Ways4all: Indoor navigation for visually impaired and blind people

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1 ABSTRACT

The project "Ways4all" is using passive RFID-tags to indentify indoor routes, barriers and means of public transport for visually impaired and blind people. The basis for this project is the tactile guidance system. At all strategic spots inside the building (entrance, platforms, intersections) a passive RFID-tag will be placed into the tactile guidance system. Those RFID-tags send their unique code trough an RFID-reader to the user's smartphone. The smartphone reads the code and sends it on to an RFID-database server where all the tags together with some additional information are saved as location points.

Before leaving the user has to enter his/her destination on the smartphone, by which the server (Gerwei-Method) calculates the optimal route based on the location, the moving direction and the user profile. The Gerwei-Method is a new developed navigation routing software based on a standard routing algorithm.

The smartphone receives real-time routing information (including additional information, like interruptions, delays and platform changes) from the database server. On the smartphone the routing information will be sent in an acoustic way to the blind person (for example through a Bluetooth headset). This way, the blind person gets his/her indoor route instructions from the system.

2 INDOOR NAVIGATION FOR VISUAL IMPAIRED AND BLIND PEOPLE

2.1 situation

Imagine a world without barriers, where all people and particularly people with special needs can enjoy daily life without running into obstacles or problems which undermine their self-determination. This is a dream which could come true within the next years. In Austria the Federal Law on Equality of People with Disabilities (Bundes-Behindertengleichstellungsgesetz – BGStG [1]), which has been in force since the year 2006, is a positive factor towards improving the situation for the visually impaired and blind people. However, barriers related to roads, transportation and transport facilities built before January 2006 have time to neutralize these barriers until the 31 of December 2015. So barrier free public transport for people with special needs is still a dream and not yet a reality.

Currently visually impaired and blind people travel with the help of a white cane, a dog or are escorted by a friend or mobility trainer. With this new law, all passengers and particularly people with special needs will have access to public transport and up-to-date traffic information in a much more simplified way than nowadays. A new individual (indoor) navigation system can raise accessibility to public transport for this group of people. Additionally, the communication between the navigational device and the respective means of public transportation (bus, tram, train and subway) as well as the static/dynamic information timetables should be aimed at increasing the feeling of safe travel. This way the visually impaired and blind people can be self-determined.

At the moment different projects in Public transport and Navigation are using the RFID-technology for routing blind people. Example Projects are 1) Sesamonet, Italy [2] which uses passive RFID-tags and an RFID-reader built in the white cane for a route along the promenade at Lake Maggiore. 2) RouteOnline, the Netherlands [3] which uses active RFID-tags and a hand held reader to find a route at different stations. 3) BIGS, Korea [4] which uses a portable terminal unit and a smart floor (each tile of the floor has a passive RFID-tag). 4) Bus-ID, Germany, [5] uses the RFID-tag for sending public transport information towards a reader and a database. 5) RFID Information Grid [6] which uses the RFID-tag for indoor routing in the Campus. The RFID-tags are programmed with spatial coordinates and information to describe the surroundings. No centralized database or wireless infrastructure for communications is used. 6) Self-contained Sensor System [7] which places RFID readers inside the building. The user will carry his/her own RFID-tag with him/her to capture his/her position. Taking these examples into consideration it can be concluded that different institutes are researching the use of RFID-tags to make daily life for visually impaired and blind people more enjoyable.

The project “Ways4all” is using passive RFID-tags to indentify indoor routes, barriers and means of public transport.

2.2 Project Goal

The project called “Ways4all” supports blind and handicapped people to find their way, for example inside the train station and to the departing platform by the help of technical equipment. The most important parts of this equipment are the passive RFID-tags, the smartphone and the RFID-reader cane. By establishing a connection between the smartphone and different traffic databases, users are informed of their final destination inside the building (train platform), real time delays in the timetables or platform changes.

The project “Ways4all” started in December 2008. The overall project manager is the University of Applied Sciences FH-JOANNEUM in Kapfenberg, Austria. Project participants are “Wiener Linien”, “ÖBB”, “Transelektronik Messgeräte GmbH”, “Hilfsgemeinschaft der Blinden und Sehschwachen Österreichs”, “Österreichischer Blinden- und Sehbehindertenverband”, “Österreichs Blindenwohlfahrt” and “Österreichische Arbeitsgemeinschaft für Rehabilitation”.

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2.3 Input Internet platforms

Since May 2009 the “Wiener Linien” and the “Verkehrsverbund Ost-Region (VOR)” have offered on their website the program “Qando” which provides real-time timetable information [8]. Users can recall this information through Internet access via their smartphones or computers at home. The program “Qando” offers besides timetables also information about public traffic interruptions, different kinds of online services and also a route planner for Vienna, Lower Austria and Burgenland. The user can obtain information about the arrival time of the train, bus or tramway. The Austrian Train company (ÖBB) offers a similar service with their programme “Scotty”, which connects to the ÖBB-website, where up-to-date timetables or delays of the different trains and busses are available [9].

The project “Ways4all” connects and combines these different timetable systems with indoor navigation software and a guidance system based on RFID-tags and a tactile guidance system.

2.4 Tactile guidance system

The most important part of the project is to develop an indoor navigation system for visually impaired and blind people. The backbone of this indoor navigation system is the tactile guidance system, which is the minimal needed guidance system for the visually impaired and blind people. With this system they can find their way through stations and public spaces. The only problem is that they need to know their way when using this system. If they have not been there before, the tactile guidance system will guide them, but to find the right direction they need extra information to where the system is leading them to. In the outdoor, the GPS software can guide the visually impaired and blind people. In the indoor areas the RFID-tags can help guiding the visual impaired people (see figure 1).

If the system functions properly for the visually impaired and blind people, it will be extended to other user groups like physically handicapped users, parents with a baby buggy, elderly people and tourists. For indoor navigation this group can use QR-Codes, which can be read by any smartphone camera. For outdoor navigation the system will use the normal GPS-software.

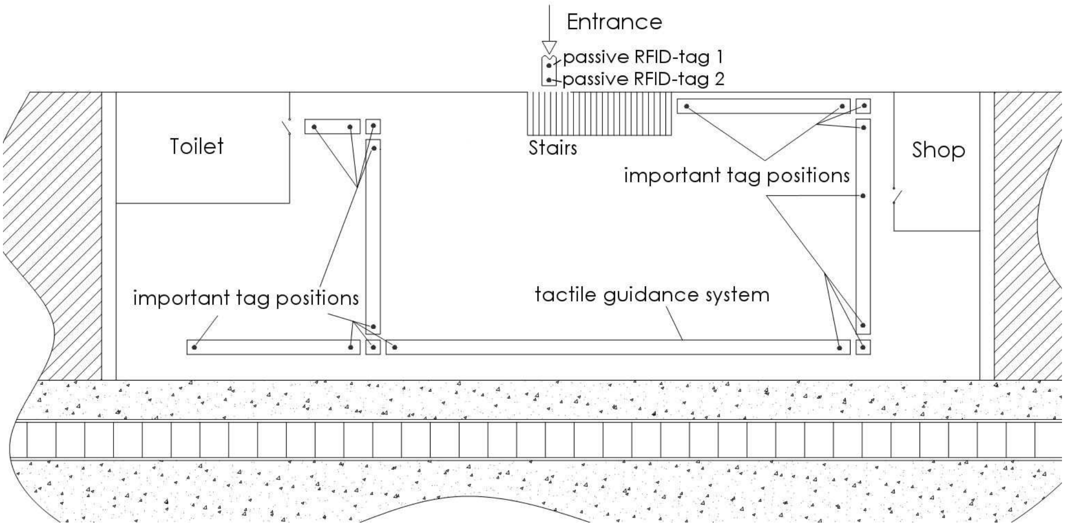

Fig. 1: Routing by tactile guidance system and RFID-tags

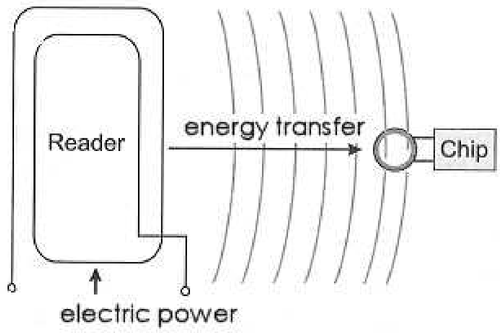

Fig. 2: Transmission passive RFID-tag

2.5 RFID-tags

At the moment the main goal is to develop a routing system for the visually impaired and blind people by using RFID-tags. There are two different RFID-tags; the active and the passive tag. The active RFID-tags have their own energy source (battery) and transmit a signal towards the RFID-reader. The transmission range varies from a few meters to 100 meters. The passive RFID-tag only transmits its signal when a reader comes close to the tag (see figure 2). The magnetic energy field of the reader activates the tag, and the tag uses the energy from the reader itself to transmit its code. The transmitting range of the passive RFID-tag varies from a few centimetres to more than 10 meters [10].

The frequency range from RFID-tags extents form low frequencies (125 kHz), to high frequencies (13,56 MHz), to ultra high frequencies (868 / 915 MHz and 2,45 GHz) and the Microwave (5,8 GHz). A passive RFID-tag can be used in all of these frequencies. The active RFID-tag can be used at a frequency of 13,56 MHz (UHF) upwards. Tests have shown that passive RFID-tags are most suitable for this project as they show fewer interference problems of surrounding materials (like iron, electric cables) [11]. Furthermore, the low frequencies RFID-tags have fewer problems with dirt or water on top of the (built in) tag in comparison with the other frequencies. Finally, the passive RFID-tag is much cheaper than the active tag as both in the cost(s) of acquisition and in the cost of maintenance. The passive tag is placed inside or beneath the floor and will function from this moment on. The active tag has to be changed every few years, when its energy cell is empty.

2.6 RFID navigation

Every RFID-tag has its own unique code which can be linked to the RFID-database. After installing the tags in the database, their location and the position are defined.

At all strategic spots inside the building (entrance, platforms, intersections of the tactile guidance system, etc.) the RFID-tags will be placed into the tactile guidance system. The RFID-tag sends its code to the RFID-reader and the RFID-reader sends the unique code to the user’s smartphone. On the smartphone an easy-kept mobile Java application reads the code and sends it on to an RFID-database server where all the tags together with some additional information are saved as location points. Through the sequence of different RFID-tag codes his/her moving direction is known to the server. In figure 3 the locations of the RFID-tags and the links between these tags are presented. Before leaving the user has to enter its final destination on the smartphone, so the server can calculate the optimal route for this user, based on his/her location, moving direction and user profile (visually impaired or blind person, physically handicapped person, elderly person, etc.). For this kind of routing new navigation software, the so-called Gerwei-Method, which is based on a standard routing algorithm, has been developed. This method uses the special database structure for its routing directions and combines the different location spots to a route.

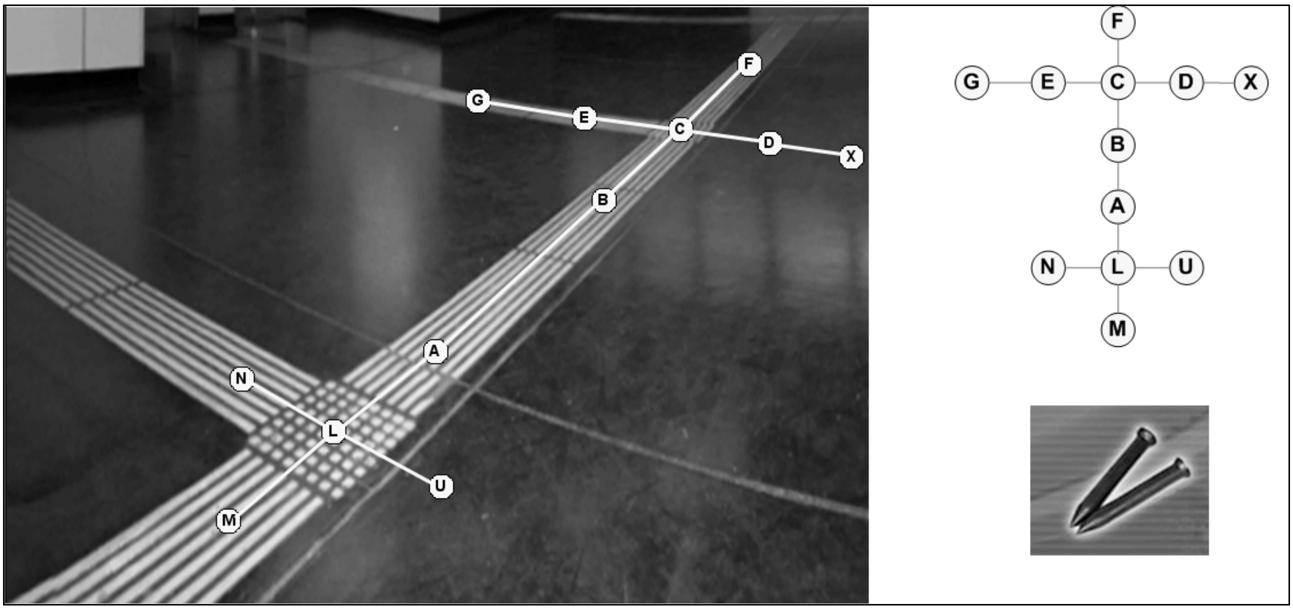

Fig. 3: The RFID-tags structure including the nesecarry links between these tags

The smartphone receives the routing information from the server. The software on the smartphone sends it to a screen-reader inside the smartphone which transmits the information in an acoustic way to the blind person (for example through a Bluetooth headset). The blind person gets from the system route instructions about the way he/she has to take. He/she walks from one reference point (RFID-tag) to the next. The software and database are developed in a way that allows the user to decide between getting just the necessary direction information to the destination or all the information at every crossing. During the routing the user can change this setting. The user can also enter his/her personal preferences for the routing. While one person, for instance, does not mind taking the stairs, others only want to take the elevator to change floors. Each user of this software can personalise his/her user profile, so that for every user his/her preferred route can be calculated.

2.7 Needed equipment

For the routing the visually impaired and blind people will have their RFID-reader and Bluetooth sender built in their white cane. A disadvantage of this is the weight of the stick because of the integrated reader. A second solution would be a shoe-clip where the reader could be placed. He/she just needs a normal smartphone and Bluetooth Headset for the routing. One of the demands of the visually impaired and blind people was that no additional equipment should be invented, but normal existing equipment should be used.

2.8 System functionality

The visually impaired and blind people can plan their trips on the internet platform at home. The necessary information to be entered is the day and time of departure, place of departure, place of arrival and the preferred means of transport. This information will be saved temporarily in the database. After leaving the house the outdoor GPS can guide him/her towards the first means of transport. While travelling, the application will just take the necessary information via the mobile internet access. If the route is changed or the planned route is no longer available, the user can ask for new routing information during the trip. As soon as he/she enters the indoor area, the smartphone will receive the RFID and routing information. If the user does not want to be online during the trip, he can also download the indoor routing information including the local RFID-database at home and uses it the next day during the routing process. The disadvantage of this is that the real-time information of last minute track changes is then not available.

This system functionality is presented in figure 4.

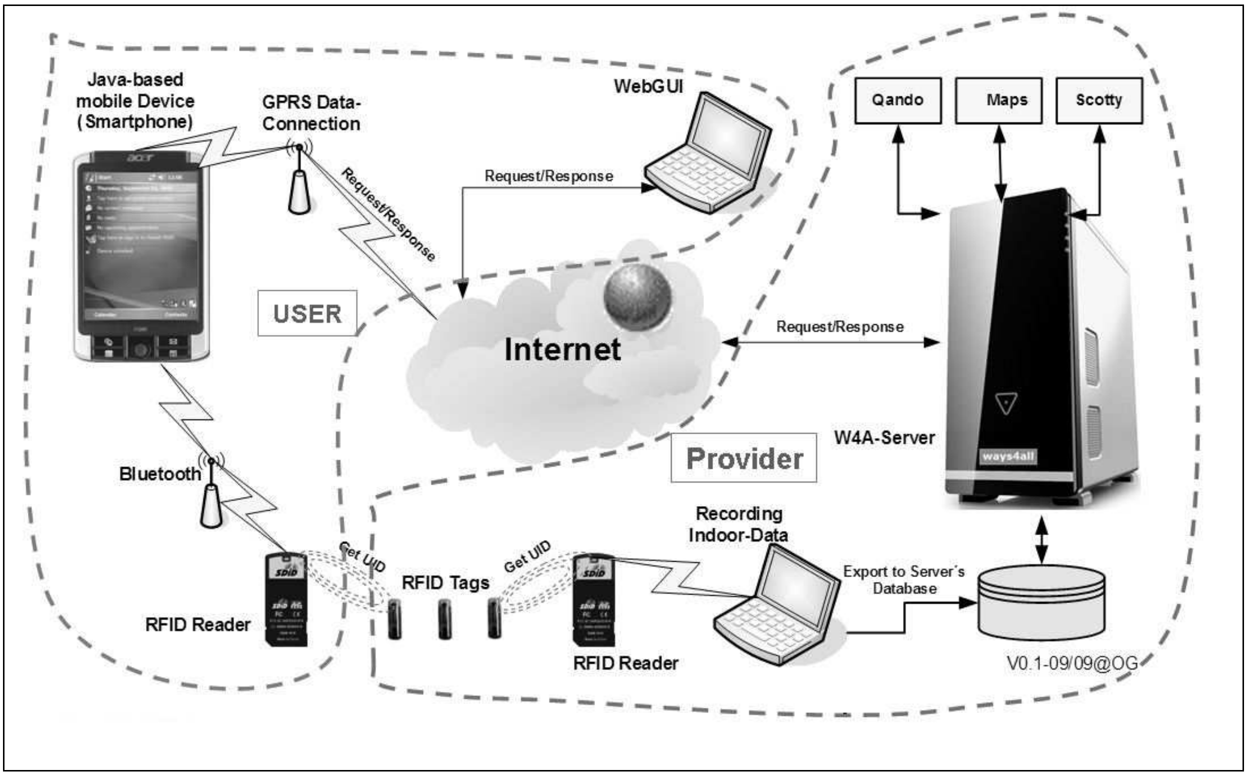

Fig. 4: System functionality

2.9 Quo Vadis

If the blind person is at a tram or bus station where more lines stop at the platform, the project “Quo Vadis” of the “Wiener Linien” and “Transelektronik” can be used [12]. A small 433 MHz transmitter in the vehicle transmits on request of the user which line it is and towards which final stop it is headed. The portable transmitter works like a garage door opener control with the same frequency band. Blind people already use this transmitter to activate pedestrian lights.

At the moment the user needs a separated portable transmitter from “Transelektronik” and “Wiener Linien” to send the request and to receive its answer.

One of the goals of “Ways4all” is to include this separate transmitter in the software of the smartphone, so the user can find his route only by using the software installed on the smartphone (including headset) and the white cane for reading the RFID-tags. The only problem is that no smartphone is equipped with a 433 MHz transmitter. So, using the existing 433 MHz sender is at the moment the cheapest solution. In the first project phase the portable transmitter will be used as a gateway to the smartphone and will be equipped with a Bluetooth chip that sends its information to the smartphone.

2.10 Project test

The project “Ways4all” ends with the equipment and routing test at the Südtirolerplatz in Vienna at the end of 2010. The Südtirolerplatz is being rebuilt at this moment and will be equipped with an underground pedestrian passage which connects the subway and tram to the new central station of Vienna, which is to be opened in 2014. For this project the Südtirolerplatz is a very suitable test area because it is a connecting point for the subway, bus, tramway and train network.

2.11 Alternative to RFID-tags for other user groups

The alternative to the RFID-tags would be the use of QR codes (see figure 5). This would be a visual modification for the indoor area. The other users (tourist, physically handicapped person, etc.) orient themselves by the guidance system in the form of QR codes. A QR Code “Quick Response" is a matrix code (or two-dimensional bar code) which allows its contents to be decoded at high speed [13].

The user turns the camera on the smartphone to the QR-code to get the requested information. The advantage of this system is that non-blind people could also use this system for their routing and no expensive

equipment is needed. Any smartphone with a camera can read the code after installing the QR-reader software. The information carrier is now a different one, but the guidance system stays identical. The QR code can be milled into the ground or be printed as a picture on the floor. The big advantage of the QR code is that the code can still be read even when the picture is 30 % broken [14].

Fig. 5: QR-code

3 CONCLUSION

The first phase for Indoor navigation for visually impaired and blind people has been made. As soon as the indoor routing and the communication between smartphone and the different means of transportation works, new opportunities may arise to make travelling for people with special needs more comfortable. These new opportunities are for example locating the entrance door with the help of an acoustic sound, telling the driver when he/she wants to exit, or if he/she needs help with getting on or off the transportation. So, “Ways4all” will be input for new projects. The first following project will be the project “Navcom” where communication over WLAN and inertial navigation (navigation with gyroscope and digital compass) will be developed and tested for indoor navigation. Another project is planned were the results of the project “Ways4all” and “Navcom” will be combined and expanded with the QR-Code and Outdoor navigation.

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