Mobile Systems for Guidance of Dependant People: Integration of User requirements and Location Based Services

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ABSTRACT
This work deals with the problem of personal localization and guidance for impaired people. The authors analyze the user's requirements of two groups: elderly and visually impaired people. The goal is to provide users with the most accurate and reliable technology depending on users' profile, adapting the information's contents to their specific needs. Location based services, integrated in a mobile device, will serve as a pervasive system which ensures the availability of the proposed solution.

Categories and Subject Descriptors
K.4.2 [**Social Issues**]: Assistive technologies for persons with disabilities. H.5.2 [**User Interfaces**]: Graphical User Interfaces. User-centered design.

General Terms
Design, Experimentation, Human Factors.

Keywords
LBS, visual impairment, navigation, mapping, dependant people.

1. INTRODUCTION
The development of location systems is driven by the growing demand of location-based services applications, such as objects or goods location or person location. From the point of view of applications that provide personal services, there is an increasing demand of that kind of pervasive services with very different purposes: professional, personal, recreational, safety, etc. Care services also are becoming assisted by location information.

When we restrict ourselves to a collective of citizens who have special needs, sensorial, motor or cognitive (dependant, disabled and elderly people), location based services can provide end users with a high level of autonomy and safety through the assistance these services can supply [3]. Thus, they promote their social inclusion and the ability to avoid physical obstacles by appropriate guidance.

In order to provide a proper location management platform, the development of a location management system is required. Besides, it provides roaming facilities to the mobile devices linked to the system.

2. USER REQUIREMENTS: APPLIED METHODS AND TARGET GROUPS
The goal of this study is to know users opinions and experiences about their habits in their routes as well as strategies and utilities users make use of in their urban routes. On the other hand, another aim is to detect user's needs regarding assistive solutions which could help them to move easier and to know the features they would like to find in a GPS or navigation device [1].

Initially performed studies were focused on elderly people and also visually impaired people. Due to the different average age of the two groups (70 and 40 years old respectively) and level of knowledge about location technologies, different approach regarding methodology for requirements specification has been applied. In addition, users who never use technological devices such as PDA, GPS systems (or any other application related to electronic maps) don't know the technical "language" to discuss their special needs.

Regarding elderly people, they were all sighted, but some of them had visual impairments to a certain level. They were a total of 12 people for the test (70 years old as average), divided in two main groups of users:

- 6 people living in a nursing home, located 15 Km away from Bilbao. They have been living there for 2 years, as average. They usually go out for a walk in the surrounding garden. Sometimes they go to the doctor or to do some shopping to another city, always accompanied by a relative.
- 6 people living independently in their homes, both in big cities and in small villages. They are able to perform almost all kind of daily living tasks (even driving a car).

Each of the volunteers was interviewed separately. The method consisted of:

1. A Google map was shown to the user, explaining the aim of the first part of the test: which were his/her abilities to do a certain route (shown on the map), orientation skills, usual ways to travel a route, etc.
2. A GPS or PDA was shown to the user, with different menus and options of the navigation application. The aim was to obtain her/his feedback about the functionality, accessibility issues, interaction, etc.

3. A questionnaire with close-ended questions was then fulfilled. In any case, they were willing to explain in detail their way to proceed and the interviews ended with open discussions about their problems and needs.

The second group (visually impaired people) has answered a questionnaire consisting of 27 items (open-ended questions) in two groups (partially sighted and blind, between 18 and 60 years old, and with different levels of expertise with tactile maps). The 27 items were organized by categories. The meeting with the focus group tests lasted 2 hours.

The 27 questions were grouped by categories:

- Learning and training, 1 question.
- Habits in customary routes, 8 questions.
- Use of technology, 3 questions.
- Habits in routes, 7 questions.
- Needs in routes, 8 questions.

2.1 Requirements of Elderly Persons

One of the problems that they face is getting lost. Here we have to distinguish two different sources of the problem: one caused by some kind of cognitive impairment, and the other one by simply having lost a geographical reference. Other requirement coming from elderly people is that they would like to avoid long and steep walks. The first help they search for is always asking people for support. However, some of them would like to have a device that could help them instead of having to ask, thus they will be more independent. After seeing a demo of the TomTom on a PDA (Acer C530) they think it is very useful and half of them will use it (those who live independently). Regarding the way of getting the information, they prefer having a combination of audio and graphical information. The majority of them select the buttons as interaction way but there was also a person who would prefer using voice command to interact.

People interviewed in nursing homes were too old to give a suitable feedback about the use of internet and mobile devices for navigating. They were not used to use computers, either. Their main helping advice for travel comes from their relatives. Their usual routes were known destinations, and they never go out alone. On the other hand, people living independently are most used with the use of mobile devices, mainly mobile phones, but not GPS or PDA for navigation. They find them useful and they are willing to use [4]. Main problem for them is the difficulty to use the user interface, the size of buttons and screen, the appearance of menus and geographical information. They would like to access the device in easier way, such as voice commands, bigger buttons or simpler menu options. The ideal appliance would be the ubiquitous one they are not aware of.

2.2 Requirements of Visually Impaired People

All users have their own special and different needs. The aim of the requirements specification was that, if we can solve the needs in the worst conditions, then we shall have a better way to manage the problem of navigation in urban environments in most of the cases. The system should be flexible enough so that the user can set up the parameters for every personal need. Other important aspect for us is the ergonomics and usability of the device. The device must be omnipresent but should not disturb the user when he/she is moving during navigation. For example, a blind person makes use mainly of auditory information coming from his/her surroundings, therefore audio instructions coming from a GPS device are not the best solution to use.

The study undertaken shows that it is a difficult task to create a list with all the possible user profiles, making every user feel clearly identified within a profile. Each user has his/her own functional diversity and face the situations, which may happen in the urban thoroughfare, in many different ways according to their limitations, not only physical and/or cognitive but also according to their abilities and aids they use. Therefore, it is necessary to create some predefined profiles so that users can choose the ones that meet their needs in the best way, but allowing them to personalize their combination, indicating to what extent users are affected by the different kind of events in their way (doors, pedestrian crossings, barriers, street works, etc.).

In the surveys that the users filled in, there were some obstacles and events listed. Users could assess to what extent they could be affected by them in an urban route. The analysis of the answers shows what kind of events affect each user profile and to what extent. Additionally, users have suggested new kinds of events which were not taken into account at the beginning, which gave a broader perspective of all the circumstances to be considered by the system.

As a result of the study of the different kind of events, regarding navigation and guidance, the system should take into account two kinds of situations:

- temporary (as for example related to a scaffolding or a trench),
- permanent (as for example related to a pedestrian crossing with a traffic island).

The ideal device that user thinks of as a personal assistant for navigation and routing should meet some requirements.

- The system must have a high degree of personalization to fit their needs by means of a rich interface. It should be reconfigurable and easy to use the configuration options. The best solution would be a device capable to detect automatically the main characteristics of the user, and thus adapting its technical features to them.
- An adequate communication interface should make use of enough alternative methods to guarantee a good person/machine communication for each one of the user profiles (vibration, alert sounds, voice, etc.) [6] [8]
- A big reliability of the system in aspects related to reception sensitivity and accurate processing of data which come from a group of satellites is required. A related issue is the level of resolution of the maps.
- Location services should be improved in order to acquire position data when we are stopped or moving slowly.
- Product design should be focused on achieving a small size of the device, in order to guarantee that it can be easily carried (they have described daily life devices such as mobile phones). But this requirement must take into account also a minimum level of physical accessibility (size of buttons and screen).
- Finally, already known requirements as the easy to use, accessible system, autonomy and easy to recharge were also mentioned.

3. PROPOSED SERVICES AND TECHNOLOGIES

In order to fulfil the user requirements identified, several wireless technologies [2], [5], [7] will be integrated and location-based services for mobile devices will be developed, under a common service platform using the "Design for All" principle. The aim is to ease the access to personalized services to visually impaired and elderly people. The system will be able to collect data from the environment and other systems, and to provide services in such a way that the user can interact with it in an accessible manner.

Proposed technology for location based services in outdoor environments is GPS, but also WIMAX and GSM are under study. For indoor locations, the analyzed technologies are Bluetooth, WiFi, Radio frequency Identification (RFID) and Ultrawideband. The main innovation for the proposed system is the option of profiling features, which adapt the way of providing information to the user's special needs. The location, navigation and general data to be sent to the mobile device will be converted to audible or haptic information if the user is blind, the displayed format will be adapted in form of colours and font size is the person is partially sighted, or the contents will be adapted if the user has to use a wheelchair to travel in an urban environment, giving specific information about physically accessible ways. An example is seen in Figure 1.

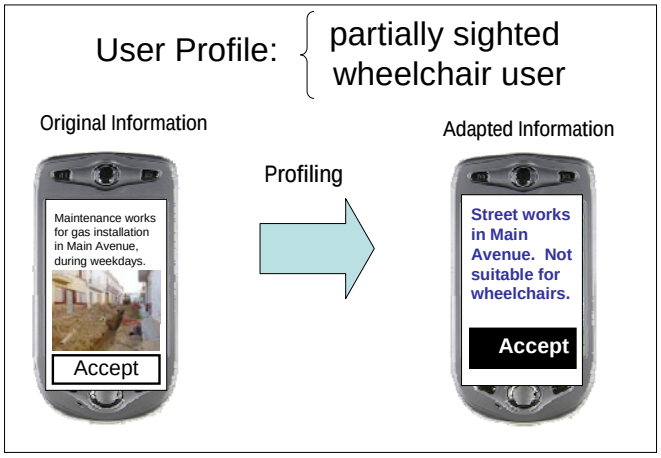

Figure 1. Profiling process to adapt the information.

Taking into account the requirements of the analyzed users, following services are envisaged for the development of the system:

Generation of user's content. Users will be able to create their own content using their mobile devices, annotating, uploading and sharing it with the community. If the mobile device has GPS or if the system is able to locate the user, the location information will be automatically included. Finally, the contents are sent to the server using one of the available communication networks (GPRS, 3G, Wifi).

Personalized routes. The objective of this service is to create a route allowing users to visit the destination points they want. The route will take into account possible disabilities that users may have. Besides, routes will use public transportation when it is adapted to user's special needs.

Public transportation. This service focuses on helping users to move on public transportation. It is targeted to any disabled people in general. Once users have selected the departure and arrival stops, the system will give them information about the availbale public transport adapted to user's needs.

Navigation. This service allows users to explore their surroundings. While they are moving around with their mobile device, users receive information about interesting locations. These locations can be related to:

- Locations which maybe of importance for the mobility of users: stairs, street works, traffic lights …
- Locations needing special explanations to be used: advanced automatic payment machines, ATM…
- Locations that have been marked as interesting places by other users.
- Locations with a cultural and historical interest: sculptures, special buildings …

Location of people. This service is focused only on helping careers and visually impaired people. A career has to choose, among users he has permissions to locate, a patient. The system will look for the last known position of the user and will show it on a map.

The system will offer integrated solutions to all the citizens, but mainly it is focused on:

Elderly people: assisted walking in unknown areas, remainder for medicine and important dates, alarm management.

Physically impaired people: providing information about physical barriers in their walking, information about public transport.

Cognitive impaired people: envisaged services are more related to professional careers who look after them: localization of patients, condition.

4. CONCLUSIONS

This paper shows a first good base for the development of an integral system to help impaired people navigate with the support of a location and guidance mobile solution for urban environments. The deployment of such a system providing both location based services and guidance for disabled and the elderly will improve users' quality of life, by eliminating/avoiding barriers and increasing their autonomy.

Our first base study also discovers the importance of some critical elements in the application of navigation systems for visual impaired users:

a) The accuracy of the cartography with the required level of detail: side walks, traffic lights, and other barriers.

b) The accuracy of GPS system. It needs other necessary technologies to win a good precision of position like: accelerometer, compass, gyroscope, pedometer, etc.

c) The necessary vocal interface user/device to leave the user's hands free to manage the cane, etc.

Also, the relation with the municipal authorities will be important to update the data base of possible barriers, new points of interest, works in course, etc. in real time.

5. ACKNOWLEDGEMENTS

The technologies and developments presented in this paper are partially supported by the European Commission (ICT project HaptiMap, contract 224675) and by Spanish Ministry of Industry, Tourism and Trade (project ELISA, contract TSI-020301-2008-16).

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