Zurich University
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Personal Mobile Assistant for Air Passengers with Disabilities (PMA)

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This paper describes the PMA research project in progress, whose aim is to develop a concept for personalized mobile route guidance and information for air passengers with disabilities (PWDs), and to implement this concept step by step. The PMA guides PWDs along their route from home to the desired departure gate (or vice-versa: from landing to destination), and provides them with information - as and when they need it - on their current position and remaining travel route, together with the latest flight information (e.g. delays or gate changes). This project mainly focuses on in-house guidance within the airport for passengers with visual disabilities. The concept is based on normal commercial mobile devices (cell phones or PDAs) with cameras. Within this project, the implementation of the concept is also restricted to the airport area, but is easily extendable to other public transport facilities.

Key words:
visual impairment, accessible mobility, airport guidance, accessibility, mobile devices, auditory interfaces, accessible tourism

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Personal Mobile Assistant for Air Passengers with Disabilities (PMA)

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1 Introduction

At present, passengers with disabilities (PWDs) are often unable to make air journeys unaided and alone, although most airports are accessible for the disabled. The most serious obstacles for passengers with disabilities are:

- Finding their way around the airport: Where is the terminal they want, where are check-in and passport control, and where is the gate they need?
- Finding the relevant flight information: Which gate does their flight depart from, when is the boarding time, is the flight delayed?

At present, the airlines themselves are still responsible for looking after PWDs. They approach this task in very different ways. On request, some of them provide PWDs with an accompanying person who will guide them through the airport as far as the aircraft. Other airlines refuse to carry PWDs as a general policy.

According to the EU's 'PRM' directive (Passengers with Reduced Mobility) which comes into force in 2008, airports will be responsible for offering an Assistance Service to disabled travelers, from their arrival at the airport until their plane departs. The airport operators must cover the costs of this service, although they may be able to pass them on to the airlines. Finally, 'Accessible Tourism' is becoming more important all over the world, and is also underscoring the requirement for accessible airports.

2 Current State of Research

Personal guidance, especially for those with disabilities, is based on the ability to localize the person. The ability to localize people inside buildings is particularly critical here.

The first mobile travel information systems are already on the market, several others are being developed or planned, and many more are at the research stage. Most of them are based on person localization via GPS. However, there is still no solution that offers an in-house localization system for persons that is accurate enough and suitable for everyday use.

PAVIP® [1] is a personal assistant for Visually Impaired People developed by Bones GmbH, Neuhausen in Switzerland. It was tested 2004 in Berne in the world's first field trial of a guidance system for people with visually disabilities in public areas. In 2007 a pilot system for the public transport in the town of St. Gall has been set up. PAVIP® is based on a specialized device and PAVIP® markers (RFID transponders) that are installed at public transport stops. If the user holds his device up to one of these transponders, the device reads out the bus lines that pass this stop so that the user can then select the right one. The device will then only react to the radio signals from buses of the relevant lines. The device can also open doors and transmit stop requests while the passenger is on board the vehicle. To that end special radio devices have to be installed in all buses. As the system is currently mainly used outside the problem of indoor localization has yet to be addressed.

The system proposed by Willis et al. in [3] and the Blind Interactive Guide System (BIGS) proposed by Jongwhoa Na in [2] also use RFID technology. They use a grid of passive RFID-tags in the floor in order to localize the person. Both systems use a PDA plus a mobile RFID reader to read the tag-information. In the BIGS system the RFID reader is placed beneath the PDA whereas Willis et al. put their RFID reader in a cane or shoe. The two systems are still in the research stage and not yet suitable for everyday use. In addition to that they need a special device (PDA), most PWDs normaly do not have with them and a quite expensive inhouse infrastructure.

The Building Guidance System GoIn from infsoft [4] uses WLAN and a PDA in order to localize people inside a building, however it is not designed for people with visual disabilities. PaxFlow from PaxFlox Holding Pte Ltd [5] uses radio frequency triangulation similar to Bluetooth for indoor localization. The system targets the guidance of people in airports and is based on an active boarding card with WLAN that contains all information of the passenger. A first field trial has been conducted in 2007 at the Geneva Airport. The system needs a costly infrastructure and is not designed for people with visual disabilities.

NOPPA [7] and OpenSpirit [6] are complete guidance concepts for visually impaired people in the public based on smart phones and GPS. The first one developed by the Technical Research Center of Finland has been implemented and tested in outdoor trials. However, the indoor navigation of this system is still at the research stage.

3 Suggested Concept

The concept for a personal guidance and travel information system for passengers with visual disabilities proposed in this project is based on the floor markings of the tactile/visual guidance systems of the VSS (Swiss Association of Road and Traffic Experts) that is standardized in SN 640 852 (see Figure 1). This system is being installed at all railway stations and also at bus station all over Switzerland. Similar systems are used in various other countries to guide persons with visual disabilities through transport hubs. These aids enable visually impaired and blind persons to feel their way to a destination with the help of a cane or their feet, without encroaching upon any hazard zones. However, these systems offer no help at all with localizing the persons themselves, nor do they provide additional information about the current public transport offers that is available (current timetables, etc.).

The preconditions for a personal guidance and travel information system are that

1. the person's destination and mobile phone number must be known, and
2. it must be possible to localize the person also indoor (railway station, airport).

The first precondition can be fulfilled by using electronic tickets or by placing visual tags onto the tickets which can be read with the tag reader on the passengers mobile phone. For the localization of the passenger inside public transport hubs the above tactile/visual guidance system is augmented with visual tags for the exact localization of the passenger. The system itself is based on ordinary cell phones with an integrated camera. The mobile phone is firstly used for finding and tracking the guidelines of the tactile/visual guidance system. Secondly, it is needed for the decoding of the visual tags and the extraction of the position information. Thirdly, the mobile phone is used for the communication with the travel information system.

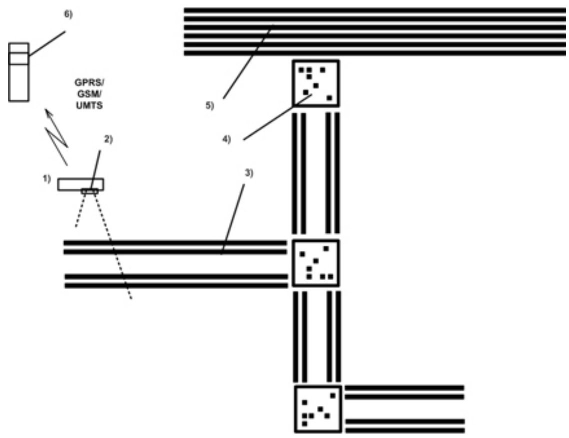

Fig. 1. Components of the suggested design

4 Design

The components of the design (see Figure 1, patent pending) are described by using a scenario where a visually impaired passenger arrives at the airport railway station and proceeds all the way to the desired gate:

The first step is to register the person's travel data together with the identification number of their mobile device 1) in the Guidance System. The traveler then receives a personal route plan which is sent to their mobile device, where it can be read out aloud at any time. When the passanger arrives at an airport railway station, he holds his mobile device in front of him with the camera pointing to the ground, and launches the software. This software recognizes the guidance lines 3) of the optical guidance system as soon as they are within the camera's range, indicating this by a corresponding acoustic signal. The person then follows the guidance lines with the help of the acoustic signal from the mobile device. As soon as the person passes a visual tag 4), another acoustic signal informs him of this. If he now remains stationary over the visual tag, it is decoded by the software on the mobile device. The mobile device immediately connects to the guidance and travel information server from which it obtains up to date information about the person's current location and a description of the route to the destination of the next stage of the passengers way to his gate. The mobile device provides this information in acoustic form. The person also receives further information, e.g. about the distance remaining and the allotted time, together with any messages about delays or changes to platforms or departure gates. The markings used in the optical guidance system are based on the markings for the tactile-visual guidance line system as per SN 640 852, so the mobile device also recognizes suitably marked guidance lines, fields indicating intersections and dead-ends, safety lines 5), steps, etc. The system has additional elements such as visual tags 3)4) to determine position, and additional markings, e.g. for escalators, including their running direction.

5 Implementation

The recognition of guidance lines has been successfully implemented in MATLAB® for simulation purposes (ref. Figure 2). The simulation involves the analysis of prerecorded video image material and the generation of corresponding audio signals or speech output. As part of this process, guidance lines can be searched for and recognized. As soon as valid guidance lines have been identified, pattern recognition of intersections, stops and tactile indicators is possible. At the same time, a continual analysis is performed of whether the guidance lines are still in the cameras range. A warning signal sounds to indicate deviation from the route.

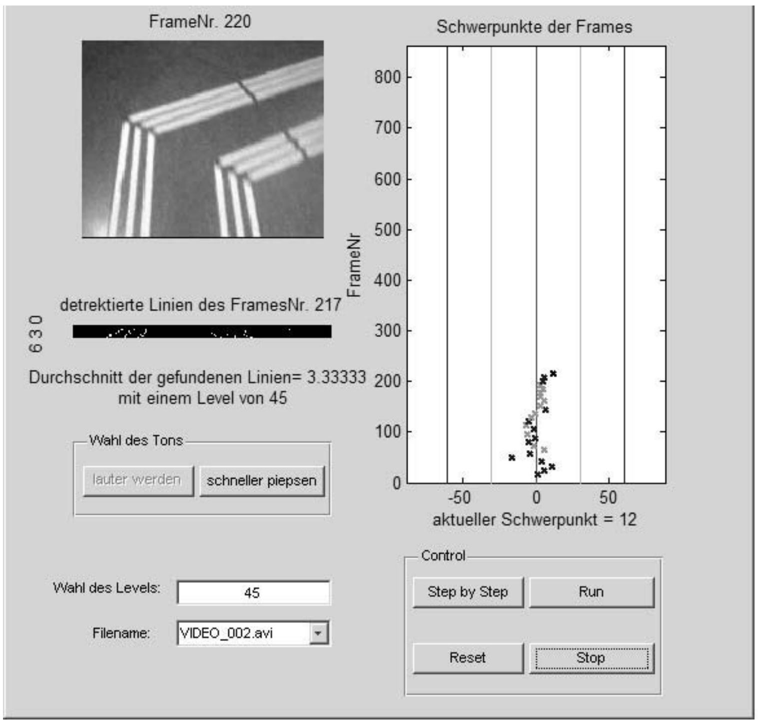

Fig. 2. Screenshot of MATLAB® simulation

This functionality is currently being implemented on mobile phones with a built-in camera, making real-time navigation possible. The tracking of the guidelines has already been implemented on an smart phone and runs in real time. For the decoding of the tags (2D codes) an available tag reader software will be adapted and integrated at a later stage. These tags will not only allow to determine the traveller's position but also the direction in which his is moving.

6 Conclusion and Outlook

This document described a novel concept for a guidance and travel information system based on ordinary mobile phones with a camera. The system targets visually impaired travellers but is also valuable for passengers without disabilities. In contrast to existing personal localization and guidance technologies the guidance system proposed can be used also inside buildings, allows reliable and accurate localisation of the travellers and does not require complex and costly infrastructure such as Bluetooth or WLAN nor special devices like PDAs or RFID readers. It is based on the normal mobile phones people have with them anyway.

This guidance system is currently being implemented on a smart phone. After full implementation of the system extensive usability tests with persons with visual disabilities will be carried out at an airport in order to improve the usability of the system and understand possible problems.

In a follow-up project the tag reader software will be integrated and the whole travel information system will be developed and implemented.

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