Augmented Reality Mobile Application: A New Media of Thai Buddhist Temple History Learning

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Abstract

Augmented Reality (AR) is defined as an imaginal technology that integrates virtual technology into its surroundings. Today, very few mobile applications provided information either on religious tourism destinations or tourist attractions in Thailand. Hence, it is crucial to develop a digital medium to ease concerns. A collection of different multimedia content forms; images, 3D, text, video, and audio, will display information on an AR application for Pong Sanuk Temple. Five items of content analysis and three items of application performance assessment evaluated by expertise are more than 4.5 scores. Thirty visitors contributed 4.56 ± 0.50 scores of user experience analysis. As the results, the developed AR application for Pong Sanuk Temple is to be used as the medium for cultural heritage preservation as well as to be an innovative idea that provides an immersive experience to visitors, allowing them to learn more about the Thai Buddhist Temple's culture and history.

Keywords: augmented reality, mobile application, digital learning media, temple history learning, Unity 3D

1. Introduction

Buddhism is one of the world major religions. Buddhist temples are generally used as the center of religious practices and other community activities. The main features of Thai Buddhist temples are "Ubosot" (ordination hall), "Vihara", "Chedi", "Stupa", Buddha images, "Sala" (sermon hall), and "Kuti" (a sleeping quarter of monks and novices). Statistically, there are 41,340 Buddhist temples across Thailand (Division, 2018). Nowadays, Buddhist temples have been carrying the role of religious tourism because of primarily located in urban areas. Moreover, they possess the distinctive beauty of art and architecture and they have become the heart of Thai culture which reflecting of the evolved civilizations of the country. Buddhist temples in Thailand are internationally appreciated in various aspects, namely the cultural heritage preservation, the spread of Buddhism as well as architecture (Klinchan, Suyajai, & Deethaisong, 2009).

Pong Sanuk temple or Wat Pong Sanuk, has strictly preserved its art and cultural heritage and received the Asia-Pacific Heritage Award for Cultural Heritage Conservation (Award of Merit) from UNESCO in 2008. Thais and the local community of Pong Sanuk can take appreciation and pride in protecting and preserving the distinctive local cultural heritage (Boonyasurat, 2015; UNESCO, 2008). The cultural heritage of Wat Pong Sanuk has been well preserved by academics, students, local authorities, monks, photographers, devotees, and the local community of Pong Sanuk (Jeena & Khutrakun, 2018). From an interview with a deputy-abbot of Wat Pong Sanuk Nuea - Phra Noi Naruttamo, Wat Pong Sanuk is a significant temple with a long history in Lampang, Thailand (Naruttamo, 2019). Therefore, it was selected to be a community knowledge center and it was established a museum of Wat Pong Sanuk by Lampang Provincial Office. Consequently, academics and students from nearby cities as well as local and international tourists, continuously visited the community knowledge center and the museum of Wat Pong Sanuk to educate themselves. Engaging educational activities are being organized at Wat Pong Sanuk. Promotional materials such as brochures, posters, websites, and QR codes have been developed to promote tourism attractions. Those available sources only provide brief information on Buddhist temples; history, travel information, inquiries, but an in-depth knowledge of artifacts or architecture is not available, causing such difficulties.

For the large areas and the five important buildings of the temple (shown in Figure 1.) are hardly covered by the

local guides, tourists might not be able to fully experience all the main temple attractions. There are not enough materials for tourists to self-explore the temple attractions or to learn all local cultural heritage knowledge. Moreover, some local heritage objects are delicate and sacred. They cannot be put on display to protect them from damage. Some will only be on display on a rare occasion. According to those limitations, the virtual reality technique seems to be the best solution for cultural preservations. Shih et al., (2020) revealed that the application of AR enabled situated learning of 68 objects of Lukang which is a small town and rich of historical memories and heritages located in central Taiwan. The developed AR application would allow students and tourists, with smartphones, to learn all the relevant knowledge through images, video, audio, 3D to resolve all these challenges (Puji Utami & Lutfi, 2019; Somdee, 2022; Jomsri, 2019). The AR application can also be used as a local cultural heritage database as well as a digital medium to promote tourism in Thailand (Kyriakou & Hermon, 2019).
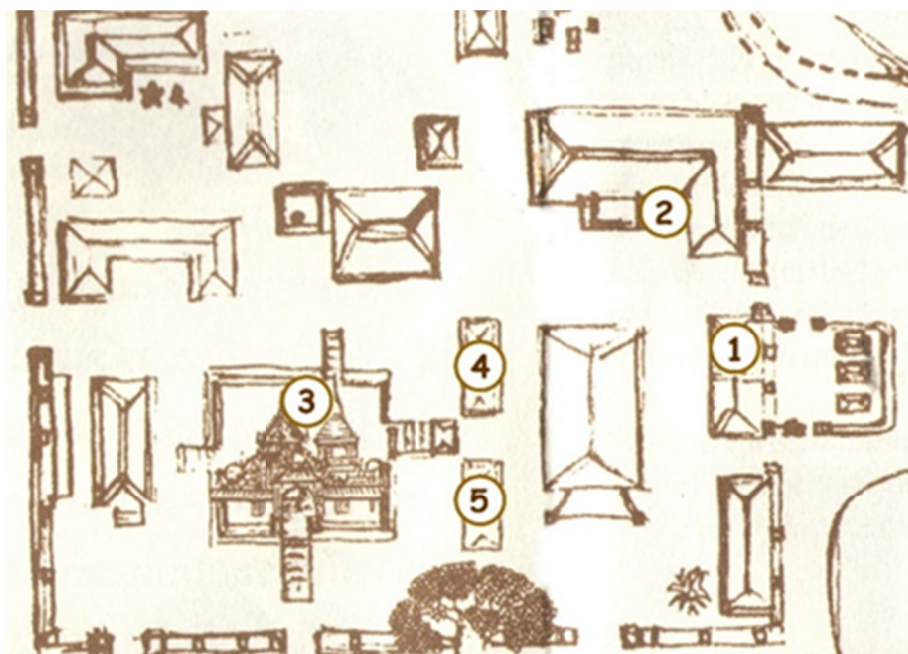

Figure 1. Wat Pong Sanuk map

A virtual museum is considered an online exhibition designed to draw attention from the audience. Multimedia is created by integrating advanced technology, communication, and the Internet. The 3D images, video technology and AR technology are enabling the audience to view video clips and listen to audio guides. It also allows the audience to experience 'as if they are' - the feeling of being there and save on time and travel costs. Related research and studies are briefly discussed as follows: Darmawiguna, Antara Kesiman, & Crisnapati, 2014 has the development of AR Book application for documenting the cultural heritage of indigenous building structures of Bali. Waruwu, Bayupati, & Darma Putra, 2015 has created the application Dewata AR that can show 3-dimensional objects, video, and audio information of the temples. The application works by scanning the brochure of tourism objects by using an Android smartphone or tablet. Then it can display 3-dimensional objects, video, and audio information about those tourism objects. Chiu, Wei, Lee, & Lu, 2019 studied the design and production of mobile device-based materials for cultural heritage tourism and tourist learning outcomes. A mobile application was adopted to help volunteer tour guides-in-training, and visitors better understand the connotations and knowledge associated with the culture of Dalongdong, Taipei, Taiwan. Gutierrez et al. (2015) resented augmented reality can be used to better educate tourists and visitors. Pendit, Zaibon, & Abu Bakar, 2014 presented the design and development of the mobile application for helping visitors to conduct enjoyable informal learning at the cultural heritage site of of Prambanan Temple Complex, Yogyakarta of Indonesia.

AR refers to technology that augments the real world with virtual components. Instead of replacing this technology superimposes a virtual object onto the physical world by integrating camera object recognition technology with computer programs. When the camera captures the pre-existing image, the corresponding virtual object appears on the screen reality (Sanglub et al., 2019; Tezer et al., 2019). As the computing power of portable electronic products advances, the application of AR technology will also continuously expand with their increasing computing power,

smartphones which can perform many graphic computing tasks (Madden, 2011). Smartphones are now even capable of deciding which information to add to the real-world environment. Cloud servers, which comprise a combination of powerful computers, also play an indispensable role in developing AR. The AR technology allows the user interface to perform more diverse operations while integrating the functionality of mobile devices' built-in cameras into the user interface (Aslan, Çetin, & Özbilgin, 2019). This helps information absorption move beyond the limitations of human senses and shortens the distance between the virtual and real world.

AR-Book combines a regular book with AR technology (Billinghurst et al., 2001). The AR-Book has two main components; firstly, the book that comes with the marker on almost every page, and secondly, the equipment to capture the marker and display the results. The AR-Book is included in the category of specially designed learning resources because it was developed as a component to facilitate users to understand the content of the book by displaying a three-dimensional object as a two-dimensional image which is printed in the book. An AR-Book can also be regarded as media because it is printed material that can display information as shown in Figure 2.
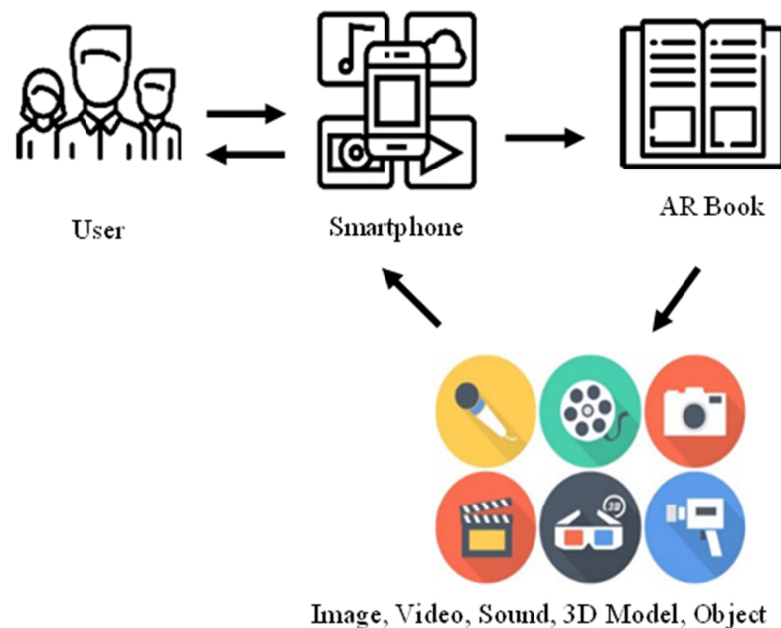

Figure 2. Interaction diagram between AR application, AR-Book, and user

2. Research Purposes

1) To study components of Augmented Reality (AR) innovation for tourism promoting Wat Pong Sanuk in Lampang province, Thailand.

2) To develop the Augmented Reality (AR) innovation for tourism promoting Wat Pong Sanuk in Lampang province, Thailand.

3) To evaluate visitors experience of using the Augmented Reality (AR) innovation for tourism promoting Wat Pong Sanuk in Lampang province, Thailand.

3. Research Methodology

The AR application was developed for visitors who were interested in the history of Pong SaNuk Temple. This new media needs to be designed to gain high user satisfaction scores. Nine step framework of AR application was applied (Figure 3). Multimedia content analysis and application performance analysis were evaluated by expertises. Thirty visitors of Pong SaNuk Temple were the target group of this study. Users' experiences were measured in ten items with five hedonic scales.

3.1 Framework of Wat Pong Sanuk AR application

The 9-step framework of Wat Pong Sanuk AR application is listed in Figure 3.
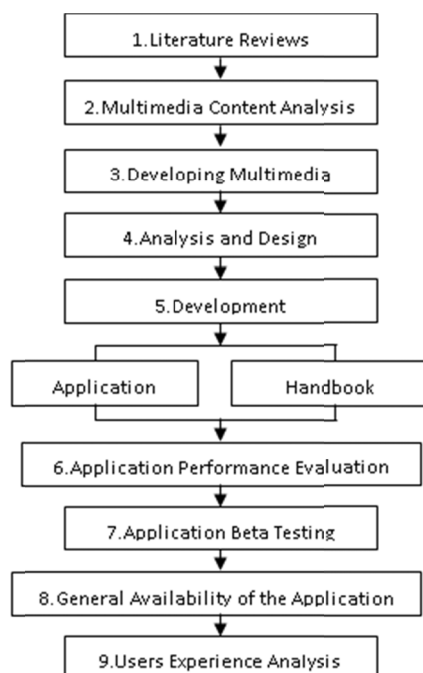
Figure 3. The 9-step framework of the AR application

Step 1. Literature Reviews

Relevant research, journals, and related studies were reviewed to shape the development of the AR application.

Step 2. Multimedia Content Analysis

Content selection was completed by the stakeholders. The selected multimedia content was the community learning center, the ancient wooden monastic cell, the "Viharn Phra Chao Phan Ong", the cultural heritage learning pavilion, and the "Dham" chests building.

Step 3. Developing a Multimedia Application Model

Images, text, video, audio were all featured in the model.

Step 4. Evaluation and Design

The multimedia content analysis was conducted. The AR application user interface was designed by Wireframe and Storyboard.

Step 5. Development

The AR application is developed with Unity and is available for Android devices.

Step 6. Application performance evaluation

The AR application was evaluated by experts for suggestions for further improvement.

Step 7. Application Beta testing

The AR application was evaluated by the stakeholders for comments.

Step 8. General Availability of the Application

The AR application was released on Google Play Store and was promoted through online social media channels along with the AR application handbook.

Step 9. Users Experience Analysis

The AR application was evaluated by tourists through the User Experience Survey Form.

3.2 Developmental System

Unity, Vuforia Studio, Blender, and Adobe were used to develop applications. The images of crucial elements of Wat Pong Sanuk were taken in order to develop an application. Examples of developmental processes are shown in

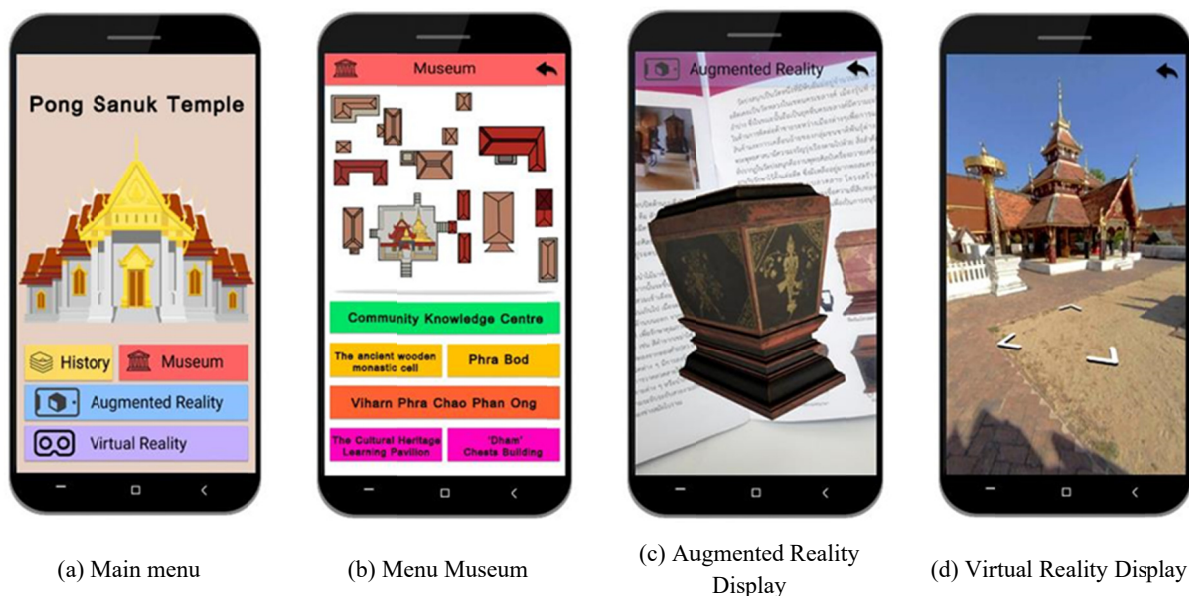Figure 4 to Figure 6.

Figure 4. Images of 3D Models

(a) Main menu | (b) Menu Museum | (c) Augmented Reality Display | (d) Virtual Reality Display

Figure 5. Examples of application interface

Figure 6. Examples of an application handbook

3.3 Multimedia Content Analysis and Application Performance Assessment

Multimedia content analysis consists of 5 items such as 1) the community knowledge centre including Phra Bod Portrait Painting and Pong Sanuk Community History, 2) the ancient wooden monastic cell, 3) the Viharn Phra Chao Phan Ong, 4) the Cultural Heritage Learning Pavillion, and 5) 'Dham' Chests Building have been evaluated in terms of image, text, video, audio, and 3D by three assessment expertise.

3.4 AR Application Performance Assessment

Three expert evaluators have evaluated content, multimedia, and application usage of Wat Pong Sanuk AR application via providing assessment scores in 5 point hedonic scales. Assessment data was anlased and presented in term of an average score and standard deviation of each item. The meaning of each average score is as follows.

> 1.00-1.50 means application performance need improvement.
>
> 1.51-2.50 means application performance was passable.
>
> 2.51-3.50 means application performance was moderate.
>
> 3.51-4.50 means application performance was good.
>
> 4.51-5.00 means application performance was exceptional.

3.5 Selecting Participants and Sample Sizes

Wat Pong Sanuk visitors were research participants in total 30 persons. Selecting criteria were 1) having the android mobile phone and 2) fluency in Thai or English language. They needed to provide their experience scores for this AR application using 5 point hedonic scales. Users experience data was analyzed and presented in term of an average score and standard deviation of each item. The meaning of each average score is as follows.

> 1.00-1.50 means less satisfaction.
>
> 1.51-2.50 means acceptable satisfaction.
>
> 2.51-3.50 means moderate satisfaction.
>
> 3.51-4.50 means very good satisfaction.
>
> 4.51-5.00 means outstanding satisfaction.

4. Results

4.1 Wat Pong Sanuk AR Applications Assessment

Relevant research, journals, and related studies were reviewed to shape the development of the AR application.

The community learning center, the ancient wooden monastic cell, the "Viharn Phra Chao Phan Ong", the cultural heritage learning pavilion, and the "Dham" chests building have been selected for developing a multimedia application model. Four types of media were featured in the modle such as images, text, video, and audio. After that, the multimedia content analysis was applied in five items and the results of this analysis were shown in Table 1.

Table 1. Multimedia content analysis

NO	Building/Content	Image	Text	Video	Audio	3D
	The Community Knowledge Centre					
1	Phra Bod Portrait Painting	✓	✓	-	✓	✓
	Pong Sanuk Community History	✓	✓	-	-	-
2	The ancient wooden monastic cell	✓	✓	-	✓	✓
3	The Viharn Phra Chao Phan Ong	✓	✓	✓	✓	✓
4	The Cultural Heritage Learning Pavilion	✓	✓	-	✓	✓
5	'Dham' Chests Building	✓	✓	-	✓	✓

Remark: √ means selected media and – means non-selected.

A wireframe and storyboard were used for Wat Pong Sanuk AR application which was developed with Unity. This AR application was available for Android devices. Application performance assessment was evaluated by expertise. The results reveal that content, multimedia, and application usage were exceptional at the average scores 4.62, 4.60, and 4.54, respectively (Table 2) (Fenu & Pittarellob, 2018).

Table 2. Application performance assessment

No	Assessment Item	$\bar{X}$	SD	Meaning
1	Content	4.60	0.49	Exceptional
2	Multimedia	4.62	0.49	Exceptional
3	Application Usage	4.54	0.50	Exceptional
	Total	4.59	0.49	Exceptional

4.2 Visitors Experience Analysis

The users' experience analysis results from using the AR application were feedbacked by the tourists. The overall average of all assessment items achieved an outstanding rating of 4.56. High-quality 3D Graphics achieved the highest overall average at 4.77 followed by AR application Handbook achieved an overall average of 4.70. The application menu achieved an overall average of 4.67 as shown in Table 3.

Table 3. Users experience analysis

No	Assessment Item	$\bar{X}$	SD	Meaning
1	User Interface Design	4.63	0.49	Outstanding
2	Application Menu	4.67	0.48	Outstanding
3	Learnability	4.60	0.50	Outstanding
4	Graphical Communication Accuracy	4.43	0.50	Very Good
5	High-quality 3D Graphics	4.77	0.43	Outstanding
6	Text	4.47	0.51	Very Good
7	Audio	4.40	0.50	Very Good
8	AR application Handbook	4.70	0.47	Outstanding
9	App Accessibility	4.37	0.49	Very Good
10	Application Usefulness	4.53	0.51	Outstanding
	Overall Average	4.56	0.50	Outstanding

5. Discussion

The development of an Augmented Reality mobile application can be used to explore the temple grounds and interact with virtual items, providing a more engaging and exciting visit. The application can be used to highlight the temple's architecture and bring to life its stories and legends. It can also be used to teach visitors about the temple's rituals and culture. The development of such an application does present some limitations, including the cost of development and the availability of data for the application. Additionally, the technology is often seen as intrusive and could disrupt the peaceful atmosphere of the temple. Despite these limitations, the application could be an invaluable tool for educating and engaging visitors. The future scope for an Augmented Reality mobile application for a Thai Buddhist temple is potentially vast. It could be used to create an interactive experience of the temple grounds, allowing visitors to explore and learn more about the culture and history. However, high scores of learnability depend on the well-designed system development of AR applications. Phithak & Kamollimsakul (2020) presented the Korat historical explorer via AR application using the same systematic development as to this studied. The results revealed that using AR technology to display 3D images can encourage more tourists to travel to Korat and 35 tourists evaluated the system usability with a high satisfaction and learnability.

The well-developed Augmented Reality mobile applications are transforming the way we experience cultural treasures. By using these applications, viewers can now explore and interact with Thai Buddhist temples in a completely different way than ever before. Using a mobile AR application, viewers can virtually explore the temple grounds and their features. Through this application, they can gain an in-depth understanding of the temple's history and culture, as well as its traditional and spiritual significance (Jomsri, 2019; Shih et al., 2020). Interestingly, Wat Pong Sanuk AR application allows viewers to virtually experience different parts of the temple that normally cannot be reached by visitors such as 'Dham' Chest Building. This allows viewers to gain a more complete understanding of the temple and its significance in Thai culture and to create the experience as immersive as possible; the application is designed to provide visuals of the temple and its features in a realistic manner. Furthermore, the application can provide viewers with additional information about the temple and its history, including audio and visual tours. Although the current technology offers a lot of potential, there are some limitations. For example, the application is only available on certain devices, which can limit its reach (Phithak & Kamollimsakul, 2020; Puji Utami & Lutfi, 2019).

An AR mobile application for Thai Buddhist temples can be used to stir interest in the religion, help gain access to religious information, and provide a more immersive experience for visitors. With the help of this technology, visitors can experience things like virtual tours of temples, and gain insight into the history and beliefs of Buddhism. The application can also be used to provide access to religious texts, prayers, and more. The limitations of this technology are the cost of developing the application, security issues, and the need for a strong internet connection. However, the potential benefits far outweigh these limitations. With the help of an AR mobile application, people from all over the world can gain access to Buddhist teachings and develop a deeper understanding of the religion.

In today's digital era, the development of AR mobile application for Thai Buddhist temples has immense potential to benefit students and young people. AR technology has the potential to transform the way youth interact with their physical environment, enabling them to create and develop their own virtual experiences (Nishant, 2020). For example, by creating an AR mobile application for Thai Buddhist temples, students and young people can access and explore interactive digital content, including 3D models, audio and video recordings, and educational resources about the temple, its history, and its symbolism. AR mobile applications can also help to bridge the gap between the physical and the digital world. For example, the application could be used to help create a virtual tour of the temple, allowing students and young people to explore the temple environment in an immersive and interactive way. Additionally, the application could be used to display interactive information about the temple's history and symbolism, enabling students and young people to gain a deeper understanding of the temple in a way that is both engaging and educational.

This research aimed to develop an AR application for Pong Sanuk Temple, Lampang, Thailand, by integrating virtual reality and image processing technology and virtual reality for image processing. The AR application has been used, and the results are as follows:

1) The AR application is always available for everyone with no usage limitations.

2) The AR application has transformed distinctive local cultural heritage into a digital format.

3) AR application users gain knowledge regarding local artifacts, local archaeological sites, and distinctive local cultural heritage of Pong Sanuk Temple community.

4) The AR application helps community participation in maintaining and preserving their own identity and cultural heritage.

5) The AR application helps raise awareness in the local community to sustainable tourism development.

6) The AR application is served as a medium to promote Thailand as a tourist destination.

7) Both private and public sectors will benefit from the AR application as knowledge regarding local artifacts, local archaeological sites, and distinctive local cultural heritage of the Pong Sanuk Temple community in digital format is readyor further research.

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