Guiding visually impaired people in the exhibition

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Abstract. We have implemented a location-aware tour-guide based on RFID localization. The guide is specifically aimed at supporting blind users. We tested it in the context of EuroFlora 2006, one of the most important exhibitions of Europe. In this paper we briefly describe the development process and discuss some preliminary results from usability tests. The experimentation involved over 100 blind people, who have been observed and interviewed by experts of disabilities and HCI designers.

Keywords: RFID, blind, wide usability, multimedia guides, wireless, sensor mesh, visually impaired.

1 Introduction

Visually impaired people represent 0.5% of the total Italian population and the World Health Organization estimates that there will be approximately 54 million of blind people over age 60 world wide by 2020 [1]. New accessibility technologies have significantly improved visually impaired people's access to computer-based services and information (5.000 blind people uses internet). Moreover, new applications are also under development, which are opening new perspectives to enhance the blinds' everyday's experience.

The ELIOS Lab of the University of Genoa has recently developed a handheld-computer-based tour guide specifically dedicated to the visually impaired. We tested the guide in the context of EuroFlora 2006 [2], the international flower exhibition which is held in Genoa every 5 years. With over 500.000 visitors in 10 days, EuroFlora is one of the most important exhibitions of Europe. In this paper we show the results of the experimentation that involved 120 blind people who used the tour guide and were observed and interviewed by expert of disabilities and HCI designers.

Visiting an exhibition is a critical task for the blind, mainly for the combination of several reasons: the site is often crowded and unfamiliar to the visitor, it may be noisy, it is difficult to orientate in a highly dynamic place.

In order to face these challenges, we have prepared a framework to develop multimedia guides based on handheld devices and smart RFID sensors, and we tested it in authentic context of use. The project set-up a multidisciplinary team, involving experts in disabilities, Human-Computer Interaction (HCI), mobile computing, radio-

frequency devices and end-users. While we focused on blind people, the developed framework may be exploited also to prepare guides for the general public.

Passive or active RFID tags are becoming ever less expensive (approaching 35 cents today, with a goal of 5 cents [3]), which makes these kinds of sensors practical in a number of applications (e.g. [4], [5], [6]).

RFID coupled with mobile devices could be very powerful in particular in the field of assistive technologies for visually impaired people. Maintaining spatial orientation is a major challenge for people with visual impairment. There is the need of systems in providing blind people with information on where they are, hazards that might be in the way, and a description of what lies in their surroundings [7]. The notion of "Spatial orientation" refers to the ability to establish awareness of space position relative to landmarks in the surrounding environment [8]. The goal of supporting functional independence to visually impaired people can be achieved by providing references and sorts of landmarks to enhance awareness of the surroundings [9].

Fig. 1. a) The packaging of the multimedia guide in a leather case; b) Snapshots from the tests: users visit EuroFlora 2006 supported by the guide and touch some dedicated plants.

2 The technology

The guide is based on PocketPC handheld devices and radio-frequency localization (see Fig. 1a). The RF signal is in the UHF radio band (915 MHz or 868 MHz), providing long-range communication and high-speed transmission rates for reliable data exchange.

We placed 99 RFID sensors on an area of 30.000 mq of exhibition, covering 99 points of interest, services and major area. RFID sensors were IP65 compliant in order to resist to water and dust, and self-powered. Power level of sensors could be set in two levels, low and high.

As software platform, we used an upgraded version of MADE (Mobile Applications Development Environment). MADE is a technology developed by the Elios Lab to experiment user interfaces on mobile guides [11]. For this project, we have built a new MADE component, the RFID module, that implements the

localization algorithm based on an iterate scanning of tags in the area. At present, the module interfaces an iCARD Identec reader [10]. This PCMCIA card can be integrated in handheld, portable or laptop computers to communicate with the iQ and iD active RFID tags at a distance of up to 100 meters. The experimental tests performed during the exhibition have shown an overall resolution (the minimum distance among distinguishable tags)of about 5 meters.

3 Designing the guide

We have organized the guide in two parts. One part provides general information about the exhibition, the guide and their services. The other part provides the description of the selected interest points. While the first part is directly accessible by the user at any moment, the second one is event-driven. More precisely, every interest point description is associated to an RFID tag, and when a user enters that area (i.e. her handheld device recognizes the RFID tag), the software asks the user whether to launch the corresponding description.

3.1 User interface

The control of the device was based on the use of hardware buttons, which is a solution suited to both the blind and the general public (see Fig. 2).

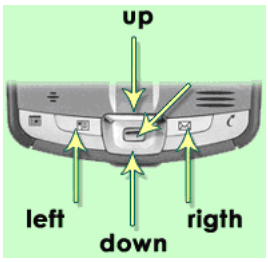

Fig. 2. The hardware buttons used to control the device

The very simple interface (it usually took a user a couple of minutes to master the guide) enabled the users to control the following guide functions:

- play/stop/pause a description (up, right, centre);
- discover the services in the area (down);
- set audio volume (side buttons);
- access to emergency number (left).

3.2 Contents

Preparation of contents has been particularly critical given the peculiarity of the target users. We tackled the issue with a design team involving HCI designers and

specialized blind assistant personnel. The description of the points of interest insisted on the shape, colour, smell and tactile aspects of objects and plants, beyond the usual information. Since the guide had to be usable by both the blind and the general public, we also used visual material such us images and animations.

We came up with a 4-level structure of the contents per each item on exhibit:

- an extended title;
- the description of the point of interest;
- one or more extended descriptions;
- descriptions to invite and spatially guide the user near the featured flowers and plants.

3.3 Setting and paths

Beyond information on plants and flowers, the guide had to give information about the service areas in the site (e.g. entrance to the exhibition, entrance to pavilions, restaurants, toilettes, etc.). In such a way we intended to support users in building a mental map of the surrounding ambient. We identified references (key places) within the exhibition and inserted them in the descriptions, sometimes in a redundancy way. This was made also with the identification of key crossroads around the exhibition. We tagged each of these key places with an RFID tag. This kind of spatial support aimed at making the user able to build and go through her own path, without being constrained to predefined tracks.

6 Tests

The target of the tests that we present in this paper was to evaluate usability of the guide. We organized different test sessions in order to pinpoint defects and shortcomings.

Tests were held in the context of the international EuroFlora exhibition, which involved 50,000 visitors per day, in a very crowded (4 squared meters per person), and highly noisy environment. For this use, we equipped the guide with a special leather package with a hanging from the neck for a more comfortable use, and we used headphones to isolate the user from the highly noisy surrounding environment (see Fig. 1a).

6.1 Pre-exhibition tests

In an early test session - we performed it 2 days before the official opening of the exhibition, when some plant stands were already ready, so that we could have a realistic test - we prepared a prototype software version, which was used by 5 selected blind users visiting 30% of the total exhibition area. We followed and interviewed the users, in this phase, in order to understand shortcomings, defects and weakness and strength point of the product. In this phase we understood and solved some problems

on user interface and contents, such as the most suited assignment of the buttons to the presentation control functionalities and the length of the descriptions. Some test-users found frustrating the long silence time between a presentation activation and the next one (i.e. the period of time in which the user is walking through areas not covered by RFID tags). We partially tackled this issue by periodically providing a message saying that the user is currently in an area not close to a point of interest.

6.2 Ecological tests

120 blind people used the guide during the exhibition. 60 of them (aged from 12 to 78 years old) participated at an ecological test conducted by the authors. We interviewed the users at the end of their tour. We evaluated 3 main performance factors: usability (including effectiveness, efficiency and pleasantness of use), usefulness and capability to support spatial orientation (in particular the approach to the points of interest). We asked users to give a general comment on the guide and a 1-5 grade for each factor (which was carefully explained and defined by the interviewers). Results, reported in tab. 1, clearly show the high acceptance by the users.

Table 1. Overall survey results

Issue	Average	Standard Deviation
Usability	4.00	0.64
Usefulness	4.25	0.75
Reach and point of interest	4.20	0.66
Session length time	201’	30’

Considering the free comments, the guide was judged as an excellent tool for users to orientate themselves inside the exhibition. Several people expressed a concept that we can synthesize with the words of one visitor: “after always having been guided, for the first time I myself have been able to guide my wife and explain her the exhibition!”. Such positive comments were also confirmed by the blind assistance experts, who highlighted the significant degree of independence the blind could reach through the guide.

Shortcomings in the interface were reported by some elderly users, while some people asked more extended descriptions, though each point of interest included at least one. The high performance and reliability of hardware, software and batteries assured long sessions of use with no troubles for the user.

7 Conclusions

We realised and tested a multimedia guide to support blind people while visiting an exhibition. The guide was widely appreciated, in particular because of its ability to support the user in having a new, engaging experience. However, we believe that significantly better results could be obtained with a higher precision of the

localization technology, which is partially surrogated, at present, by using ad-hoc descriptions and traditional physical system (such us relief paths and maps). New developments in RFID Sensors Network technologies promise significant advances in this regard in the near future.

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