Promoting user experience with gamified AR travel guide system for city tourism

A Thesis Submitted to the Department of Computer Science and Communications Engineering, the Graduate School of Fundamental Science and Engineering of Waseda University in Partial Fulfillment of the Requirements for the Degree of Master of Engineering

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Abstract

Travel has always been an indispensable leisure activity and plays an important role in people's life. Studies have shown that travel has a positive impact on people's quality of life. Thanks to the development of pervasive computing and multimedia technology, the application and research of information technology in travel and tourism has gradually become a popular topic. Travel satisfaction is an important factor which affect human subjective well-being. In recent years, more and more attention has been paid to the improvement of travel satisfaction. On the other hand, the popularity of Pokemon GO has brought location-based augmented reality games into the public's view. Compared with high-cost and sophisticated augmented reality wearable devices, mobile augmented reality has greatly reduced the cost and threshold of the public to use AR technology, allowing people to go out and explore outdoors. The success of the Pokemon GO allowed us to see the interesting and immersion of combining virtual game stories with reality, and at the same time, it also provided inspiration for the city exploration based on geographical location. This research aims to explore how to promote the travel experience in city tourism and investigate what the motivation and needs of travelers during interaction with the city tourism destinations. Based on a review of the literature, this research proposed an AR travel guide system based on role-playing gamification, which combines incentive mechanism of gamification and real-time geographic location services to provide users with appropriate travel information interaction without disturbing the user's own exploration and roaming in the destination. We conduct functional evaluations and user study of travel satisfaction. According to the results of experiment, we find that these functions have positive impact on user travel experience. Moreover, we also summarize some addition findings which in order to let us understand user's motivation and needs better. We hope this research to provide some insights and interesting ideas for the travel assist system to promote the user experience and to explore the demand of human-computer interaction design about human and real-time location-based information service in the future.

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Chapter1 Introduction

1.1 Background

Travel, as an indispensable and influential behavior in human life, has always played a very important role in recent years. Many studies on travel and tourism have shown that the travel experience has a great impact on the quality of life (QOL) and well-being of travelers. For example, it could generate a positive impact on family, society, culture and other fields related to human daily life. An unforgettable travel experience will generate more positive memories for us and help us discover ourselves from anxiety and depression. Therefore, a large number of researchers have also started to study how to improve human well-being during traveling, especially in the rapid development of information technology today.

Thanks to the ubiquitous mobile smart devices and the massive amount of information connected to the Internet, information technology has gradually become an integral part of current travel activities. Tourism assisted tools have ability to greatly promote the entire travel experience and allows tourists to make use of information on their way. Like some travel-related information retrieval, accommodation and transportation reservations, map navigation, and business recommendation systems, and other kinds of location-based services. The application of information technology in travel assistance penetrates every link of the travel period, which provides a lot of emerging topics for our researchers to study, because travelers usually require diversity information before the trip and these needs would be continued during trip and will last until the end of the trip. Travel behavior is inevitable linked to information technology and smart devices.

Travel satisfaction is an import Figure10: Display photo   man subjective well-being. Many studies have shown that for tourists, an unforgettable memory with travel destinations are important and also one of the important factors that affect the travel experience of tourists. Satisfaction with travel services plays an important role in determining satisfaction with the travel experience [16]. Thus, how to provide tourists with a more practical, interesting, and immersive travel experience, and how to satisfy the users' need of tourism information service, promote the engagement during travelling and make travel activities colorful and meaningful. Smart devices and information technology provide travelers

with more meaningful travel experience is an important subject that never stops.

There is a lot of research on the application and technology of travel assistance before travel, such as the introduction and recommendation of tourist attractions, itinerary planning, travel reviews, etc. Most of the information comes from the official travel destination information and tourist reviews on the Internet. However, for those who do not have the time and information to make a travel plan in advance, he or she needs guide services that can start a trip in a strange place right now. Unlike other places of interest or outdoor tourism attractions, the exploration and roaming in attractions formed by the integration of city blocks, some attractions and commercial streets cannot be experienced just through a travel strategy, because such tourist places focus more on current travelers Interaction with tourist attractions itself. The success of the Pokemon GO allowed us to see the interesting and immersion of combining virtual game stories with reality, and at the same time, it also provided inspiration for the city exploration based on geographical location.

Furthermore, Travel increasingly becomes a social behavior nowadays, which you cannot avoid other travelers' opinion and contents generated on daily social media platform as well. More and more people are intendedly searching shared contents from social media networks, such as text descriptions, photos, geo-tag, and hashtags like Instagram and twitter rather than some official travel website and review system. This kind of information is also contained many popular travel information, and some even illustrated in some interesting way.

Travelers need some real-time geographical information at some certain time, such as the present evaluation of some popular restaurants and tourist attractions, some recent hot spots and events people shared on social media, like Facebook, Instagram, Twitter and so on. These SNS opened their resources to third parties via Application Programming Interfaces (APIs). Many users on SNS like to share geo-tagged photos and hash tag keywords at the moment, which we could make use of these information to provide better services [5].

The development of ubiquitous computing devices also provides envision for real-time services. Some studies proposed online Q&A function to help travelers to solve some real-time problems. In [2], the authors proposed a

service that people can ask temporal and geo-sensitive questions, such as how long the line at a popular business right now, and then receive answers that crowdsourced from other users in a timely way. Such online services research made effort on the real-time information interaction, and connect the social relationship, while they need the users to ask questions manually and probably need a long time to wait answers. Some current research focused on the trip recommendation system to provide travel assistant such as route plan that is mostly based on points of interests (POIs) to achieve personalized trip recommendation [3, 4, 6]. These systems mainly devoted to the algorithms of recommendation, while they lack the design of the way the information present and the interesting of interaction between user and information. So, how to use ubiquitous technology to improve the user's satisfaction with mobile device service, and thus make tourists more satisfied with the travel experience of the destination, will be an ongoing subject at present and in the future.

Therefore, this research is dedicated to exploring how to promote travelers and satisfaction during travel. Based on literature review, we proposed an AR travel guide system based on role-playing gamification, which combines incentive mechanism of gamification and real-time geographic location services to provide users with appropriate travel information interaction without disturbing the user 's own exploration and roaming. Moreover, we use data from SNS to enrich the travel real-time information. And we conduct user study to investigate the functions in our system and explore the motivation and needs of travelers during city tourism.

1.2 Research Objective

The objective of this research is to explore how to design smart mobile service to promote the satisfaction of users' city travel experience and thereby increase the well-being of traveler. Through the design and exploration of information assistance services during travel to improve the user's participation, immersion and interactivity in the traveling. Make the whole travel exploration interesting and memorable.

This research conduct user study by using system we proposed to investigate if these technology and interaction could provide travelers a

more satisfied travel experience, and also to hope the result could provide some insights and interesting ideas for the travel assist system to promote the user experience.

1.3 Structure of the Thesis

This thesis is organized as follows.

In chapter 2, we did a sufficient paper survey related to several aspects of research in travel and tourism, they are: Travel Behavior and Human Well-being, Technology in Travel, Gamification in Travel and Tourism.

In chapter 3, we introduced our approach for system function design and implement our system.

In chapter 4, we explain the design of two user study and experiments details. We then analyzed the collected data to conclude the result of the user study.

Possible limitations are discussed in chapter 5.

In chapter6, we will talk about the future work based on this research.

Finally, we draw the general conclusion to end this thesis in chapter 7.

Chapter2 Related Work

2.1 Travel Behavior and Human Well-being

2.1.1Quality of Life and Wellbeing in Tourism

In the progress of human civilization, it has never stopped discussing and studying how to improve the quality of life and happiness. With the rapid development of production technology and the improvement of material life, people began to pay more attention to spiritual wealth. Happiness itself is a philosophical topic, however, in recent years, research on quality of life and well-being has crossed into various disciplines and fields. WHO defines Quality of Life as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. The quality of objective circumstances and subjective psychology is equally important.

Travel, as a social behavior that allows people to temporarily leave a period of time from familiar daily life and explore and experience in an unknown place, has a very important impact on our physical and psychological health. The benefits of travel to the human body are obvious, and in recent years, research on the impact of travel on people's quality of life and happiness has become increasingly important.

For example, study to investigate whether the activity of holiday-taking has any effect on the life satisfaction and subjective well-being of those taking vacations. And the result illustrated that holiday-taking did alter or impact on the subjective or sense of well-being of the holidaymakers: respondents experienced a higher amount of pleasant feelings after their holidays [17]. In order to find to see whether tourists are happy during a day of their holiday and what makes them happy, [18] invited 466 international tourists in participate in the survey, and found that on vacation, tourists are generally high on hedonic level of affect, with positive affect exceeding negative affect almost fourfold.

Diversity interdisciplinary study topics related to the impact between tourism and human subjective well-being for quality of life have emerged along with the development of the current social context, science and technology, and characteristics of the times.

2.1.2 Promote Well-being During Travel

Majority of researches on how to improve people's well-being. Researchers in different disciplines have made many efforts to improve human happiness and well-being in different aspects. The prosperity and development of information technology and mobile communication technology enrich the definition and form of travel. Travelers use these technologies to obtain information, make business transactions, record and share, and so on. In addition, ubiquitous computing technology continues to enrich and broaden the way people interact with travel. It is undeniable that at most of time travel activities cannot be separated from the assistance of information technology and computing device, and this sort of assistance is ubiquitous and diverse. Therefore, research on the impact and enhancement of well-being by smart devices and information technology has also emerged in response to the needs of the times and society. For example, there are questions about how smart information technology affects people's subjective well-being during travel, and how smart information technology and varieties of interaction forms can be used to improve the satisfaction and participation of travelers in the travel experience to improve the happiness of travelers. In [19], they present results from research, which seeks to explore and set directions for computing's place in outdoor recreation. And study illustrated that spending time outdoors can positively impact mental and emotional wellbeing.

Travel satisfaction is an important factor affecting human subjective well-being. Satisfaction with travel services plays an important role in determining satisfaction with the travel experience [16]. People have begun to pay more attention to how to use the advantages of these technologies to allow travelers to participate more and makes the travel experience more satisfying.

2.2 Technology in Travel

In the information age, travel services are not limited to the services provided by the local service industry. The impact of services provided by mobile devices and a large number of ubiquitous computing devices on travel satisfaction is also worth studying. In the past, the more satisfied a tourist is with the service at the destination, the greater his or her demand for the service, and the longer he or she will stay at a particular destination [16], while, today services provided by smart mobile devices

could also improve the user's satisfaction, and thus make tourists more satisfied with the travel experience of the destination.

People have begun to pay more attention to how to use the advantages of these technologies to allow travelers to participate more and makes the travel experience more satisfying.

2.2.1 Review of Information Technology Applied in Travel

With the popularization of mobile communication technology, smart phones are indispensable in all aspects of people's lives. Many smart information technologies that help travel and enhance the travel experience are implemented through smart phones. [20] the results of the research show that using smartphones can transform the travel experience by changing the travel planning, constructing and destructing one's travel awareness, and reconfigure the relationship between entertainment, places, and others greatly change the travel experience. Location-based services are also an essential technology in travel information providing. In [20], the use of smartphones for travel enhances the travel experience by enabling the traveler to better experience of the authenticity of a destination.

Early mobile travel technologies mostly provided users with information, reviews, route inquiries, recommendations, etc. With the enrichment of multimedia information technology, smart devices also provide travelers with the environment and the people and things in the environment. Interactions offer more possibilities. For example, [21] supposed a review on the usage of digital technology for enhancing visitors' user experience in museums. These studies provide us with idea, that is, increasing the interaction between travelers and travel scenes during travel has an impact on the user experience of travelers. And in most cases, these effects are positive.

According to recent research and development trends, there will be more information technology in the future to provide more interaction which could enhance travel experience of travelers. The travel would be a more personalized and memorable experience.

2.2.2 Augmented Reality Applied in Travel and Tourism

Virtual reality (VR) and augmented reality (AR) are two technological breakthroughs that stimulate reality perception. Both have been applied in tourism environment to enhance users' experience [22]. The application of VR in the field of tourism is mainly concentrated in digital display, cultural heritage, digital museums, etc., while AR focuses on the expansion of the real world and some outdoor mobile interactions to improve the user's travel experience. Instead of creating a non-real environment as in VR, AR enhances the reality by amplifying it through information technologies [22]. From the word cloud map, we can see that there are more articles about mobile AR technology related research, while compared with the popularity of VR in the tourism industry, the application of AR in the tourism industry needs to be broadened and deepened.

Figure2: Word cloud for VR [22]   Figure1: Word cloud for AR [22]

According to a Statista report [23], the Augmented Reality market is estimated to grow from 5.91 billion to more than 198 billion U.S. Dollars by 2025. Therefore, research of AR technology in the field of tourism is prospective and has market and commercial value.

Pokémon GO is a location-based augmented reality mobile game, which once launched, quickly became the most successful mobile game in the world. Its' popularity means location-based augmented reality game into the mainstream for the first time. There are many academics and industry practitioners for studying and designing location-based augmented reality game experiences. [9] proposed to construct a behavior model for Pokémon GO user through consideration of motivation, sport involvement, and tourism benefit, which illustrated that motivation has significant influence on sport involvement and tourism benefit. Tourism

industry should attach importance to their attraction with Pokémon related product and event to enhance the motivation of Pokémon Go users. This study provided some practical suggestion for related tourism industry and directions for researchers in future. Based on such research, we could combine location-based augmented reality technology with tourism to provide more attraction and interesting services. [10] proposed a novel pervasive mobile augmented reality location-based game. This game comprises of a mobile client and an online authoring tool, which encourage visitors and locals to explore the city. And similar to [11], which proposed a location-based game named City Explorer to find how transit commuters capture, share, and view community information based on locations. Research like these papers give us envision of more possibility by designing location-based augmented reality service for tourism. Tourism is all about creating unique experiences, and augmented reality has the potential to support tourism with innovative modes of customer servicing.

2.3 Gamification in Travel and Tourism

Gamification is an idea of making use of game design elements in non-game contexts to motivate and increase user activity and this idea is widely used in finance, health, education, sustainability, news and entertainment [13].

In different situations, gamification elements and interactions are added to improve user participation, motivation, loyalty, and fun. [24] design a mobile role-playing game (RPG) where the character evolves based on the exercises the user performs in reality, which can motivate and persuade a potentially large demographic of users to engage in physical activity for an extended period of time through the enjoyment of an engaging game. [25] investigate how different personalities respond to various persuasive strategies that are used in persuasive health games and gamified systems, which offer design guidelines for tailoring persuasive games and gamified designs to a particular group of personalities. Gamification promotes user engagement and creates higher intrinsic motivations. [26] applies gamification to employees' micro-learning and considers gamification as a method to increase user promote user engagement.

In recent years, the application of gamification in the tourism industry has focused on gamified interactions indoors such as museum roaming, outdoor location such as check-in based on location, sharing their travel content, and thus earning virtual points for miles and so on. [14] suggested that the key principle of generic gamification framework for

eGuide applications provided to visitors in tourist attractions, which provide some thinking about gamification in tourism. In [15], researchers designed a location-based game which could lead a tourist through Tainan City in Taiwan. The traveler follows the guides to complete variety tasks. In the process of game, traveler experience culture, learned knowledge about sites in the city, meet local citizens, which do not need to do detailed plan ahead. [12] also designed a game to help people strengthen the sense of community. Players can also create geo-tagged posts to describe and share community-related information. These designs provide novel game design for non-game daily contexts. In [27], author developed a game for an Italian historical residence to communicate its 18th-century history to teenagers, capitalizing on narrative and game mechanics to foster young visitors' motivations to explore the museum and facilitate their meaning-making process. Table1 illustrates summary of gamification research in travel and tourism.

Unlike museums, art galleries, theme parks, or some famous city which have a background story, it more focused on randomness and walking exploration. So, for such city travel destinations, the gamification design idea is not just to keep users loyal and tell users a complete story or to make users simply play some games to increase fun in travel.

Related work	System/application/service	Feature1	Feature2
Caroline Arkenson (2014)	Tag and Seek leads a traveler through Tainan city in Taiwan.	location-based game for travel scan a Near Field Communication (NFC) tag	The traveler's task is to find Harry's friends who are hiding at different sites in the city.
Paula Alavesa and Timo Ojala （2015）	SAG In the real streets	location-based game MR mobile phone game	tagging predefined locations around the city to claim their ownership and busting nearby players of competing gangs.

Irene Rubino （2015）	Gossip at palace developed for an Italian historical residence museum	location-based game travel AR mobile phone game integrating a storytelling approach	narrative and game mechanics to foster young visitors' motivations to explore the museum and facilitate their meaning-making process.
Armir Bujari (2017)	PhotoTrip Travel suggestions and recommendations	identify points of interest by gathering pictures and related information from Flickr and Wikipedia provide the user with suggestions and recommendations service	exploited social networks, crowdsourcing and gamification to involve users in the process of improving the response quality of system
R Nóbrega (2017)	Unlocking Porto an application was designed for the city of Porto	location-based game travel story engages the player into the main sights	following an augmented reality path while playing small games.

Table1: Summary of gamification research in travel and tourism

2.4 Social Impact on Travel and Tourism

People have become accustomed to inspired by other people's reviews and comments to evaluate things in the current physical environment. Some websites based on travel information reviews and sharing functions provide travelers information for retrieval in an unknown location scenario to make decisions.

With the rapid development of social networks, even personalized travel would be influenced more or less by others. In addition to the prevalence of various mobile devices, information technology is constantly

penetrating into every link of travel life. Travel planning is always done before the trip, which make use of existed information through travel assistant technologies, and most of them focused more on the traveler as an individual one, while traveling can be a social endeavor [1]. Travel is no longer an individual's behavior. Some research also indicated that the behavior of other people would affect the individual's decisions. [28], for example, indicated that the influence of social media on information and evaluation of alternatives stages is higher than the rest of the stages of the purchase decision making process. Social media has been steadily increasing as an important information source for tourists who access social media frequently through their mobile devices. Research has shown that travelers rely more on the suggestions and reviews provided by experienced tourists for their travel planning and decision-making. Social media has become an important source that can be shared and analyzed to support user better strategy making.

There are many travel guides and word-of-mouth, review sites like Yelp, Trip Adviser and Google map/trip used to help travelers make their plan and seek review. Some travelling plan services provide some pre-planned itinerary suggestions, but the need for information for travelers to travel is equally important, and in a sense, affects the user 's travel experience. but cannot provide real-time valuable information.

Information sharing on social networks is different from official tourism information websites, review sites, and travel recording applications. SNS (Facebook, Twitter, Instagram), as online contents-sharing social media platform, allows large number of users to share them with friends or public. These contents always associate with geographic information and hashtag below the text and photos are also displayed point of interest, association, and so on information, which could be made use of. This kind of information is also contained many popular travel information, and some even illustrated in some interesting way. More and more travelers are searching for information about travel destinations by searching for location information, popular tags, keywords in SNS, and can choose time or popularity, whether it is before or during the trip on the way, this real-time information retrieval is more capable of obtaining the latest and highly relevant information, and the content posted on personal social networks is different from travel notes, reviews and other content written on a review site. The information on SNS is more real-time and personalized, and sometimes it could search for information that is not available on special travel review sites, such as some personalized niche attractions, shops, and places. For travelers, although the content of these information may also cover other irrelevant information, while

these informations are updated real-time and diversity, which may enhance and enrich the current travel experience and surprise the traveler sometimes.

Take advantage of the instantaneity and richness of the large amount of contents shared by other users on social media networks, we could acquire contents and integrate them, so as to provide users with better information interaction. There are many researches pay attention to data mining on social media. [7] explored how social media data can be employed in order to study tourism on European Cultural Routes. [8] proposed that geo-tagged image-based platforms represent an unprecedented untapped source of data and investigate the use of Instagram photos to analyze tourism consumption. Text, photos, location information and hashtag provide us connection of all aspects of the context.

2.5 Summary

Based on the review and summary of the above related work, we can learn that the way in which information technology is used in tourism and travel is constantly changing with the development of science and society as well as the needs of travelers. Breakthroughs in technology can continuously enrich the expressive forms of mobile travel technology, while the research on the user's motivation and demand in every link of traveling has also greatly been stimulating the development of technology. Therefore, research of user experience is also important, which researchers could explore the motivations and requirements of users during every traveling behavior, as this may bring new imaginations and blueprints for technological research.

In addition, make use of some methods to enrich the travel experience, improve travel satisfaction, engagement and immersion, consequently deepen travel memories and thus improve travel satisfaction， thereby improve well-beings. Because the recording of travel can also enhance people's satisfaction and happiness. However, what kind of travel is memorable? Many studies focus on the use of technology and design method, while have not revealed how to make users experience more in-depth during travel and better record after travel, this is also one of the subjects that this research wants to explore.

From the literature survey, the current application and research on augmented reality gamification in sightseeing travel are not very rich, and the presentation forms of augmented reality technology are also different in different types of travel destinations. At present, the

mainstream applications are Indoor gamification-based guides such as museums, art galleries, etc., use wearable devices and applications that can interact with virtual exhibits; on the other hand, use removable smart devices, such as mobile phones and tablets, for some well-known sights, cultural sites, and commercial establishments provide augmented reality information interaction. However, for some tourism in the city, because of the gathering of some popular shops and famous attractions, a small travel destination with certain popularity and hot topics is formed, and many travelers cannot get the introduction of travel attractions such as TripAdviser. Abundant travel information about such a destination. However, on social media, you can search for a large number of geo-tagged locations and share content of popular tags, which can be used to deepen our understanding and perception of travel destinations.

There are not many studies on the improvement of travel experience of city block attractions through gamified augmented reality technology. Therefore, this study is very meaningful and enhances the travel experience of tourist destinations in the city. Both the traveler and the urban community in which he travels, and has positive impact, and these positive impacts can be related to improving people's happiness and quality of life.

Chapter3 Approach and implementation

3.1 Approach

In order to promote user experience while city traveling, this research proposed an AR travel guide system based on role-playing gamification, which combines incentive mechanism of gamification and real-time geographic location services to provide users with appropriate travel information interaction without disturbing the user 's own exploration and roaming. System was designed to provide travelers with a more memorable, highly engaged and satisfied travel experience. Functions of the system will be described in detail below, which allowing travel experience more attractive and impressive, so as the memory becomes clear and coherent and memorable.

3.1.1 Function Design

Based on the analysis of the needs of travelers, the system designed in this research, on the basis of ensuring that the user is provided with a real guide to the attractions, adds role-playing gamified dialogue interaction and incentive mechanisms to improve the system's interesting and immersion. Figure3 illustrates the designed function structure of the system. Detailed function will be described below.
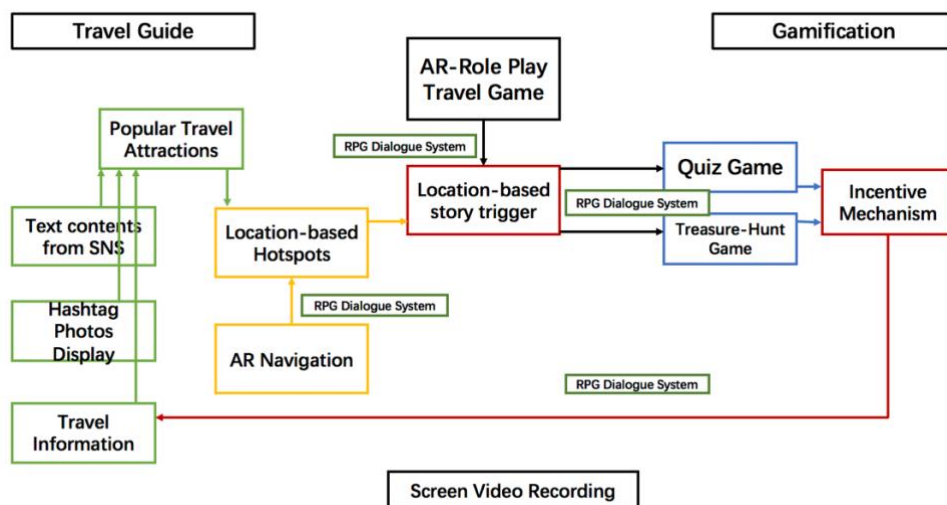

Figure3: System function design

Location-based hotspot trigger: First of all, we set a series of hotspots in the travel destination based on geographic coordinates (GPS) of scenic spots. When the user is in the destination area, the system will display the direction and distance of the hotspots nearby and virtual character shown in Figure4 as a companion with user and guide the user to the hotspot exploration. When the user is within a set radius (5m) from the center of hotspot, system will send notification to users. When the hotspot is activated, the interactive game related to this scenic spot is triggered, shown in Figure5. We provide AR navigation, illustrated in Figure6, for direction of the hotspot and display distance from the user.
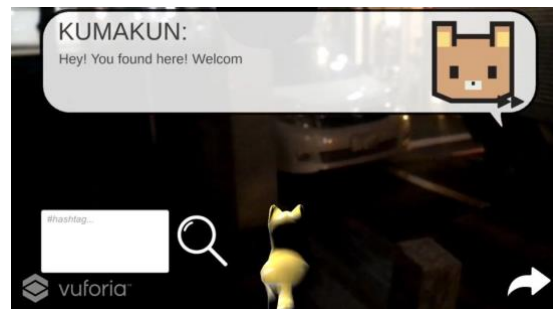

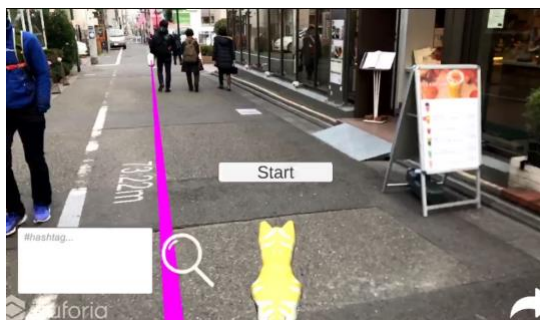Figure5: Hotspot is activated

Figure4: Virtual character guide

Figure6, Figure7: AR navigation

Gamification mechanism design: In order to make users get more interesting travel experience, and also to promote users to explore more attractions, we designed a gamification and incentive mechanism for the system. We added a role-playing game with story for the system, that allows users to explore in real environments like a game. Each activated hotspot can trigger a game. Similar to a RPG's dialogue system, user can have a dialogue and interaction with virtual characters. As game NPC, these virtual characters will introduce the attraction and arrange the tasks for user, and the user will follow the instruction and game episode to complete tasks. User can start a game adventure at travel destination.

When the user finished the game task successfully, different from other gamification system, the incentive mechanism designed in this study is

not in the form of game scores or ranking, however is to provide user with another interesting attraction information as a reward, which encourage user to explore interesting places around this hotspot. Figure8 illustrated incentive mechanism of gamification.

Figure8: Incentive mechanism

Travel information from SNS: The system also provides the latest real-time contents from social networks in multiple dimensions, which can help users understand the environment better and enrich their travel experience from the perspective of other users (travelers). This feature could help user to establish social connection on social network.

Mark #hashtag in unity scene based on real-word location coordinates and provide real-time image searching function for display in the scene. User can choose to input #hashtag as keyword for searching latest images in twitter and help user know more information of an attraction, restaurant or a store.

(1) Display text from SNS. We acquired several latest month tweets related to the #hashtag and location and displayed them based on location data to promote user's immersive and provide information. Show in Figure9.

(2) Display photo gallery from SNS. We acquired several latest month photos related to the #hashtag and location and displayed them based on location data to promote user's immersive and provide information. shows in Figure10.
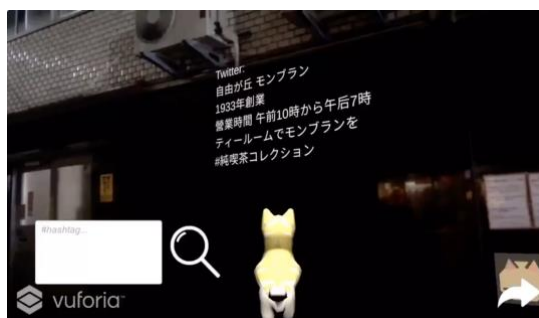

Figure9: Display text

Figure10: Display photo

3.2 Experiment Scenario：Jiyūgaoka

This research chose Jiyūgaoka as an experiment scenario.

Jiyūgaoka is a residential area located in Setagaya-ku, Tokyo. It is surrounded by various shopping streets and residential district. Various stores hidden in the narrow streets that are popular in local residents and visitors. In addition to colorful and interesting shops, there also has very famous places of interest, including ancient Kumano Shrine, a miniature version of Venice and old Japanese-style café Kosoan.

We selected several popular locations located in Jiyūgaoka district and obtained their GPS coordinates latitude and longitude from Google Maps as hotspots for experiments. As shown in Figure9.
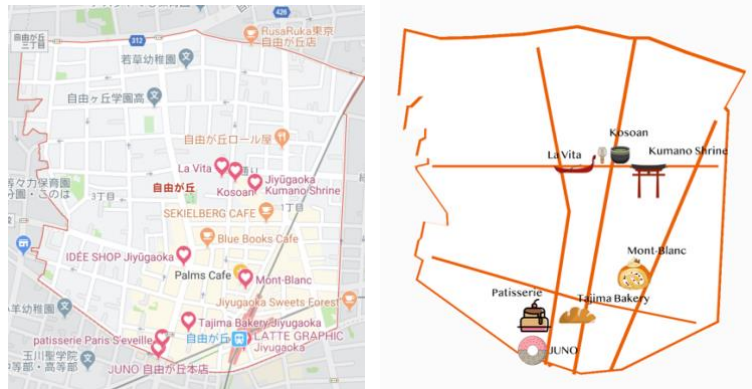
Figure11: Map of JYUGAOKA and hotspots

3.3 Implement

This study developed the application based on the above system design with Unity3D [29] game engine. The augmented reality features are supported by Vuforia [30] SDK. The real-time image searching is developed through Google Custom search API. The application is installed in an iPhone smart phone with system of iOS12.1.4. system implement is shown in Figure12. Figure13 and figure14 show some UI interface and function in application.

Figure12: System implement

Figure13: Application UI interface
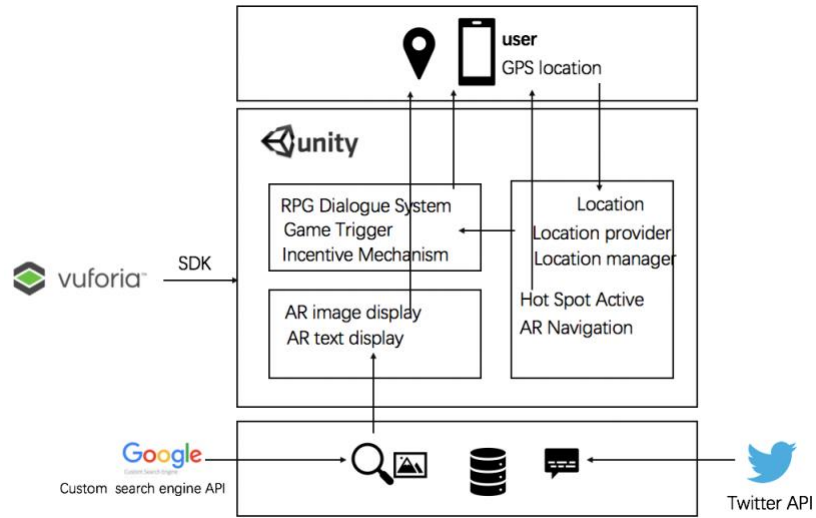

Figure14: One of the functions displayed in application

Chapter4 Experiment

4.1 Objective

In order to investigate whether the system functions proposed in this study have positive impact on the user's travel experience, and then explore how could we design travel assistive system to promote the travel experience in the future, we conducted user study.

We invited 5 participants to use application designed based on the functions we proposed to conduct a user study in real travel destination Jiyūgaoka in Tokyo as experiment scenario. Because the number of participants of the user study in Jiyūgaoka was not large enough, and the result evaluation score was relatively high, in order to make the experiment results more objective, we invited another 18 participants to conduct user study by watching the video demonstration on the preference and usefulness of the function. We will describe some detail of the two user studies in this chapter separately.

4.2 User Study

Before user study, we invited a pilot participant to use our application to explore the travel destination in Jiyūgaoka, and recorded video of the smart phone screen in actual use process.

Video-based user study

We invited 18 participants (8female, 10male, aged 21-29, average = 23.9) from different professional backgrounds. We firstly asked about the basic information of the 18 participants, including age, gender, and usage of gamified mobile travel applications. All of 18 participants have used mobile apps for travel assistance, however 16 participants have not used gamification apps designed for travel and tourism.

Then we introduce background and functions about our system and confirmed that they understand all function designs clearly. After watching pilot travel experience video recorded before, we asked each participant to answer a questionnaire.

Application-based user study

We invited 5 participants (3 female, 2 male, average=23.8). We firstly asked about the basic information of the 18 participants, including age, gender, and usage of gamified mobile travel applications.

Then we introduce background and functions about our system and confirmed that they understand all function designs clearly. And participants were asked to use our smartphone application to explore a real destination, JIYUGAOKA. We asked each participant to answer a questionnaire. Finally, we also conduct a semi-structured interview for each participant.

4.2.1 Functions Evaluation

Regarding the functions evaluation of the system, we asked participants to complete the following 10 questions, 0 stands for not at all, 4 stands for very. Participants were asked whether they liked the function and whether they thought it was useful or not. Questions are illustrated in Table2.

Questionnaire1
Q1.Do you like this Role-playing game AR travel guide system？
Q2.Do you think this Role-playing game AR travel guide system useful for your travel？
Q3.Do you like to explore and interaction with destination by location based hotspots game story trigger?
Q4.Do you think it is useful for exploring and interaction with destination by location based hotspots game story trigger?
Q5.Do you like incentive mechanism in each game?
Q6.Do you think incentive mechanism is useful for encouraging you to continue to explore more attractions?
Q7.Do you like this navigation function for hot spot direction guide?
Q8.Do you think this navigation is useful for you during your travel？
Q9.Do you like displaying latest information related to travel destinations from SNS in immersive way?
Q10.Do you think it is useful to display latest information related to travel destinations from SNS in this immersive way?

Table2: Function evaluation questionnaire

4.2.2 Experience Satisfaction Evaluation

Regarding the experience satisfaction evaluation of the system, we asked participants to complete the following 10 questions, 0 stands for not at all, 4 stands for very. Both video-based and application-based user study participants were asked to answer 6 questions in Table3.

Questionnire2
Q1.Do you think this system can meet your needs during travel?
Q2.Do you like using this system in your practical travel?
Q3.If the application is perfect enough, would you like to use it in the future?
Q4.Would you like to use a similar application in other similar travel destinations?
Q5.Would you like to recommend this application to your friends?
Q6.Would you like to use this application with your friend together?

Table3: Experience Satisfaction Evaluation questionnaire

In addition, the participants in the application-based user study were asked to answer another 4 questions about subjective satisfaction in actual use, such as, enjoyable, interesting，impressive and attracting. These 4 questions showed in Table4.

Q7.Did you feel enjoyable during travel experience?
Q8.Did you feel interesting during travel experience?
Q9.Did you think this system make your trip impressive?
Q10.Did you think you are attracted to the travel experience?

Table4: 4 questions about subjective satisfaction in actual use

4.3 Result and description

The result of functions evaluation in application-based user study is shown in Figure15.
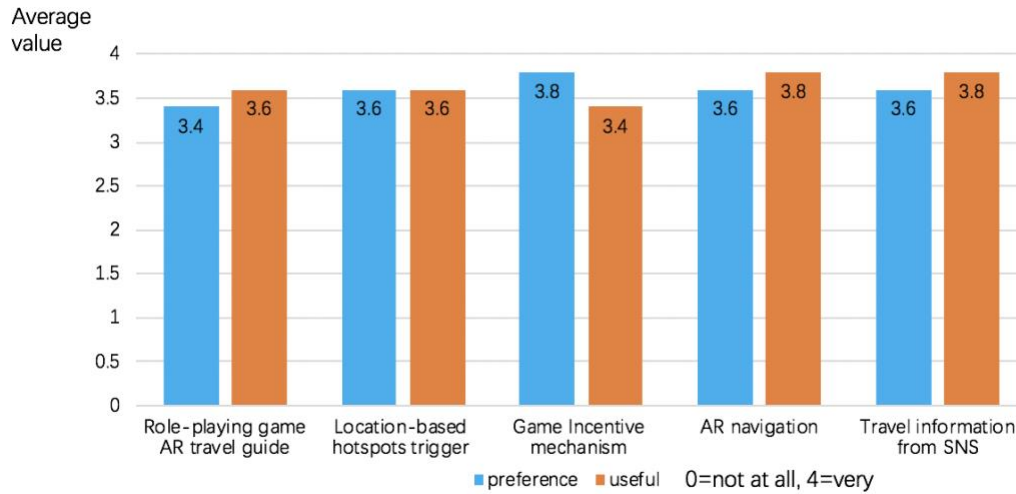

Figure15: Functions evaluation in application-based user study

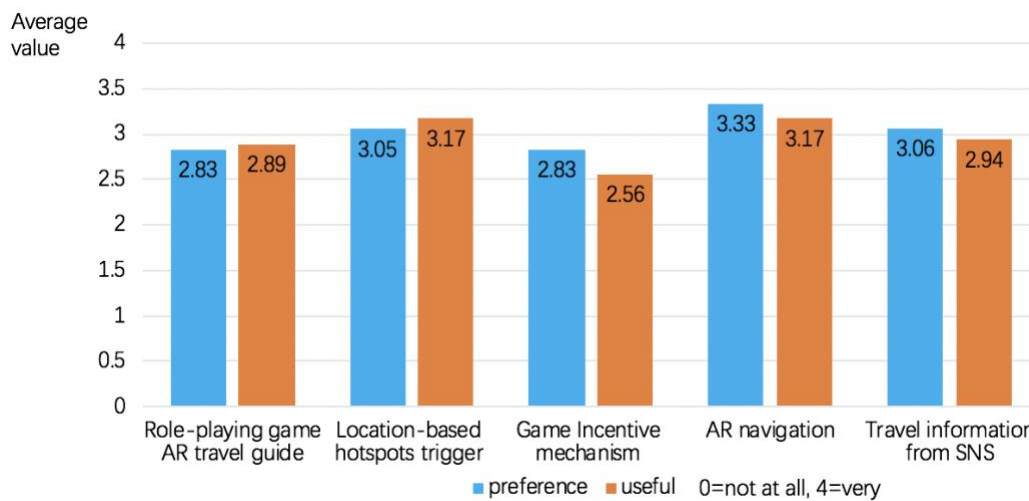The result of functions evaluation in video-based user study is shown in Figure16.

Figure16: Functions evaluation in video-based user study

The average value shown that most participants found the function of the system interesting and useful for their travel exploration experience.

As for the travel experience satisfaction evaluation, the results are shown below.

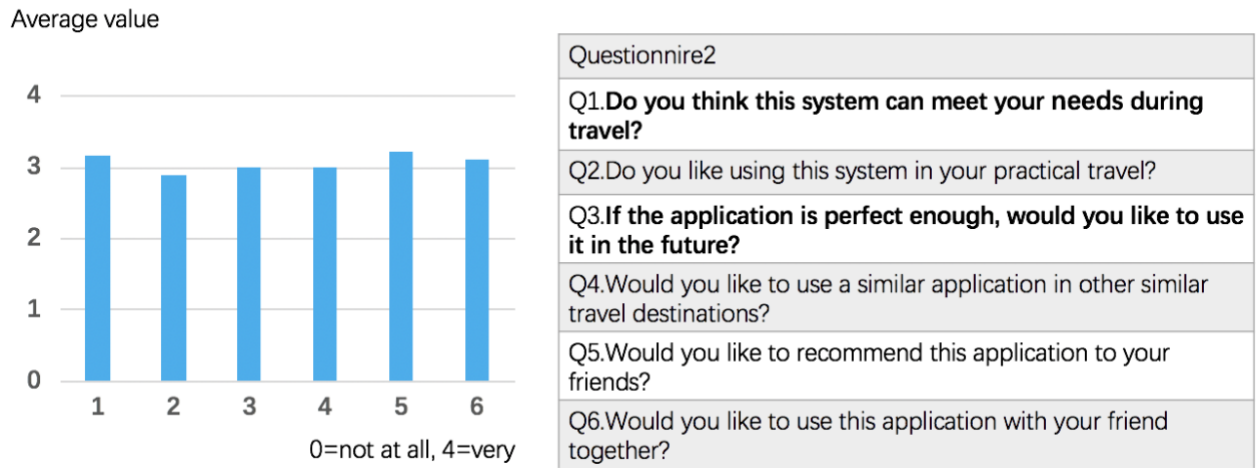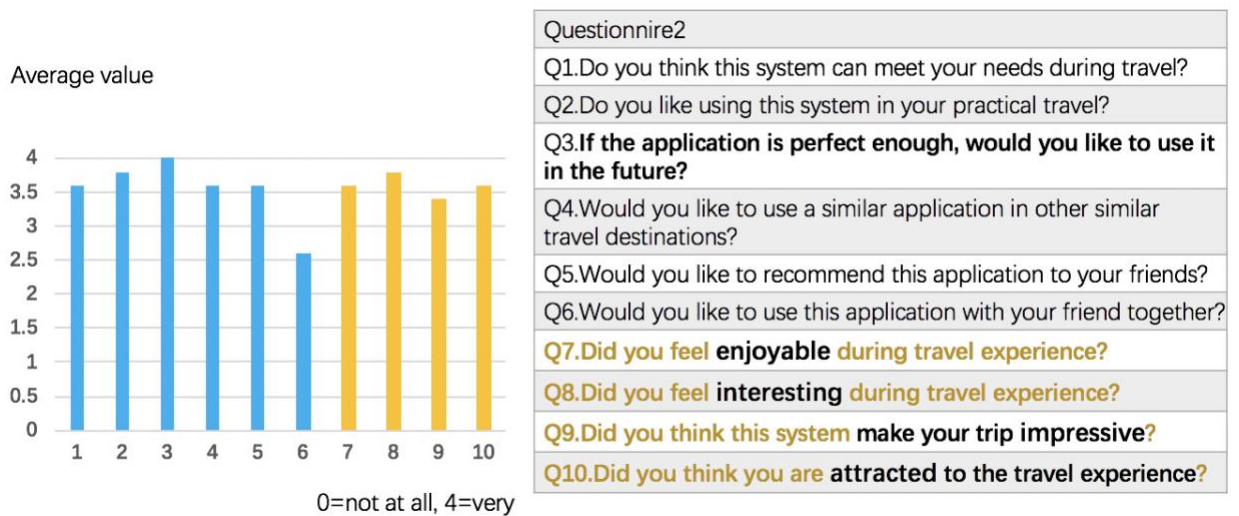Figure17: Experience satisfaction evaluation in video-based user study

Figure18: Experience satisfaction evaluation in application-based user study

After finished the application-based user study, 5 participants are also invited to a semi-structured interview. The interview asked participants to describe their experience and some suggestions on the functions of system. Some comments of the interview are shown in Table5.

Participants	Comments
P1	"I think this is a very interesting design. I was attracted by gamification contents. It can help me explore unknown destination, and sometimes I can get unexpected surprises. If it is to be used in real, I hope it can be more intelligent , which could understand context both my mental and physical condition, and provide me with a more comfortable service in a time···"
P2	"if there are several customized route plans for me to choose when I first arrived···I hope to use the least time to explore the most attractions"
P3	"maybe the group of people who used the app should be classified···travel destination as well···"
P4	"more travel mode for choose is better for me, such as weather, mood and so on···and the information. and virtual character should be more accurate···"
P5	"personalized service and interaction with other traveler maybe more interesting activity.."

Table5: Show some comments of the interview

Chapter5 Discussion and Limitation

Analysis of Result

Based on the result of user study, we found that most of participants think that functions of the system we designed is useful and interesting and have a positive impact on travel experience.

From the interview with the participants, we learned that many of the participants think the role-playing game plot have increased interest in traveling interaction and obtain travel information. In our gamification design, the incentive mechanism, which let user obtain travel information of other attractions by completing games or tasks for reward make them feel very surprise, and this incentive mechanism can motivate them to explore more nearby attractions. In this way, they could have more deeper understanding of the destinations. Some participants believe that following the system's story line to explore the attractions will help them to generate a complete and continuous memory of the trip, meanwhile learned more information of each destination. Moreover, the game line connects their journey memory and helps them to remember what happened during the day.

In addition, the interactive and navigation functions based on augmented reality make participants feel that virtual and reality are combined, and the appropriate interaction and game dialogue will not make them feel too immersive in the game to ignore the reality attractions, but also allow them to better understand the real attractions.

Because it is based on mobile augmented reality system, users can according to his or her preference to make a screen recording. Many participants suggested that he was very like this kind of functions, though it looks simple and it just like a game recording and the whole trip can be recorded by video, which is convenient to editor or share in the social media network or to family in the future.

However, this way of travel is different from person to person. Not all of the travelers want to play game or use digital mobile device anywhere. For some participants, they supposed that maybe they want more real-time feedback from themselves like emotion, weather, point of interesting, etc.

Moreover, the service that the system provide could be different for different travel demands. Thus, how to provide more intelligent, customized and personalized services in the future is a key issue.

Other Findings

And there is also a finding about navigation. According to the research results, people have high demand for navigation functions during travel, no matter whether it is a game or not. Most of them think that the navigation should be more accurate and easier to understand.

We also find that how to free user's hands is important as well in the future. Some participants said that they would not like to hold their smartphone all the time. They want some other form to provide guide without hold smartphone in sometime. For example, by using headphones for voice interaction and navigation, or use AR glasses.

In our experiments, we also found that this kind of interactive system based on location can not only help travelers to have a better experience, but also drive the business prosperity of the destination. For example, we can extend the interaction function to the reality businesses or with local residents.

The last but should not be ignored is that more than one participant mentioned they are concerned about safety and privacy during using this kind of system. They proposed that it seems dangerous when holding smartphone walking in the street. On the other hand, when they hold up their mobile phones to record the video, whether they will invade the privacy of other tourists is also a question we need to consider in the future

Chapter6 Future Work

Based on the investigation of user motivation and experience in this research, in the future, travel support technology will be considered from the perspective of the user-centered to provide users with more intelligent and personalized services.

Thanks to the development of pervasive computing technology and the prosperity of big data, we can use these technologies to provide users with more intelligent and customized service. In addition, the device for providing travel assistant should be more variety in the future, not only by smartphone.

And not only just in tourism. In our daily life as well, how to record personal information and how to use data around us so as to provide users with real-time information and help the user to track personal record with all kinds of devices and ubiquitous services, is the next Important issues to consider in the future.

As for this system, we plan our future work below:

1. Add more audio guide and notification as interaction;
2. Make use of SNS location-based data to automatically form hotspots for user to explore rather than we set in advanced in this case;
3. We will accurate AR navigation and expand its function;
4. Redesign the system functions and apply the system to daily use, not only for city travel and tourism of tourists, but promote resident well-being as well.

Chapter7 Conclusion

In order to study how to improve the user's travel experience for travel and tourism in the city with the information technology, this study focus on literature review of influence on travel and people's quality of life and well-beings, and investigate the information technology related to travel support, and design a gamified AR travel guide system to promote travel experience. Moreover, through the user study and interview, we understand motivation and demand of users during the travel and verify whether our proposed system helps to improve the user experience in travel.

The result shows that this system provide interesting way which can help users promote their participation and immersion in travel. Especially, this system is helpful for those who do not have the time to plan their travels in advance. In addition, the function of gamified hotspot story trigger can help users avoid missing some popular and interesting attractions, and sometimes bring travelers surprises. Based on the result and user study, this research also gives us some insight and direction for designing travel assistance system and meanwhile, make us explore the demand of human-computer interaction design about human and real-time location-based information service in the future.

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