The Discussion of Interactive Outdoor Guidance and Appliance on Smart Glasses from the Aspect of Human Computer Interaction: Taking Dihua Street for Example

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Abstract. The research has expanded Augmented Reality (AR) technology by applying the smart glasses "Moverio" with guiding systems, and has use Taipei Dihua Street as an example. After site investigation, interviewing workers, and understanding the historical, environmental and cultural background, the tour routes and associated objects are set. The smart glasses allow its users to see the complete picture of the historical building along with its introduction. This leads them deeper into the historical environment which achieves the goal of outdoor tour guiding. Hopefully, the results can be used in future AR technology researches, or other related interaction designs.

Keywords: HCI · Interaction design · Guide system

1 Introduction

While the ways of tour guiding has increased as technology advances, the purpose remains to draw people's attention, allow them to throw themselves into the atmosphere and then become interested [1]. Thus, the research has place strong emphasis on the "interaction with users" as an important element in designing guiding systems, for an interactive exhibition compared to a traditional one, can appeal to users more.

To achieve this, AR technology is used. It uses photograph calculation and imaginary technique and overlaps the virtual with the real world through the monitor. There are two advantages in using it. Firstly, the user does not need to be fixed in a certain place or equipment which makes the interaction more natural. Secondly, it maintains the original context and spatial perception by adding sensory stimulation into the actual environment which makes it easier for users to adapt and learn.

As for the location, Dihua Street was chosen. It is 800 m long and has being Taipei Tataocheng important trading post for groceries and dry food, tea, Chinese herbs, and cloth since the 19th century. The research combined AR technology with smart glasses to develop a tour guide system that can show users three-dimensional images of the historical buildings, heritages, and information of Dihua Street. For example, it gives

introductions, pictures, and voice guidance which can allow the users to become more interested in the history and culture by placing them in the actual historical atmosphere.

Different methods were used in this research. The observation method was one of them. And through interviewing workers and visitors at Dihua Street, needs of both sides were collected and set as the basis of designing the prototype. The textual analysis was also used to integrate domestic and international related cases, and their principles in interaction design.

2   Related Works

2.1   Human-Computer Interaction and User-Centered Design

The human-computer interaction (HCI) is aim to design, evaluate, and operate the system from the users' point of view. Hence, designers should understand the user mental model beforehand, in order for the users to easily interact with the computer system. In other words, to what point users can understand the system. Then, by using the right designing concept, make the system's using experience more fluent, understandable and easy to use. Zhang thinks that human and technology are the core elements of HCI. Therefore, designers should understand the human information processing mode, and cognition, action and limitation theory, as well as related technology development, whereas, the "goal" and "background" are the other elements that gives it its meaning; HCI involves many concept, like the "design", the "usability" and other related issues. However, "interaction" remains its main element [2].

Norman states that a complete human-computer interaction model can be divided into "execution" and "evaluation" which is the well-known execution-evaluation cycle. This means that the users interacts with the system consistently, and by operating and understanding how it works, the system image will become the user's mental model towards the system, and if the conceptual model is closer to the user's mental model, it means it is a more acceptable system for the user [3].

Overall, the research claims that all systems should be equipped with a good human-computer interaction. Achieving it can decrease the problems and obstacles that may occur when users are operating, and satisfy user's needs so that the system can work with high efficiency and function.

User-centered design (UCD) is fundamental to the HCI. It focuses on involving the users within the design and consistently checking whether each part has met the user's user mental model when developing the product. That is to say, UCD stresses the importance of a products usability and learnability [4].

Furthermore, experts view were summarized in the research [5–8], and it has being found that when designing products, it is crucial to find the best mode for the human to interact with the product, and make it a pleasant experience that meets the needs of the consumer. In the same time, the effectiveness and efficacy must be attended to in order to make sure that the product is usable. Thus, by using the usability principle, a user interface that is suitable for the smart glasses to upgrade the experience when using the designed tour guide system has been proposed in the research.

2.2 Related Document Discussion on Tour Guiding

The ways to tour guide has increased, and places other than museums has eventually put more focus on this service. Moreover, the innovation of technology and researches has greatly increased the quality of tour guiding. Thus, the research has looked into different aspect given from scholars.

Tilden states that the goal of tour guiding is to use the original object, firsthand experience and media to highlight the displaying item's meaning and their relevance. It is not only a way to spread facts and information, but also an educational activity. Tilden also thinks that tour guiding must combine the theme and the environment with the tourist personality and experience [9].

Edwards on the other hand states that "tour guiding" is a combination of six services. This includes guiding, educating, providing information, promoting, inspiring, and entertaining. The purpose of it is to lead the spectators to a new field through giving them new knowledge and by obtaining new interest [10].

Therefore, it can be seen from above that a tour guide is the bridge between the product and the viewers. Tour guiding involves more than facts and knowledge, but the understanding of any related medium, environment, equipment, tourist, and resources. The goal is to help users to obtain knowledge and passion.

The research has concluded five elements that are needed in tour guiding which is to lead, to educate, to entertain, to provide information and to raise interest.

- To lead: To lead the viewers through a route that is planned beforehand to decrease their sense of insecurity.
- To educate: Help viewers acquire proper knowledge, and understand the meaning behind the exhibiting object and the relation with its environment.
- To entertain: Allow the viewers to have a pleasant experience, and enhance their ability to enjoy and appreciate.
- To provide information: To give viewers right information regarding to the exhibiting object and it's surrounding.
- To rise interest: Through tour guiding, help viewers obtain knowledge and understanding of the exhibiting object and raise their curiosity.

2.3 AR Technology Development and Its Use on Tour Guiding

AR technology's development started from the year 1960, and till 1990, it stepped into the refined stage of the Virtual Reality (VR) when it was widely used on simulated training, commercial entertainment, and tour guide route planning [11].

Nowadays, there are many cases that can be seen that uses the AR technology in tour guiding. For example, Furmanski et al. have mentioned that the AR technology can use the vision of the spectators and use arrows to help the users to locate their whereabouts, and can even see the internal structure of sealed objects through overlapping images [12]. Figueroa states that experiencing virtual objects through a multi-sensory interface with the sense of vision, auditory and touch can make the displaying objects in museums more attracting then just seeing them through a glass case [13].

Below is a summary of the research and use of AR technology:

- Street Museum App

  Street Museum App was released by the London Museum as a tour guiding app. It combines smart phones with GPS positioning and overlaps the historical photos with where the person is at. These intertwining images of the past and present along with words to explain can greatly increase viewer's interest towards the history.

- TimeWarp

  TimeWarp is an AR tour guide game. Their aim is to design an adventurous game that fits the local culture by using AR technology. Players must follow directions to move to the corresponding location and interact with the virtual elements. Due to the lack of user's visual experience and to lead them through the routes when playing the game, it also provides sounds to support the players [14].

- Self-Adaptive Animation Based on User Perspective

  Papagiannakis and others used the AR technology to create virtual characters, and use them to tour guide. By doing this, they combined the historical environment with virtual images which increased the entertainment level and makes users more involved in it [15].

- ARCHEOGUIDE

  Vlahakis et al. have reproduced the ancient Greek palace through the use of AR technology and has upgraded the whole tour guiding experience by increasing its level of entertainment [16].

  Overall, this research has summarize the perspective, use and studies of the above professional scholars and combined it with the human-computer interaction theory, "usability" and other related tour guiding elements as the basis of developing the tour guiding system in this research.

3   Methods

Within this research experts of related field are invited to propose and share their point of view of what elements and function the tour guiding should include, as well as how it should be displayed through in-depth interviews. And the outline of the discussion is planned by the results of the literature reviewing.

For the analyzing and integrating of related researches, articles about human-computer interaction, usability, AR technology, and tour guide system designing were used as the reference and basis of designing the system.

Moreover, consulting professionals in the related field, as well as interviewing tour guides who works in historical sites was also conducted by using the semi-structured interviewing method. Before the interview, the questions that will be asked are planned with the respondent's perspective as the main focus. And according to situations, different kinds of open-ended questions are given. This can lead the respondent into a deeper level of discussion.

Then, prototyping was the method chosen to develop the product. Which is to propose a prototype, display it, and after testing it on users, to find out the problems as well as evaluate the actual effectiveness of the product.

The research has followed Laudon four steps of the prototyping [17] and is summarized below:

– Step1: After investigating the human-computer interaction and the tour guide system elements and incorporate it with AR tour guiding literature and cases, propose the concept in designing the system.
– Step2: Develop a smart glasses tour guide system and use literature as reference throughout the process to correct the design.
– Step3: Maintain consistent discussion with users while developing the product to find out problems and correct it.
– Step4: When the prototype is finished, observe the users level of satisfaction, see if there are any feedback, and summarize the final results and start the process of modifying.

To sum up, the research has used smart glasses (Moverio) as a development platform, and AR technology to develop the tour guide system. The interface of AR tour guide is the main focus, and the suitable interface for smart glasses has also been discussed with further hope to be useful for further researches.

4 Design and Implement

As local tourism becomes more and more popular, the use of tour guide, tour guide software and relevant research has started to be focus on. In this research it has being discovered that people may plan their schedule according to the tour guide timetable, and some may even cancel their trip because there are no tour guiding provided at that place.

However, many guiding software can be seen more focus on the navigating then the guiding function. Examples of these apps include the "YuShan National Park", the "Play in PuLi", or the "PingTung Local Cultural Museum" app. Therefore, to develop a system that can guide the users when they reach their destination, and through GPS positioning, 3D display of the AR technique, it can make the users experience a more pleasant trip without the limitation of time that may occur when attending group or person lead tour guiding trips.

4.1 The Components of Forming the Tour Guide System

The smart glasses (Moverio) has been used as a basis in this research to identify the historical sites in Dihua street Taipei through a built in camera within the glasses and achieve the goal of using AR to tour guide. System environment is developed with Unity, and has used Vuforia image recognition technique. In addition, IBeacon was used to estimate the distance that the user had from the object, and through the change of distances, the displayed information and the directions given for the objects location

may vary. Nonetheless, IBeacon only supports Bluetooth 4.0, whereas Moverio does not. Due to this reason smart phone was used to receive the Bluetooth signal from IBeacon and transfer the distance data to Moverio through WIFI Fig. 1.
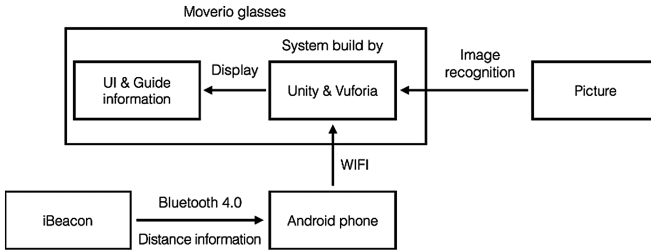

Fig. 1. Framework diagram

4.2   The Contents and Route Designing of the Tour Guiding

The Dihua Street has been Taipei's important trading post for groceries and dry food, tea, Chinese herbs, and cloth since the 19th century. It is Taipei's most preserved traditional street that has nearly all its architectures kept in their original state with four different kinds of style; modernism, western, and Baroque style. The risen of tourism has contribute to the large amount of people visiting Dihua street. This re-search has chosen Dihua Street as the target to tour guide so that its history can be displayed and continued in a good way.

After interviewing three local tour guide workers, the techniques of how to tell the history in an objective way that could allow listeners to understand the history and culture was learned. Furthermore, through analyzing the interviewing script, the actual meaning, procedure, and technique was not only understood, but also from cultural workers point of view the way to display Dihua Streets specialties through the tour routes has been collected and organized in the article below.

To emphasis the connection between Dihua Street and its building, the pieces selected to put into the tour guide all had history, culture, historical important events, and significant historical people to it. The content on the other hand focused on explaining the interrelation or relationship between the historical information given. And to strengthen it with people's knowledge, actual site was connected with virtual image.

The tour guide routes was selected and planned through looking into different aspects. First, actual field investigation was done to understand Dihua Streets local sites and knowledge. Second, experts were consulted to choose the routes and sites. Third, the historical background and local specialties was gathered from experts and put into reference for the tour guiding contents basic material. Thus, the route was planned and numbers were followed to conduct the tour guide as it is shown below (Fig. 2):

1. Lin-Fu-Jhen Trading Company: The earliest merchant that moved to Dihua and ran business was Lan-Tien Lin. However, You-Zao Lin who moved from Bangka due to business failure in the "Dingxiajiao conflict" was the one that established the

blooming economy there. Lin thinks that Dataocheng had the potential to become a commercial port. Hence, three companies Fujhen, Fuyuan, and Fuxing were built there. In the same time, a charity of businessman was formed by Lin to run business with areas in China. For example, Hong Kong, Xia-men, and this contributed to making Dataocheng the most flourished commercial area in Taiwan at that time. Thus, Lin was named as the "Pioneer of Dataocheng".

2. Hanchengtan Pharmacy: The building is in Baroque style which is a representative of Dihua Street, and is constructed with red bricks and granolithic. Tall gable walls, delicate carving of flowers and plants, and glamorous pillars all gives it a wealthy touch.

3. The House of Lan-Tien Lin: In 1985, Lan-Tien Lin moved to Dihua streets from Keelong to escape from the pirates. One of the earliest companies in Taiwanese building style which Lin named Linyishun was built in Dataocheng to trade with China, and at that time Dihua Street was still surrounded by farmland.

4. The Former Home of Wu-Hu Lin: In 1985, the Lin ancestors traveled from Quanzhou, Fujian to Taiwan. The Former Home of Wu-Hu Lin has been classified by the city government as a third graded ancient sites with three halls. The first hall was constructed with no nails in a card tenon structure by using solid wood. This demonstrates the use of traditional craft, and is convenient to take down and put back together for goods to be transferred in.
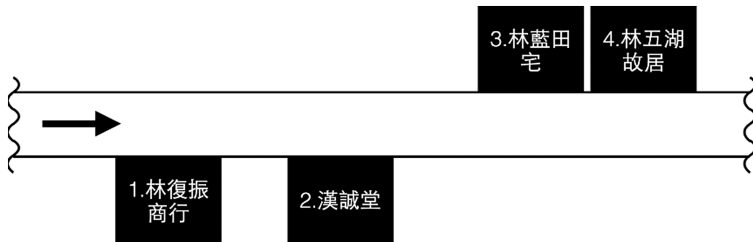

Fig. 2. The route map

4.3 The Designing of the Tour Guide System

It can be seen from literature that device guidance compared to using people to guide is that the latter is often through one to many, and visitors have to move around in groups without the freedom of choosing what they wanted to see. Hence, one of the reasons that the research used IBeacon was to distinguish through the distance in whether the person was interested or not, and then decide to what extent of information should be given. Description is given below: If the distance is 10 m between the person and the object, then only a basic introduction for example the name would be given. If the distance shortens to 5 m, a more detailed introduction with a diorama will be given. Another reason is that image recognition technique has its limitation, for it may be affected by the weather and the lights. Hence, with IBeacon as support, the system can become more stabilized.

Moreover, visual stimulation that the AR provides is not efficient enough [14]. Thus, traditional voice tour guiding function has being kept to increase the usability of the system Fig. 3.

Fig. 3.   Testing the system at Dihua Street

The tour guide system instructions:

– Step1. The user wears the smart glasses and walks on the Dihua Street.
– Step2. Users sees or get close to the selected objects by using Moverio.
– Step3. Triggers the event on the tour guiding system and use the interface and voices to introduce the objects.
– Step4. Words and pictures can be read form the screen.

4.4   User Interface Design

The principles that this research has followed in designing the interface was proposed by Tullis [18]. By only putting the necessary details on the upper right corner in the smallest size, with the interface around the screen, users will have the biggest visual range that allows a good tour guide experience. Furthermore, the related interface will be invisible till an event is triggered by the user coming within 10 m close or by the

Fig. 4.   Left: The related interface that is shown when there is a successful recognition of the image or if it is within 10 m; **Middle:** Choosing the "more" on the left side will show related pictures and introduction. Through choosing the up and down arrow, other related information can be seen.; **Right:** By using the diorama, structure and space arrangement of the building can be seen.

system recognizing the image. Also, the tour guiding system uses a diorama to let the users see the buildings whole structure and space arrangements Fig. 4.

5   Finding and Informal Evaluation

15 participants with attending tour guide experience were used in this research to antic-ipate in the user testing of the AR tour guide. The mission was to go through the planned route and a simple route introduction and tour guide system user's instruction was given before setting off. After the test, there were findings and there were adjustments been made.

The general introduction of the voice tour guiding was canceled, and only a short introduction in words would be given at the front. This is because many participants reflected that the sudden voice of the tour guiding was frightening and that from the feedback given, displaying word introduction on the screen is enough for users to make an initial judgment on whether they are interested in the object or not.

The operating and the interface of the device had no significant problems. This may be because that the user interface and the interactive logic is similar to other handhold devices. Thus, the system has matched the learnability principle. However, the partici-pants mostly would stop walking when reading the tour guide information. Meaning that, reading words may be difficult while moving around. Therefore, suggestion was given to cut down the amount of word information given and replaced it with voice introduction. Other than the reason above, other 5 participants said that it can be disturbing when the actual sites and the information can be seen through the glasses in the same time. Moreover, Dihua Street is quite narrow. When people stop to watch the tour guide, they can easily be hit by cars, or bumped by others.

Compliments from 10 of the participants includes that the AR technology tour guide device is better than handhold multimedia tour guide device. For there is no need to hold the machine for a long period of time, and to look down onto the screen constantly to match the displaying image with the actual view. However, the information given is in black and white. Thus, it is not suitable to watch for a long period of time as it can cause user's eyes to fatigue.

Other feedback includes that 7 of the participants out of curiosity would move around to test how big the angle was when seeing the 3 dimensional diorama introduction. But later on they would stop this movement with the feet and only slightly move their eyes. 12 users thought the idea of using 3 dimensional diorama to show the buildings structure and arrangement was interesting, for parts of historical sites was not open to the public, and through 3 dimensional diorama, there can be deeper understanding of the buildings characteristics.

6   Conclusion and Future Work

The use of glasses to display the AR technology tour guide has a better outcome than using a handhold device. It can more easily draw the users into the tour guiding. Never-theless, problems with users too busy to attend to the real world around them can be

seen, and to draw the line in between is the next target of this research. As within the user testing, the original tour guide interface was not visible enough which caused the target object being missed. Hence, improvement of the interface design is another following job to accomplish. Furthermore, users were found to be interested in what the building looked like in the areas that were not opened to the public. Therefore, by combining AR technology with diorama when displaying, has been found as a great advantage in AR tour guiding. As for operating the tour guide system, not much problem was found as the touch screen is design similar to handhold devices. However, the touch screen is installed on a panel not the smart glass this caused some users to feel that the button was difficult to press. To solve this problem, new tangible user interface and models will be developed to upgrade the tour guiding using experience.

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