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Study of the use of Handheld Devices for Tourist Navigation

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Abstract

This paper describes the first phase of the research performed to identify the profile of the users of handheld devices, grade the performance of such devices in tourism situations and to evaluate commonly used applications etc. It is particularly under consideration of customer satisfaction with graphical user interface (GUI) to these applications and their use in the full mobile location - based services environment. The target group of users were average people, who occasionally undertake tourist trips to unfamiliar areas in their homelands or abroad. The survey was conducted in Croatian and English with respondents from Croatia and the EU. The survey results revealed the information about their habits, geospatial/technological skills and abilities, previous task experiences, the frequency of travel, and psychological features such as attitude and motivation. The analysis results defined the problems encountered by users in the use of applications for tourists primarily intended for navigation and searching for geoinformation, but also the problem of customer perception in relation to the information requested. The classification of user profiles in different categories gives an interesting pattern of users, based on their general needs and variations within each category. Generally, holiday-related travel (i.e. tourism) is largely characterised as carrying out tasks in pursuit of goals, without the need or presence of rigid aims. Indeed, the purpose of today's tourism is simply to 'experience' a new location, which may require little to no planning. There are, however, a number of high-level tasks and associated goals that can be attributed to the use of geospatial information in mobile environments, and in tourism in particular, which are expected to be relevant for the target user community.

Keywords: Tourism, handheld devices, usage, GUI, applications

Introduction

Currently, the statistics show that 91% of the world population possesses some kind of mobile device. Smartphones take up 56% of those devices. They have become essential for most people and performing everyday tasks without their help would be hardly imaginable. Tablets, smartphones and other mobile navigation devices are personal computers with incorporated functions of other popular devices such as mobile phones, PDAs, digital cameras, devices for the reproduction of sound and videos, and GPS devices. They have Internet access and an operational system, which can start various types of applications. Because they are practical, portable and multifunctional, they are slowly replacing all other devices.

Mobile Location Based Services (mLBS) available on smartphones and occasionally on handheld devices are becoming increasingly widespread and popular nowadays. There are a growing number of people with access to geoinformation on their mobile devices. They use them to get answers to position-related questions such as "Where is the nearest ATM?" and "Which direction leads me to home?" mLBS were developed 1996 in the US to increase the efficiency of the reaction to emergency calls to 911 from mobile devices. They were used to see the location of the caller, that is, the location of the mobile devices used to make the emergency call. Huge moves in the development of technology, such as the development of 3G and 4G mobile network, the improvement of positioning techniques on mobile devices and developing new functions and options on smartphones through new application have spread the use of mLBS to higher dimensions. The technology for locating users has evolved and is no longer used only in rescue situations, but also in everyday life when a user needs local information (navigation, weather forecast) and information on the location of various (POI) objects, institutions and other persons. The market of applications using mLBS is constantly growing, along with the number of its users. Therefore, it is important to know the needs and the wishes of users to offer the market an application that will attract most users and bring most profit to the developer. This paper researches the details, techniques and methods that influence the creation of user interfaces for applications, bringing into view the interaction of users, who are not necessarily professional cartographers but common, everyday users of all age groups, with all other factors. The interface should enable the user to focus on the task and on performing it intuitively. It is a "window" into the application and the summary grade of the usability of the interface and the quality of maps should correspond to the popularity of an application.

Existing Projects

Marti Hearst offered many useful recommendations for user interface design (Hearst 2006, White 2007). Users play the key role in the success of any application, as they are the ones who create the demand for a certain type of

service and decide upon whether an application should be applied or rejected, based on their user experience with it. The accepted cartographic depictions were mostly chosen in accordance with the development of technology (Reichenbacher 2004). The programmers have been emphasizing the improvements in technology, especially taking into consideration the users, their individual goals and expectations. This has been an improvement from the research of map use and technical aspects of map making during the 1980s and 1990s (van Elzakker 2005). The development of design in accordance to modern technology is very important. (Goodchild 2005). The need to bring more attention to the habits and demands of users in developing information systems has been recognized for a while now in many branches, especially in the field of Human Computer Interaction (HCI) (Gould and Lewis, 1985.), (Nielsen 1993). Cartographers have as well become aware of the increasing need for research. Although previous researches focused on map use and the evaluation of geovisua lization and multimedia maps, they rarely included real users. (van Elzakker gives examples). The next step would be to spread the scope of cartographic research to the characteristics and the needs of users and the hardware, software and cartographic user interfaces used. This is of special importance for mLBS, considering their unique restrictions related to technology and content. A similar need has started to be recognized in many other fields. (Reichenbacher 2004). The main goal is user orientation and the provision of usefulness in geospatial data communication through mLBS applications. This would be achieved by using the UCD methodology, which is increasingly being supported by programmers and researches as a method of developing products that satisfy the needs and expectations of users.

Maps on mobile devices enable users to see their current position at any point and to view digital maps from any location on the Earth's surface. In comparison to traditional maps, online maps, if distributed directly from the database, can provide real-time view. Other advantages of mLBS are that they give detailed information about the weather in a local area and the locations of certain services and objects (POI).

There are many instructions for designing UIs (user interfaces), varying from general outlines to very detailed and specific ones, but most of them deal with how to modify them for desktop computers (Shneiderman and Plaisant 2005; Liu 1997; Nielsen and Molich 1990; Hoh and Thomas 2000). Numerous researchers have tried to summarise them into a few categories of usability by following the principle of "thorough, widely applicable and long-lasting" (Shneiderman and Plaisant 2005 , p.66), while still remaining adjusted to designers and programmers (Nielsen and Molich 1990). The most remarkable ones are Donald Norman with his seven principles of designing everyday things (Norman 1990), Ben Shneiderman with his eight golden rules of interface design(Shneiderman and Plaisant 2005), and Jakob Nielsen giving his ten usability heuristics for user interface design (Nielsen 1993). Each of them proposes design solutions based on a similar concept of design.

Karen Wealands wrote her PhD thesis in 2007. Wealands' focus was exclusively on tourists and testing the prototype of the application for helping

tourists in their journeys called "Holiday Assistant", as well as the use of navigation, spatial orientation of the users and the use of LBS. The research was also conducted by using the UCD method of interviewing correspondents through surveys and interviews to determine the level of efficiency of the "Holiday Assistant" applications for target users.

Tumasch Reichenbacher generally reviewed the visualization of all geographic content on mobile devices in his paper „Mobile Cartography – Adaptive Visualisation of Geographic Information on Mobile Devices" at the Fakultät für Bauingenieur– und Vermessungswesen of Technische Universität München. The elements of visualization he dealt with were cartographic depictions, user interface, geoinformation and LBS. He theoretically enhanced and proved the methodology of depicting geoinformation on handheld devices, considering their advantages and disadvantages.

Some researches on the use of graphics on small screens have been conducted, but maps are usually more complex than pure graphics. Furthermore, the smaller the screen, the bigger is the importance of problems regarding the graphics, such as the definition of minimum depiction dimensions. Neudeck (2001) studied various recommendations for minimal map dimensions on mobile devices and offered a new range of border values based on conducted tests. The minimum dimensions should be much larger on mobile devices to provide the optimal readability on small displays. Neudeck also presents the first practical guidelines for the graphic visualization of maps that can be applied in the design of maps for mobile devices.

An interdisciplinary research group from the European Media Lab (EML) has developed the prototype of a digital personal mobile tourist guide for the city of Heidelberg. The "Deep Map" integrates the research from various fields of information technology, such as geoinformation systems, databases and intelligent user interfaces. The aim of their project was to develop an information technology that could handle huge heterogeneous collections of data and can deal with complex functionality, yet remain available for inexperienced persons, such as common users. The core of the tourist guide program is the GIS system. However, GIS will eventually spread onto the fourth dimension by integrating time information (e.g. the visualization of changes in the course of history of a town). Trip planning, virtual walks and locating the user via GPS were the main tasks in this project. "Talking Map" was an interesting sub-project, which researched voice recognition, natural language of input/output interface and voice instructions. The specialness of voice output was at the time of the research a new, alternative way of providing the user with spatial information. No similar research has been conducted in Croatia so far.

Survey on the Habits and Needs of the Users of Mobile Location-Based Services and Devices

There were 214 participants in the survey from the Republic of Croatia and the rest of the EU, as well as from the Federation of Bosnia and Herzegovina, and the Republic of Serbia.

Survey Goals

The goal of the survey on the habits and needs of the users of mLBS and mobile devices was to gather as much information as possible from a large sample of respondents working in the field of geodesy and geoinformation science, but also in other fields of expertise. These information regard the frequency of the use of navigation applications on handheld devices, their usability levels, and the advantages and disadvantages of user interfaces.

Survey Construction

The survey was divided into five sections with the titles: Section A – General Information about User Profile, Section B – Travels, Section C – Location and Geoinformation Search, Section D – Current Use of Mobile Devices and Section E – with affiliation of users who are willing to cooperate within further research.

Section A collected information considering the respondents' demographics, education level, etc. for the purpose of categorizing the participants and comparing those information with the results in other parts of the survey to establish correlations. It contained five questions of closed type.

Section B was supposed to gather information about the users' travelling habits, travelling frequency in homeland or abroad and the use of navigation applications during those trips. It comprised eight closed and open-ended questions.

Section C referred to the opinions, needs and wishes of participants regarding navigation, space orientation and searching for geoinformation. It contained five questions of closed type.

Section D comprised eighteen questions referring to the participant's current use of mobile devices, tablets and other mobile navigation devices, their handling them, as well as personal opinions and attitudes. They were questioned about how important it was for them that the navigation application contains information about the location of different objects and services. In the end, they had to evaluate certain applications according to defined characteristics: appearance of the user interface, speed of reaching wanted information, simplicity of use, quality of geoinformation provided and personalization options.

In the E section participants were able to leave comments regarding the survey and their contact if they were interested in further participation in the project.

The invitation for the participation in the project briefly explained what kind of a research they would participate if they decided to do so, the goal of the research, privacy statement and the definition of LBS services.

The time to fill out the survey was not limited.

The creators of the survey aimed to satisfy the following seven criteria. (de Vaus 1995):

- Variation – Questions should elicit answers that provide a spectrum of variations, so that the results differ and could be compared.
- Meaning – The respondents should clearly understand each question, and the evaluator should understand their answers.
- Repetition – Questions that provide similar answers should be eliminated.
- No answer – There should be a minimal number of unanswered questions, which is accomplished through questions that are clearly stated, unassertive, moderate in length, not repeated, etc.
- Sequence – Questions should connect to each other. The transition between the sections should be almost invisible.
- Time – filling out the survey should not require much time.
- Interest and participant's attention– If they are not accomplished, participants will skip questions or give false answers to complete the survey as fast as possible.

Expected Survey Results

The participants were expected to give honest responses to evaluate the current interface of the navigation application that they had the chance to use in their everyday life, to point out their flaws and difficulties in use due to not being able to successfully operate the interfaces on mobile navigation devices. They were also required to answer the questions regarding their general travelling habits, activities they usually do, and the ways they manage with space orientation and navigation on trips. This served to obtain information on how they indirectly find answers to questions relevant for all travellers or tourists on vacations, which a navigation application should contain. It is expected that most users will emphasize the same disadvantages of navigation applications, and that it would be possible to make new suggestions for the model of cartographic user interface for each application respectively.

Conducting the Survey

For economic reasons, it was decided to distribute the survey per Internet. The participants were mailed the link, and they could fill it out at their homes at the time they preferred. The survey was voluntary and anonymous. It was made in Microsoft Word 2010 and posted online through the free online service for surveys – e.Surv. The time for filling out the survey was not limited. It was not obligatory to answer all questions, which were closed-type – where users could choose one of the given answers, and open-ended – where

users could fill out the answers themselves. The survey was active since January 28th 2014 till April 3rd 2014. The results were analysed in MS Excel 2007 and MS Word 2007. The characteristic answers were chosen to show the answers to open-ended questions, and the repeating ones were left out. URL 2 contains a link to the survey. The languages chosen for the survey were Croatian and English (Župan 2014a).

Results and Findings

Survey Results

In the following chapters we give only the most interesting parts (questions and answers) in the polls and interviews regarding the use of navigation software and hardware and usability of the typical tourist situations. Users of LBS will give their views on the disadvantages and improvements through the use of functional and geovisualization tools of small handhelds. Survey results are as follows:

Describe the factors that made the ride dangerous? Answers can be grouped regarded:

- handling the device during the ride ("Watching the mobile phone diverts attention, causing the driver to approach the end of the track with his vehicle.")
- no voice navigation option ("The navigational system had no vocal instructions. The driver was watching the screen, rather than the road. Possible car crash was avoided.")
- misleading to a wrong/inexistent way ("The navigation device directed us into the woods and offered us an exit across the path for pedestrians leading to a very busy road, and there was no way for us to go back. Luckily, the driver's experience got us out of that situation. However, that was seven years ago, when navigation devices were much less developed than today.").

If YES, explain how?

Answers related to:

- poor readability on too small screens, because they show only a smaller part of the map, which complicates spatial orientation: "A smaller screen makes distinguishing the details more difficult. It requires more time to concentrate on the visualization."
- the characteristics of the display itself, such as slow response time, bad touch mechanism, poorly developed zoom in/zoom out options: "Unsatisfying level of customisation of the data provided", "screen contrast issues"

- reflection in the daylight, poor adjustability of screen brightness: "Too small size of the display, reflection, reflecting of the sunlight and from other light sources."

What Problems did you face when looking for the Target Location during Navigation?

- "I didn't know what the official name of the street was (example: fra Andrije Kačića Miošića Street 26 is not the same as Miošićeva Street 26)."
- "I was following the road suggested by the navigation device but there was a church on that road and I had to take the other way. The road suggested was covered in grass and not suitable for a vehicle."
- "Target location is not shown precisely enough"
- "Instructions were unclear."
- "Maps of some locations are not up-to-date"
- "Maps are not updated. Some roads don't exist. Road works were in the process. The device leads to the turning points where it is not possible to turn by car."
- "House numbers were missing."
- "I had difficulties with traffic jams, the language of the navigation device and not knowing the street name."
- "The search itself should not limit the way of searching. It is desirable that the search enables us to enter the coordinates, street name and house number and the place."
- "The device couldn't find the street because it doesn't recognize diacritics in street names and because it requires the full street name (e.g. Pavao Šubić Street instead of just Šubićeva), the route suggested by the device was closed/ changed/ doesn't exist.
- "It does not find the shortest way."
- "Language barrier; outdated maps (digital and classical)"
- "How to get there - which transport to use (metro, bus, train or something else)."

Which Problems did you face when determining your Current Position during Navigation?

The standard answers were:

- "Satellite signal was poor."
- "Insufficient accuracy. Sometimes the location would vary up to 100 meters."
- "The time needed to determine the position through the GPS signal."
- "Roads and paths were not entered into the system. "

According to your opinion, which are the biggest advantages of navigation applications and the access to geoinformation on mobile devices against paper maps or city plans?

- "The simplicity of use, amount of data, fast search, locating and movement tracking"
- "A big amount of information is available in short time."
- "An advantage is the fact that they are on my smartphone, which is constantly on me. I don't need to carry an additional paper map or a city plan; simple search – I just enter the address or the object that I'm looking for and the application shows them"
- "Less subject to the outdoor conditions, more maps can be stored in one device, map scale can be changed (zoom)."
- "Easier space orientation. Voice instructions lead to the goal."
- "The biggest advantage would be the immediate availability of geoinformation."
- "The option 'search' or 'search route calculation' would be the fastest and economic one."
- "An advantage is the option to make a route."
- "They can show you the way to the desired location and facilities, while on a paper map you have to orientate yourself to a specific location and it usually doesn't show you all information, because they would be very complex and hard to read."

According to you, which are the biggest flaws of navigation information and the access to geoinformation on mobile navigation devices in comparison to paper maps or city plans?

- "Price, they don't work without a battery (electricity)
- "Incomplete information. Sometimes inaccurate and imprecise."
- "Lack of Internet connection on some places."
- "It is harder to orient one regarding the current location in relation to the larger area (the depicted area is restricted due to screen size)."
- "Some cartographic standards are missing."
- "Mobile devices are more expensive than paper maps."
- "If you are abroad, the cost of data transmission to the smartphone can be very high."

Complete poll results can be found at Župan (2014c).

Interview Results

Some of the most interesting interview results and comments together with the questions are available at Župan (2014b).

Conclusions

The majority of the surveyed population turned out to be men (62% of the respondents), in the age group between 18-24 years of age (78%), with finished secondary education (57%) and educated in the field of geodesy and geoinformation science (87%). The current residence of the majority of respondents was the city of Zagreb, Croatia. This data formed the basic profile of participants in the first part of the survey.

Regarding their travelling habits and the use of geospatial information, the results of the questions from Section B showed that the biggest part of them (32%) travelled outside their residence in their country more than 12 times in the last 2 years, and abroad 1-3 times (54%) in the same period. Most frequently used travelling means were car and bus. When asked whether they have ever been in a car accident because of using the navigation device during the rid they all answered negative, but 6% had to avoid a dangerous situation. 82% of participants think that the characteristics of displays used in navigation handheld devices satisfy a desired level of use.

In Section C, the respondents expressed their own wishes and needs regarding the search of locations and geoinformation. The means they mostly use for navigation and spatial orientation were apps on handheld devices (18% of the respondents), road markings (15% of the respondents) and online maps (15%). To look for geoinformation on objects, they most frequently use apps on mobile navigation devices (26%) and online search browsers (31%). The majority of the respondents were students from the faculty that deals with topics from the field of geoinformation, GIS, cartography and geography (26%). The question on how important it is for them to have the information on the location of objects listed, that is, how often they search it, the most useful information turned out to be connected to gas stations, ATMs, markets, hospitals, Wi-Fi hotspots, public transport and touristic attractions. The least useful information were the locations of bet shops, insurance companies, rent-a-car dealers and florist shops. Most of respondents need to search geoinformation 2-3 times a week (27%) or once a week (19%).

The last part of the survey explores the current use of handheld devics and navigation applications. Eighty-four per cent of the participants use a smartphone. Most popular ones are: Samsung Galaxy S2/S3/S4/Nexus, Samsung Galaxy S4, Nokia Lumia 820, Samsung Galaxy Tab 3, LG Optimus 4X HD/ LII, Magellan, iPhone 4/4S/5/5S, iPad, Garmin Monterra, HTC Desire 200/One, Sony Ericcsson Xperia, Pipo S3, Navigon, ZTE Blade III. Eighty-four per cent of them use their mobile device daily, that is, more times a day, and the majority of participants use navigation applications and access to geoinformation 2-3 times a week. When asked how much are they willing to pay to use the navigation application and access to geoinformation with the improvements they suggested, 41% left a blank answer and 47% answered 10 – 15kn (~1-2 euros). Twenty-seven per cent of the respondents evaluated their handling navigation applications on handheld devices as “with ease”. It was also shown that they tend to follow voice instructions easier than the written

ones. 39% of the respondents think that it is easier to follow the instructions when they point the direction in reference to some familiar markings. Twenty-one per cent of the respondents always use the same application because they desire not to learn how to use new ones. The options, which users want to have most are the ones that enable finding the fastest and the shortest route. Voice navigation and paper maps are the most desirable forms of navigation. Sixty-eight per cent of the participants responded they liked using mobile navigation devices. The information most searched for was: use instructions (31%), weather forecast (23%) and public traffic schedule (19%). Among the offered applications (Copilot GPS, OsmAnd Navigation, Navfree, Sygic, Mireo GPS, iWay GPS Navigation, Maps +, Google Maps) the users mostly use Google Maps and Maps+, 2-3 times a week in average. These same applications have been graded as the best, regarding the appearance of the user interface, the speed of acquiring wanted information, simplicity of use, and the quality of geoinformation, ,as well as information about the traffic. The best grades regarding the level of personalization options were given to Google Maps and iWay GPS Navigation.

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