The Effect of the Smart Navigation System Based on Augmented Reality

Kunyanuth Kularbphettong, Ausanee Singkoo, Phanu Waraporn

Abstract: *Currently, virtual technology is applied to everyday life. AR (Augmented Reality) has widely become a challenger technology that brings virtual 3D images into the real world through a camera. Augmented Reality is a technology that brings virtual images that is a 3D model simulated into the real world through cameras and processing that brings objects to overlap into one image and AR can help people to understand the content easily. Hence, in increasing the efficiency of services and publicizing various information, this paper presents the smart navigation system using augmented reality based on a smartphone in the case study of Benjakitti Park, Thailand. The application can navigate users to the POI destination and the system based on mobile devices is composed of two parts: the navigation application and the bone collector game. This project produced user satisfaction at a good level and the proposed application was able to support the significant information for navigation in aspects of performance, usability, and effectiveness.*

Keywords : *navigation system, augmented reality, smartphone, location-based.*

I. INTRODUCTION

Augmented Reality technology (AR) is a virtual world designed to enhance user experience. Nowadays, AR is used in our daily lives whether playing games, learning the lessons or applying in social media applications like Instagram, Facebook and etc. Pokemon Go is a big phenomenon for gamers around the world that allows players to find and catch Pokémon around nearby [1]. The principle working of Augmented Reality technology is coordinated with many hardware parts such as camera, compass, GPS and accelerometer and there can be categorized to be 3 types which are Marker-based AR, Marker-less AR, and Location-based AR. Augmented Reality plays an important role in applying to various applications such as the medical industry, marketing, entertainment, tourism, and etc.

In the tourism sector, the main challenge of using augmented reality technology is to allow tourists to experience the interesting places. Nowadays, many countries have started using AR for promotion tourism like Canada, Australia. Tourists can use their mobile devices such as smartphones or tablets to look at the marker provided on various media such as brochures, signboards, tourist attractions, etc. and visitors will get information in various aspects such as static text, animated regions, sound and 3D animated models combined with the ability to interact with the user. Benchakitti Park is one of the most popular public parks in the city center, Bangkok, created in honor of Queen Sirikit. The park offers a health park, a children's playground and Bicycle tracks for everyone who needs to escape from the chaos in the city [2]. With the Advance of mobile phone and AR technology, the use of mobile has increased every year especially Thailand. Mobile devices can facilitate the publicity of tourist information and give related travel information to target areas. Hence, this project was developed a smart navigation application using augmented reality in the case of Benjakitti Park to provide and give information for users to make a route around the park.

II. LITERATURE REVIEW

The project was studied with the following related research: Augmented reality plays a significant role to enhance a user's interaction and much research has been conducted in aspects of how to develop AR application [3]-[5]. Pokémon Go is a game developed using AR (Augmented Reality) technology, which simulates both the real world and the game world, and allows users to hunt virtual creatures in the real [6]. The applications have explored the benefits of AR in various fields especially in the manufacturing environment to guide and give content instead of the outdated manual [7]. GPS (global positioning system) is employed in a Marker-less navigation system to provide location information however GPS enables well to identify in the outdoors. The indoor positioning navigation system is an advent technology to indicate the target position through smart mobile devices. According to research conducted by U. Rehman and S. Cao, it is found that the time spent on using indoor navigation systems was shorter when compared to using paper maps. Also, the prototype of navigation was proposed to develop the simulated physical shopping mall environment based AR. ARToolkit was applied to use in the indoor environment with a wireless marker through image processing [9] and ARToolkit markers were used in many applications to track and location information [10]-[12]. Mapbox API is employed to develop the augmented reality navigation application based on tilesets instead of the traditional GPS signal navigation [13].

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From the previous studies, the evidence shown that AR could support and develop in a wide range of work domains.

III. SYSTEM DEVELOPMENT

To implement the proposed smart navigation system using AR technology, a case study of Benjakitti Park, the project was divided the operating procedures in the analysis, design and development of the system, which had operations in accordance with the following steps: System Requirements Analysis; System Design and Program development.

A. System Requirements Analysis

To collect data and information in requirement analysis phase, the researchers studied related documents and research in AR and virtual technology. From the survey and questioning users in the park, it was found that when wanting to walk to various points inside the Benjakitti Park, they must look for the attached sign at the entrance. The map will present the overview of the park and moreover, some signs were damaged and causing those who use the service to not know where to go. Therefore, from studying the previous problems, this project was implemented and applied AR technology to be a benefit for users who use the service and exercise at Benjakitti Park.

B. System Design

In the system design phase, this section presents the system overview as shown in fig 1 which is divided into 3 parts: the navigation section, the game section, and the help section. To develop the smart navigation system using augmented reality, the first step is to indicate path generation to demonstrate the destination locations.
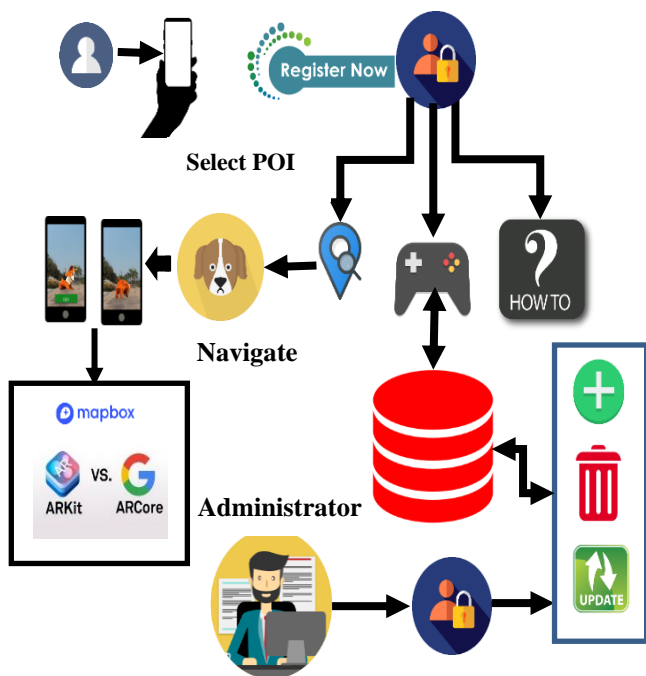

Fig. 1.The System Overview

In the navigation section, users can select a three-dimensional model to navigate to your destination and the system will display a three-dimensional model created by AR technology to guide you to your place. In the game section, users can play the game, like collecting bones, when finished playing the

game, bones act as scores collected to the database in order to make a chance to get other 3D models. The help section plays a significant role to give and suggest users when using the application. Also, figure 2 was presented the database of this application.
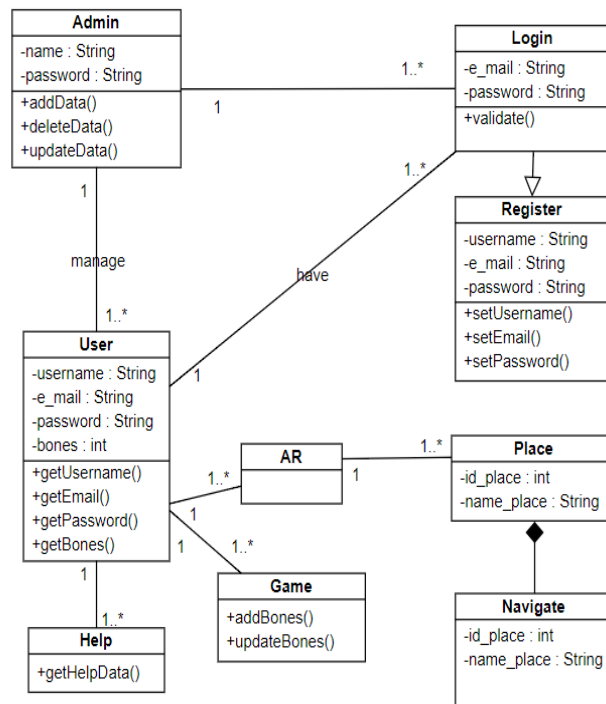

Fig. 2. The Database of the System

C. System Implementation

To implement the smart navigation system, there are many software programs like C#, and unity and the research determined 8 points of interest in this park. Mapbox was applied to build location-based on this project. There are two parts to develop this project: the administration phase based on the website and the navigation system based on the mobile device.
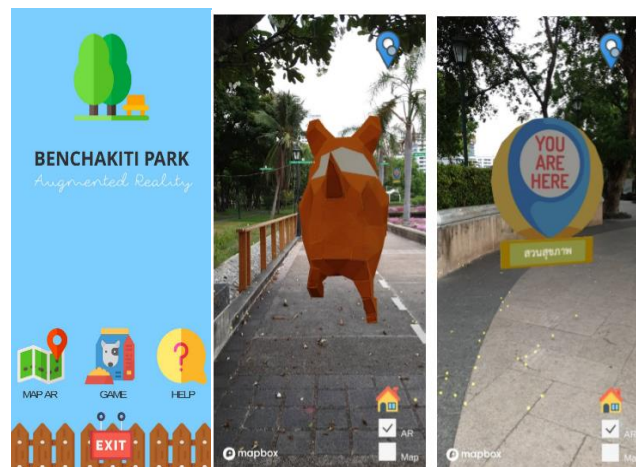

Fig. 3. The user interface screen in navigation section

The navigation program operates when a user enters this application and chooses a 3D model and then the system will display the 3D model to navigate to user destination. The figure 3 and 4 were presented the user interface of this application.
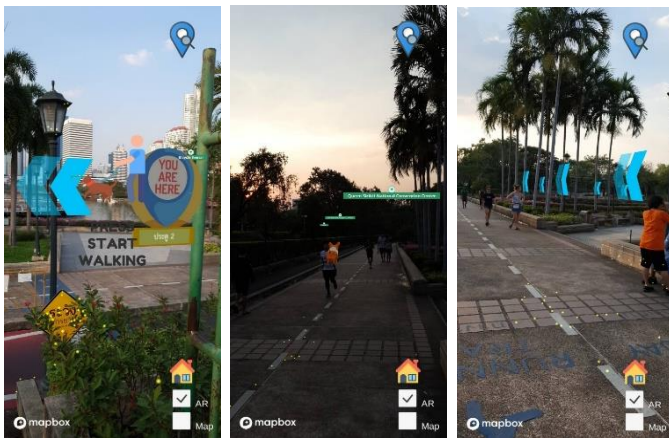

Fig. 4.The user interface in a navigation section

When a user enters the game section, a user is able to check the total number of bones that the user has collected and a user can change the 3D model if the amount of bone has accumulated enough as specified by the system as in Figure 5.
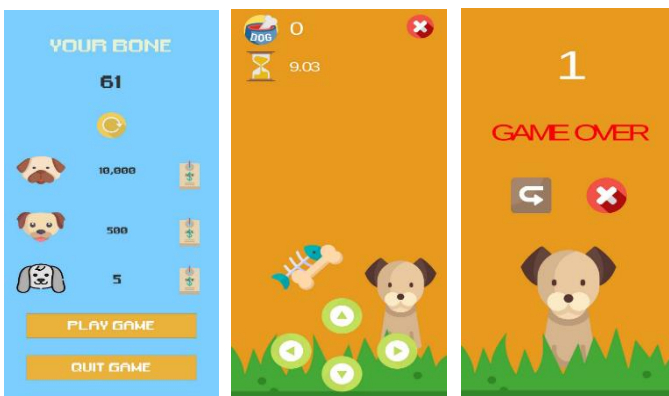

Fig. 5.The user interface in a game section

IV. RESULTS

This research aims to develop the smart navigation system based on augmented reality and to assess the user satisfaction in the developed system Therefore, the presentation of the section is divided into 2 parts: part 1 is the part of the evaluation of the application performance and the last is the assessment of the user satisfaction.

A. The evaluation of the application performance

The software testing approach in this project was used the Black Box Testing, the significant software testing method applied to assess the functionality of a software or application by ignoring how the system works and how the software has been implemented [14]. Black Box Testing is widely adopted to test environments and this method consists of the following steps: function requirement test, functionality test, Usability testing, security testing and integrity test [15]-[16]. The function requirement test is an estimation of system functionality that meets the needs of users and the functional

test is an assessment of system performance. A usability test is an evaluation of the ease of use of the system and a security test is an assessment of data security in the system. Also, integrity Test is a system integrity assessment.

The participants were 3 experts and 20 users for evaluation of this application. The interview and questionnaire were important tools for this assessment. When bringing AR applications for expert evaluation of AR applications, the results can be analyzed as displayed in Table I.

Table- I: The application performance

|	Level of Proficiency		
	$\bar{X}$	SD	Result
1. The Function requirement test			
1.1 The appropriation of the information presentation	4.55	0.72	Highest
1.2 The display is suitable for the screen of various devices.	4.30	0.49	High
2. The Functional Test			
2.1 The ability to scan images through mobile phones	4.75	0.50	Highest
2.2 The ability to display content	3.75	0.50	High
2.3 The ability to take pictures and share images	4.50	0.58	High
2.4 The ability to get directions to the destination	4.00	0.82	High
3. The Usability Test			
3.1 Ease of use of the application	4.00	0.82	High
3.2 Suitability of tourist attraction models	3.75	0.50	High
3.3 Suitability of movement of tourist attraction models	4.50	0.58	High
3.4 Suitability of displaying tourist attraction information	4.50	0.58	High
3.5 Suitability of the screen design	4.50	0.58	High
4. The Security test			
4.1 The system has protection solutions.	4.13	0.75	High
4.2 User-defined operation	4.30	0.46	High
5. The Integrity test			
5.1 The system has complete and complete components.	4.25	0.74	High
5.2 The system is creative.	4.32	0.72	High
5.3 The system has to search for correct information.	4.35	0.67	High
5.4 The display is appropriate for the screen size.	4.12	0.68	High
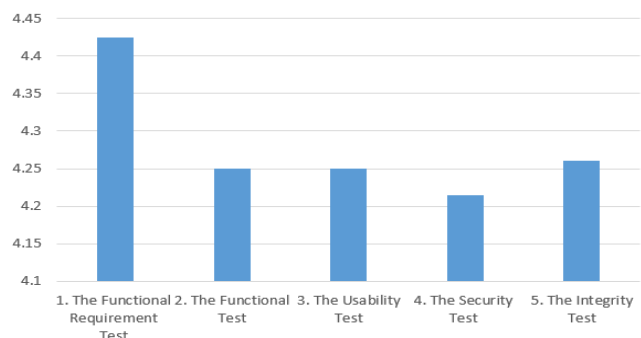
Fig. 6.The summary of the Black Box testing results

B. The assessment of the user satisfaction

To evaluate the proposed application, the population were tourists using the AR application and the results was explained in table II.

Table- II: The user satisfaction

	$\bar{X}$	SD	Result
1. The proposed application is unique and modern.	4.59	0.69	Highest level
2. The proposed application makes users feel close to tourist attractions.	4.58	0.60	Highest level
3. The screen is displayed the suitability of the size, style and font	4.50	0.71	High level
4. The language used is clear, easy to understand.	4.46	0.70	High level
5. The command menu is in the right position and covers the use.	4.45	0.74	High level
6. The user interface design was presented in the suitability of the positioning in various parts including images or descriptions.	4.34	0.48	High level
	4.50	0.68	High level

It is found that tourists are satisfied with the AR application in high level and when examined each item, it was found that the satisfaction is high level.

V. CONCLUSION

The aim of this project was to implement the smart navigation system using augmented reality that can use in Benchakitti Park to make a fun and knowledge for users. This project was implemented by C# and Unity and applied MapBox API to enhance the point of interests (POIs). The application was composed of 2 parts, the mobile app and the admin web site developed by AngularJS 7, CSS, and JavaScript and Node.Js. The operation of the mobile application is divided into 4 parts, the user part, the navigation part, the game part and help part. The result of this project was satisfied at a good level by experts and users and the proposed system was able to navigate and to enable users to have fun. However, the further development of the premise is to improve the augmented reality model to be more accurate and focus on the UX/UI aspect more. Moreover, the Speech Recognition techniques is suggested to make it easier for users to find destinations.

ACKNOWLEDGMENT

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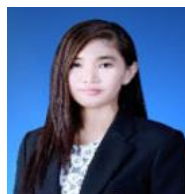
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