Software Requirements for Mobile Augmented Reality Tourism Application.

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Published online: December 2016
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Abstract Augmented Reality (AR) technology have received attention in recent year due to the growing number of smartphone devices. Smartphone function is powerful enough to have the capabilities to support AR technology. One of the fields that AR can take advantage of is the tourism industry. AR application installed in a smartphone able to provide features to help facilitate tourist activities and enrich their experiences. Developing such application require a thorough study on software requirements. Thus, the purpose of this study is to analyze the requirement needed to develop a mobile AR tourism application and propose such requirements for future research and development.

Keywords: Tourism, Mobile Application, Software Requirements.

1. INTRODUCTION

The traditional way of tourist traveling is by using pamphlet of city map or travel guidebooks to navigate through the city. This type of method is favorable with an elderly person and research found out they have a good experience when using it in their traveling activities (Ireland, 2012). Further explanation gave by Brown (2007), guidebooks are designed in a structure and standardized manner, filled with information about attraction, accommodation, and point of interest including contact details and opening hours. Tourist like to be informed and get a recommendation so that they can plan their traveling activities ahead of time especially to unfamiliar places. This is due to the fact that tourist hates surprises and uncertainty on the place they about to visit (Brown, 2007). Guidebook gives a glimpse of what to expect on the recommended places, so this pique the interest of tourist to follow suits the recommended activities given by the guidebook. Having a guidebook becomes a more practical approach as it gives a sense of guide to tourist during traveling.

The only problem with these type of guidebooks is that the book is rarely updated with its contents. For example, some of the best shop or tourist destination have been close or move to other places. It will take a long time for the guidebook to update its contents. By the time the contents are updated more changes are required and it quickly becomes obsolete. Brown (2007) added that additional information and description on interesting places are needed in a guidebook as it is insufficient and can lead to confusion. He also suggests the use of satellite positioning system alongside guidebook because guidebook alone is not enough to help tourist navigate through the city to their intended destination. Using application can solve most of the problem.

Outdated contents can be solved by the using mobile application and internet connection to push a timely update to the users. Developing such application require a proper software requirements analysis. Software requirements are needed so that the application can achieve it intended purpose and objective.

Software requirements are created as a way to describe purpose and intents of solving the problems (Wiegens & Beatty, 2013). Requirements also contain condition or criteria that need to be met in order to satisfy the specification of the end product produced. This is done so application development phase that comes later can access some form of control and monitor the progress of the product to be in line with the proposed software requirements. Thus, translating the product to match the planned objective of what it is intended to be.

This study will analyze and proposed the requirements needed to develop an effective mobile tourism application. Existing mobile tourism application functions are reviewed and selected in the proposed requirements

2. LITERATURE REVIEW

Tourism has been the main driving force of economy in some countries with continued growth and diversification.
that have a multiplier effect on all types and level in a society. According to the United Nation World Tourism Organization (UNWTO), tourism market account for averages of 10% of Gross Domestic Product (GDP) year to year basis with 1.5 trillion in export earnings in 2014 alone. Furthermore, average annual growth globally is at 3.8% with Southeast Asian region account for 7.9% growth from 2005 to 2014. It is forecasted that global tourism market will grow from three to four percent more (UNWTO, 2015). The result showed that there is a high-value market for tourism especially in the Southeast Asian region and it is expected to grow more in the coming years. Malaysia takes a step further to capitalize on this opportunities by listing tourism as one of its National Key Economic Areas (NKEA) to further geared toward reaching high-income status and a developed country by the year 2020 (ETP, 2010).

Demand for tourism has never slowed down, in fact, it is ever increasing due to globalisation and ease of travel from one place to another (Castillo-Manzano, López-Valpuesta, & González-Laxe, 2011). Mobile tourism application can be the one to take advantage of the tourism growth. Mobile tourism application not only should help domestic tourist but also be built to cater for international tourist as well.

Such application can be used to improve tourist experiences (Chung, Han, & Joun, 2015; Kounavis, Kasimati, & Zamani, 2012). Tourist like to be informed and recommended interesting places as an obligatory way to make their trips satisfactory (Brown, 2007). Mobile tourism application can provide information and knowledge regarding tourist attraction or destination that are interesting to them. For example, the tourist is able to learn more about subject's history, culture or heritage. Mobile tourism application, when used in the tourism context, helps enhance tourist experience.

Software requirement is one of an important component in software development. Lack of research exposure in software requirements, especially in AR field, is even mentioned by Han et al. (2013) where they take the initiative to produce one of their own. Their proposed user requirement can be implemented in this study with little adjustment required. The user requirement will be discussed in the second part of this section.

2.1 Requirements Pyramid Model

Software requirement is a detailed description of the system or application that are about to be developed. Software requirements give reasons as to why a software needs to develop, solving a particular problem or achieving its objectives. This section will discuss on two requirements pyramid proposed by Leffingwell & Widrig (2003) and Hoffmann (2010).

The works of Leffingwell & Widrig (2003), discussed in the field of software requirement. They proposed on the topic of finding needs or problem first before proposing software requirements by characterizing it into two domain; problem domain and solution domain. Figure 1 below shows the requirements pyramid proposed by Leffingwell & Widrig (2003).

The process starts with problem domain where the needs or the objective of the project are identified. In this process, understanding the user needs is crucial as it able to tell what the current state are now, problem and opportunities. Some basic idea can germinate from this process such as tackling the problem faced. Features and software requirements are considered as solution domain. Features are services provided by the system that will fulfill the end user needs and act as a bridge between problem and solution (Leffingwell & Widrig, 2003). Lastly, specific software requirement is constructed intended to address the user needs.

Another model of requirements pyramid comes from Hoffmann (2010) research. Requirements contain criteria or condition that must be met in order to satisfy stakeholder of the project. Software requirements are used to establish the basis for an agreement between each one of them. For example, software requirements are divided into four major part called business requirements, user requirements, technical requirements, and system design (Hoffmann, 2010). Figure 2 shows the requirement pyramid with each stakeholder exists in the project.
objectives, aims, and benefit can also be considered as business requirements. Business requirements is a broad and vague statement that then be decomposed into more detailed requirements further down into the process. User requirements are the collection of user needs and expectation on how the software should do and behave. User requirements are similar to a wish list that an idea for function and feature are a discussion in a group such as a brainstorming session. The proposed idea then be categorized and sorted according to the priority and added to a list. This process also known as product backlogs. A technical requirement pertains to the technical aspects that your system must fulfill, such as performance-related, reliability, and availability issues. These types of requirements are often called quality of service requirements. Lastly, system design is the process of defining the elements of a system such as the architecture, modeling, components, and framework. In addition, the different interfaces of those components and the data that goes through that system are also considered. It is meant to satisfy specific needs and requirements of a business or organization through the engineering of a coherent and well-running system.

2.1 Discussion on Requirements Pyramid

Both requirements model proposed by Leffingwell & Widrig (2003) and Hoffmann (2010) have similarities between them. The only difference is that Leffingwell and Widrig's model make use of identifying user requirement earlier, compared to Hoffmann. Hoffmann emphasizing more to business requirements and business point of view. Hoffmann model is in favor towards organization type of requirements as the views of business and stakeholder are taken into account.

This study selects Hoffmann model of requirement pyramid as a reference. The reason for this is because Hoffmann model gives a more in-depth focus in software requirements such as user and technical requirements that can better translate user needs and expectation much better. Thus hoping to make the application more relevant and favorable for the tourist in assisting their tourism activities. This research model also suitable to be used in achieving the objectives highlighted in this study.

2.2 Requirement for Augmented Reality Application

This study will use extensively two criteria of the requirements pyramid model which are; 1) user requirements and 2) functional requirements. User requirements pertaining the user needs and task to complete that can be facilitated by the use of technology such as software application. In order for such technology to complete the task for the user, a technical requirement must be done to find out how the user requirements can be translated into a more measurable and practical way so that it can be implemented in a software development. Functional requirements pertain the descriptive of the system function, while the non-functional requirement pertains the quality attribute of the system.

2.2.1 User Requirements

There are a few types of research done in the field of user requirement especially augmented reality application (Han et al., 2013). Han et al. (2013) claimed that this is due to the nature of the technology, augmented reality to be in its infant as compared to another mobile computing context. Thus, this study aims to find out the suitable user requirement criteria to have in an augmented reality application by looking at existing research in the user requirement domain.

User requirement proposed by Han et al. (2013) make use of mobile computing context reoccurring theme to find out the user requirement of augmented reality application. 10 criteria have been found out that are needed in an AR tourism application which are:

1. Simple and Authentic User Interface
2. Relevant and Updated Information on Surrounding
3. Speed
4. Price and Product Comparison
5. Privacy and Security
6. Accessibility
7. Social Function
8. Personalization
9. Efficient and Time Saving
10. Ease of Use

Based on the selected user requirement proposed above, a more concrete technical requirements is needed to realize the user requirement in a more structured form. User requirements is a vague statement that cannot be measured (Walek & Klimes, 2012), by using technical requirements each user requirements can be given a set of description on how it should behave in the system design point of view.

2.2.2 Functional Requirements

Functional requirements refer to the statement of service the system should provide, how the system react to specific input, and how it behave in the particular situation. Functional requirements describe what the developer must implement in order for the user to accomplish their task, thereby satisfying the business needs (Wiegens & Beatty, 2013). Wiegens & Beatty (2013), claimed that producing a good and precise requirements is difficult as people need to visualize a non-existing system that will function under a specific circumstance and translate that into requirements.

The review of mobile application has been done in the smartphone market. 22 AR application has been studied based on criteria chosen by the researchers. 11 criteria have been selected for a comparative overview of each app (Yovcheva, Buhalis, & Gatzidis, 2012). These criteria are suitable to be used as a functionality for the
development of AR tourism application. Below is the overview criteria of AR application.

1. Search and Browse
2. Context aware
3. E-Commerce
4. Feedback
5. Routing and Navigation
6. Tour Generation
7. Map services
8. Communication
9. Exploration of visible surrounding
10. Interactive AR view
11. Filtering AR contents

There is other research done in the mobile tourism application context. According to Dickinson et al., (2014), primary mobile application function in most tourism application replicate other information sources such as travel guide and website. The common function is listed as follows:

1. Information
2. Two-way sharing capabilities
3. Context awareness
4. Internet of things
5. Tagging

Both of the researchers proposed the function of a mobile tourism application. There are many similarities between the two reviewed studies. Information, two-way sharing, context aware, and tagging have been found to be proposed by both studies. A study by Dickinson et al., (2014), shows that the proposed function are relatively general and cover most of what have been proposed by (Yovcheva et al., 2012). Thus, this study will adopt the works of Yovcheva to be used in the functional requirements of the requirements pyramid.

2.2.3 Proposed Requirements of Mobile Tourism Application

The comparison has been made to 10 mobile tourism application in this study. The comparison is used to find out the most reoccurring function in mobile tourism application. The result suggested that the most popular functions are 1) Search, 2) Map and Navigation, 3) Location aware, and 4) Information Portal.

From the previous discussion, the user and functional requirements for mobile tourism application are shown in Table 1.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>1. Simple UI</td>
</tr>
<tr>
<td>Requirements</td>
<td>2. Location Aware</td>
</tr>
<tr>
<td></td>
<td>3. Speed</td>
</tr>
<tr>
<td></td>
<td>4. Affordability</td>
</tr>
</tbody>
</table>

Table 1: Proposed Function for Mobile Tourism Application

3. METHOD

This study will use design science research process model (DSR Cycle) adopted from (Vaishnavi & Kuechler, 2004) that contain the flow, process, and output necessary to do a systematic research. Table 2 below shows the design research process model. The methodology contains five important steps which are listed as follows. Awareness of the problem, Suggestion, Evaluation and Development.

<table>
<thead>
<tr>
<th>Process Steps</th>
<th>Expected Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness of the Problem</td>
<td>Solution</td>
</tr>
<tr>
<td>Suggestion</td>
<td>Tentative Design</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Performance</td>
</tr>
<tr>
<td>Development</td>
<td>Measure</td>
</tr>
</tbody>
</table>

Table 2: General Methodology of Design Research

3.1 Awareness of Problem

The first phase is the identification of a problem exist in software requirement field. Currently, there is insufficient attention given by research community on software requirements in mobile AR tourism application. Development in the mobile application cannot proceed without proper software requirements. Thus, by analysis of other literature, this study found out that there seem to have a gap in software requirement in mobile AR application. Analyzing software requirement on another computing context such as web or desktop application, a proposed software requirements can be constructed in mobile AR tourism application.

In order to solve the problem, two objectives in this research are highlighted. Firstly is to analyze the requirements needed specific for mobile AR tourism application context. Secondly, proposing the requirements necessary for the development of mobile AR tourism application.
3.1 Suggestion

In this second phase of this research, the suggestion is required to further help in the development of mobile AR tourism application. Software requirements proposed are adopted from already establishing computing requirement as well as research on tourism field. Requirements studied to allow for the mobile application that is to be developed able to reflect on end user needs and expectation. Using latest technology such as augmented reality and other useful function and feature included in the application is to appeal to the potential users and helps them in their tourism activities.

3.2 Evaluation

Validation of the proposed software requirements will be the third steps in this study. Proposed requirements in this study consist of the user to technical requirements, thus evaluation are done to the user (user requirements) about the functionality of the application (functional requirements). The questionnaire will be used to validate whether the proposed user requirements are correct and reflect the needs of the user. The questionnaire is distributed to 105 total respondents by means of social networking sites and tourism forum.

3.2 Development

In the development phase, a proposed software requirements will be introduced. This software requirement can then be used in application development that can fully capture the needs and expectation of the user.

4. FINDINGS

Requirements pyramid have layer stacked on top of each other. Each layer represents a task or requirements for the application developed. Each of these that can be detailed up further down it goes. From the requirements pyramid, user requirements are converted to technical requirements.

User requirements are considered as customer perspective and that their needs and expectation of using a particular system or application is very crucial to the project. Their comments and feedback are collected as user requirements. Due to the fact that user requirements are in the form of description or ‘wish list’, it cannot be measured. Thus, a more concrete and precise solution are required that can be measured and controlled.

Technical requirements describe the feature and functionality of the planned project in more technical terms. In technical requirements, there exist a form of measure or control in the project.

Data on the questionnaire distributed are collected and analyze. A measure of the central tendency method has been used to analyze the data from the 105 total respondents. Table 3 below shows the result of the mobile tourism application functions.

<table>
<thead>
<tr>
<th>Functions</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search &amp; Browse</td>
<td>Mode 5</td>
</tr>
<tr>
<td></td>
<td>Median 4.0</td>
</tr>
<tr>
<td>Context aware</td>
<td>Mode 4</td>
</tr>
<tr>
<td></td>
<td>Median 4.0</td>
</tr>
<tr>
<td>E-Commerce</td>
<td>Mode 4</td>
</tr>
<tr>
<td></td>
<td>Median 4.0</td>
</tr>
<tr>
<td>Navigation</td>
<td>Mode 5</td>
</tr>
<tr>
<td></td>
<td>Median 5.0</td>
</tr>
<tr>
<td>Tour Planning</td>
<td>Mode 4</td>
</tr>
<tr>
<td></td>
<td>Median 4.0</td>
</tr>
<tr>
<td>Map</td>
<td>Mode 5</td>
</tr>
<tr>
<td></td>
<td>Median 4.0</td>
</tr>
<tr>
<td>Location aware</td>
<td>Mode 4</td>
</tr>
<tr>
<td></td>
<td>Median 4.0</td>
</tr>
<tr>
<td>Personalization</td>
<td>Mode 4</td>
</tr>
<tr>
<td></td>
<td>Median 3.0</td>
</tr>
<tr>
<td>Social Network</td>
<td>Mode 4</td>
</tr>
<tr>
<td></td>
<td>Median 4.0</td>
</tr>
<tr>
<td>Internet connection</td>
<td>Mode 4</td>
</tr>
<tr>
<td></td>
<td>Median 3.0</td>
</tr>
</tbody>
</table>

Based on Table 3, functions proposed have positive response most notably search and browse, map, and navigation. These functions are favorable compared to others and scored a high frequency. This is probably because the user likes to search and browse interesting places based on their current location. An example of a mobile application that has these functions are a point-of-interest (POI) application.

Location based application such as map and navigation have been discussed multiple times in research (Brito, 2015; Buhalis & Jun, 2011; Han, Jung, & Gibson, 2013; Hannam, Butler, & Paris, 2014; Jung & Han, 2014; Olsson & Salo, 2011; Yovcheva, Buhalis, & Gatzidis, 2012). Location seems to be the core function in mobile tourism application. This function helps tourist navigate unfamiliar places, see surrounding area, interesting places, and receiving relevant information. The next trend in mobile tourism application function such as context-aware will be using location as context clues to send user relevant information (Dickinson et al., 2014; Han et al., 2013).

5. CONCLUSION AND FUTURE WORKS

The software requirements can be used to collect the needs and expectation of tourist in their traveling activities. Using user-centered design, these requirements are given extensive attention at each stage of the development process so it can satisfy the end user needs. Mobile application suit best in tourism context because it is mobile and powerful enough to provide useful features to assist tourist.

The software requirements are useful and can be adopted to various discipline especially in mobile application development. Data collection and analysis can be done to other location or countries to find out the user needs and expectation of that particular place. This area can be explored further in future research.

4. REFERENCE
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