then, functional, integration, and system-level tests are performed according to the detailed test cases listed in the test plan. Before the test execution, various test data are prepared to simulate various real user scenarios.

Throughout the testing phase, a series of advanced testing tools and frameworks are used. Each test step and its results, as well as any defects found, will be recorded in detail. Ensure that the problems found are solved in a timely manner, and regression testing is performed to ensure that the solved problems will not occur again. Subsequently, the test results will be deeply analyzed and summarized to evaluate the overall quality and stability of the system.

The user usability test invited 12 subjects to experience the system. More than 90% of them said that the operation was simple and intuitive, the content was rich, and the interactive questions were interesting.

5.0 CONCLUSION

The conclusion chapter serves as a comprehensive wrap-up of the HoloHeritage project, which aimed to explore the integration of wearable augmented reality (AR) technology in enhancing the exploration of artifacts at Museum Negara. By reflecting on the research objectives, methodology, and outcomes, this chapter synthesizes the key findings, evaluates the project's achievements, and identifies areas for future development. It also contextualizes the project within the broader landscape of AR applications in cultural heritage preservation, highlighting its significance and potential impact on museum experiences.

The HoloHeritage project aims to enhance the visitor experience of the National Museum through wearable augmented reality (AR) technology. Based on the AD DIE model, an AR

application prototype was developed to achieve dynamic interactive exploration of cultural relics. The project first analyzed user needs and existing AR applications, and found that traditional museums were insufficient in interactivity and historical context presentation.

The HoloHeritage project has many advantages. It innovatively integrates markerless augmented reality (AR) technology. With the help of technologies such as simultaneous positioning and map construction, plane detection and depth sensing, virtual content is accurately superimposed on physical cultural relics without the need for specific visual markers such as QR codes, which improves the naturalness and flexibility of the user experience and enhances the sense of immersion.

Future improvements include expanding the range of artifacts covered to provide a more comprehensive experience and adding multi-language support for different levels of visitors. Optimizing augmented reality performance (reducing loading time, improving gesture accuracy) and integrating artificial intelligence to provide personalized content will increase engagement.

6.0 REFERENCES

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