VIATOR – A Mobile Travel Companion for Disabled Persons

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1 ABSTRACT

VIATOR (lat. "the traveller") is a mobile platform for smartphones that guides disabled (i.e., blind or physiaclly impaired) persons on their journeys using means of public transportation. It appropriately provides up-to-date information concerning connections, delays and alternative transportation options across different transportation companies. It considers physical obstacles and hints for each particular target group (e.g., stairs vs. elevators for wheelchair users), triggers re-planning if required, and provides an open interface for leaving self-created location-bound hints for each desired target group (e.g., blind people guide blind people) such that the mobile phone appears as an active companion throughout the journey. This paper presents the technical architecture for VIATOR, which is based on an open, extensible framework for mobile location-based services (named Digital Graffiti) and illustrates the results of a first prototype implementation.

2 INTRODUCTION

Disabled persons are facing a manifold of disadvantages when using public transportation. On the one hand, stairs and raised vehicle entrances are considered insuperable obstacles for wheelchair users. On the other hand, missing tactile lines or path descriptions prevent blind or visually impaired people from maneuvering on their own at public transportation nodes. Existing information- and navigation systems for public transportation only instruct their users in terms of transportation means, departure times and departure platforms. Instructions considering the way to and from public vehicles for handicapped persons especially at larger transportation nodes are lacking or outdated due to ponderous and inflexible content management mechanisms at the backend of such systems. Moreover, most of the systems are proprietary and unable to link to competing transportation companies in order to provide a closed information chain for a journey.

In the course of the research project ways2go within the framework of the strategic initiative IV2Splus funded by the Austrian government (FFG) a prototype for a mobile travel companion for disabled persons informing them not only about means of transportation but also guiding them through stations regarding their needs has been developed. It consolidates diverse travel information systems and provides navigation instructions from arbitrary sources, even from the users themselves (self-organizing content management).

The technical basis for implementing this research issue is a mobile location-based and context-sensitive information-, communication-, and collaboration system (Digital Graffiti) (NARZT 2013) developed by the University of Linz, in association with Siemens Corporate Technology in Munich, and the Ars Electronica Futurelab also in Linz, which enables its users to arbitrarily place and consume information in both public and private locations using state-of-the-art mobile tracking-enabled cell phones and the current location of a user as a contextual input for appropriate delivery of information. Travel information (including up-to-date actual data of delays, cancellations or detours, etc.) is provided, classified and made generic for shared networking by the project partners ÖBB (Austrian Federal Railways Company), OÖVG (Upper Austrian Transport Association) and Linz AG (Local Traffic Line Service Provider in Linz). In cooperation with the Department Integriert Studieren at the University of Linz and CEIT Alanova (Central European Institute of Technology in Vienna) new paradigms for barrier-free interaction have been created not only guiding users but also offering them an instrument to provide self-created content for other users. Blind people shall be able to annotate their way for other blind people regarding their special needs.

3 STATE-OF-THE-ART

Unaided free movement for people with disabilities using public transportation is the focus of research in a project called NAVCOM (BISCHOF 2012). Blind persons are required to find the right vehicle or to signal their wish to enter or leave a vehicle. The authors propose a WLAN-based system communicating between public transportation vehicles and smartphones, an extension to navigation systems for pedestrians, the functionality of which ends at the entrance door of the vehicles. In general, this project group investigates the potentials of technical support for navigating handicapped people in public spaces. Within the project ways4all (funded by the Austrian government), they explore indoor navigation for visually impaired persons using RFID, in order to compose navigation instructions not based on absolute coordinates (KIERS 2011).

MofA – Mobility for All (MOFA 2010) is a project that goes a step beyond when planning public transportation nodes. The project provides tools for creating accessible squares, entrance areas and accessible public transport buildings. It employs weak-point analysis in order to manifest rating systems for travel information services, evaluating form and up-to-dateness of the provided information (e.g., real-time capabilities, elevators, width of doors, stairs and level differences, etc.). The project focuses on mobility in public space and compares existing approaches and comes up with new description-, observation- and classification methods for accessibility-checks including recommendations to solve the discovered problems.

A similar approach is examined as the key issue in the project MoViH (MOVIH 2011) trying to identify both mobility and hindering factors for persons with visual or hearing impairments. The outcome of the findings is a catalogue of effective and efficient measures to be depicted in recommendations and standards supporting public transport companies in planning environments considering special needs of blind or acoustically disabled persons. BIS – Barriere Informations System (BIS 2012) especially focuses on the requirements of wheelchair users. The project aims at developing a barrier-free interactive routing system in close coordination with the target group, technology experts and administrative and political stakeholders throughout the research process in order to calculate and visualize the most suitable ways to go for wheelchair users.

In terms of closed information chains across different transportation companies, hardly any reasonable solution exists for commercial usage, yet. Public transportation service providers offer proprietary information systems enabling their users to consume provider-specific travel information on their mobile phones when entering their desired start and target coordinates into a provider-related mobile app (e.g., Scotty – a route planning service of ÖBB (SCOTTY 2011). The integration and consolidation of various proprietary information systems is a particular challenge.

Target-oriented automatic delivery of information to the traveler (e.g., for indicating a transfer or delay) is the next field of investigation. Most systems do not inform their users about changes in the time schedule, once the trip has been calculated. Travel information has to be requested from scratch at every transition point or is difficult to handle due to a complex system of rules across transportation providers. Until today, to the authors' knowledge, there is no automatic mobile travel information system that continuously guides the passenger during his journey and context-sensitively keeps him up-to-date considering transfers or delays.

However, reference to actuality and automatic delivery of personalized travel information (and consequently the difficulty of a closed information chain) are already recognized as key issues in a series of current research projects: WISETRIP – Wide scale network of e-systems for multimodal journey planning and delivery of trip intelligent personalized data (FOSTIERI 2007) is an approach within the course of an EU project to connect different travel information systems and transmit personalized data in real-time. Similarly, i-Travel – service platform for the connected traveler (KOMPFNER 2007) is trying to develop a virtual travel assistant providing current travel information for passengers during their journey. OASIS – Open architecture for accessible services integration and standardization (BONFIGLIO 2007) even goes a step beyond and develops a generic platform for integrating different information services.

As a summary, we already recognize a series of isolated research subjects dealing with navigation aspects for disabled persons or closed information chains. The VIATOR project aims at integrating all these issues with a different and innovative approach based on utilization of a smart location-based information system, which is capable of triggering specific actions due to regional closeness of its users to selected locations.

4 ARCHITECTURE

The technological basis for VIATOR is a location- and context-based platform named Digital Graffiti (NARZT 2013), which connects any position in three-dimensional space to arbitrary information ele-ments (e.g., text, images, sound, videos, links, or even executable code). This data tuple (geo-position and information element) is provided with a visibility space and a set of recipients and is transferred when any of the recipients crosses the visibility space. For related developments see e.g., (AIT-CHEIK-BIHI 2011). In particular, the technology platform enables depositing information in the form of Digital Graffiti on mobile devices at any location in public and private space and consuming such. As a special feature, the platform offers automatic control of electronic actions (e.g., opening a gate, starting or stopping a machine, triggering a measurement or transaction) without any additional manual action, when a given device is in the vicinity of a Digital Graffito containing executable code (see NARZT 2009, NARZT 2011), presuming adequate access privileges that relate to a person, a device, a software system, etc. or that results indirectly through the settings of a certain interest profile.

Applying this platform as the technological basis for a mobile public transportation guide means utilizing the location-based action control mechanism for up-to-date calculations regarding transpor-tation schedules. In particular, the transportation companies have to provide standardized interfaces for requesting their schedules, enabling their users to site-specifically and automatically perceive appropriate departure information when they arrive at a station or stop (similar to the big screens showing the departing trains). The user is consequently able to pick the desired destination by a single click and thus to anonymously specify a route.

Concerning travel routes across transportation companies, the system does not invent routing algorithms and scheduling procedures from scratch. Instead, it utilizes existing services and triggers them on demand in the same way as the time schedule example given above. So, the system continuously (and also location-sensitively) re-initiates calculations regarding the selected route by the location-based action control mechanism. This means, that a user automatically triggers the route planning service of the appropriate vendor at spatial proximity to his next stop and is informed about his schedule and connecting means of transport, giving the passenger a continuous information chain during his journey.

Barrier-free and target group-related routing is based on the same mechanism: Whenever a user enters a station or stop he automatically triggers navigation calculations due to his user profile (i.e., specifying the type of disability), selected route and schedule. These calculations are externally sourced out to special route computing services with centralized data collections to be updated either via CMS operators or by the users of the system themselves, who are able to edit these instructions due to their experiences on-site via the inherited mechanism of the basic system for editing Digital Graffiti information elements.

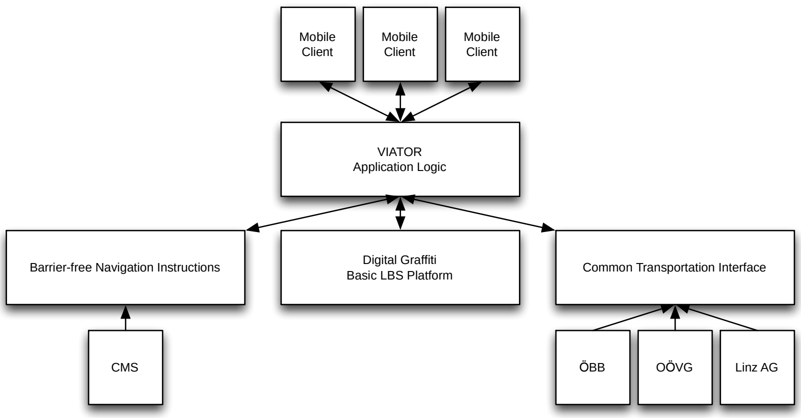

Fig. 1: VIATOR system architecture (simplified excerpt)

Thus, the general mechanism for barrier-free navigation across transportation companies providing up-to-date travel information and offering an active notification- and feedback instrument for direct interaction and self-organization of the information content is based on location-based action control, a function available from the basic platform Digital Graffiti. Thus, the VIATOR system does not contain complicated new algorithms for managing complex collaboration of different information providers. Instead, it utilizes a simple mechanism applied for all tasks, which makes the entire system easy to understand, maintain and extend.

Fig. 1 gives an impression on the collaboration of involved components, neglecting details due to space limitations: The application logic is encapsulated within the main VIATOR server component, communicating to its basic platform Digital Graffiti, which remains completely unchanged in its elementary behavior and is executed as a separate process. The mobile clients connect to the main VIATOR server component, which delegates all Digital Graffiti-related functions to its underlying platform, enabling the clients to create and consume location-based information elements. The system is extended by two separate processes consolidating travel information from different transportation providers on the one hand (right side) and providing barrier-free navigation instructions on the other (left side). The latter can either be managed through CMS or via the VIATOR application logic indirectly by the clients.

5 PROTOTYPE

The system architecture as shown in Fig. 1 has been prototypically implemented by the University of Linz using JBoss AS7 Java Enterprise Application for the server components and Android for the clients. The project partners ÖBB (Austrian Federal Railways Company), OÖVG (Upper Austrian Transport Association) and Linz AG (Local Traffic Line Service Provider in Linz) have provided their data through the Common Transportation Interface (see Fig. 1) and CEIT Alanova has provided route calculations for disabled persons to be retrieved from their server component.

For the users, the system depicts as follows (the user interface is kept rather simple in order to comply with requirements concerning blind users, for whom only the texts in appropriate order are essential, see Fig. 2):

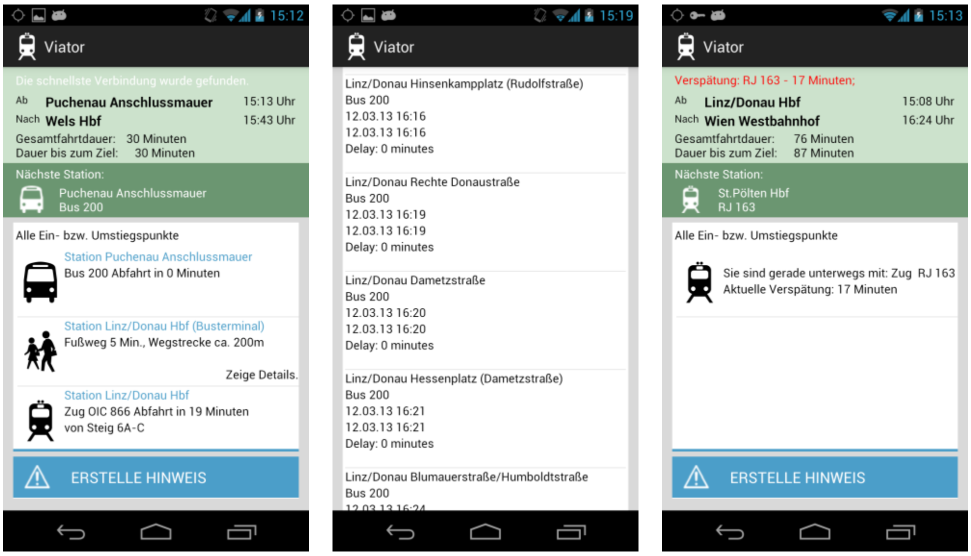

Fig. 2: VIATOR user interface. (a) display route, (b) display details on route, (c) automatic announcement of a delay

The system starts with a screen requesting the desired destination (not depicted here). The user can either enter (and auto-complete) a destination or select from a list (considering the transportation options due to the user's current location). A summary of the input, the next station and all subsequent maneuvers are listed (Fig. 2b). For each list item, the user is able to take a detailed look and experience the consecutive stops and times during his journey (Fig. 2c).

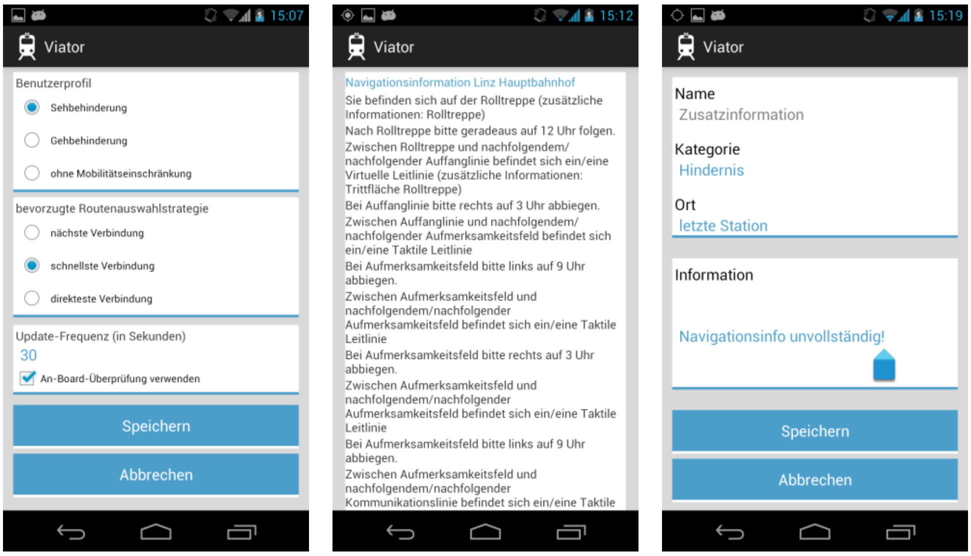

Fig. 3: Barrier-free usage: (a) select impairment, (b) maneuver instructions for blind persons, (c) self-created content

So far, the VIATOR looks similar to existing travel information systems. The first difference is noticeable, though, when unforeseen events occur and the route changes (i.e., either means of transportation or the schedule). In these cases, VIATOR actively reacts, informs the traveler about the change and immediately calculates and displays the traveller's new options without manual intervention. Fig. 2c gives an example of a delay immediately announced via sound to the user.

In terms of barrier-free usage, VIATOR offers to select the type of impairment as part of the user profile. The prototype implementation contains two options for blind and disabled persons (see Fig. 3a). Fig. 3b shows a (pretended unstructured) flow of text representing navigation instructions for blind people. A visual format is unnecessary, though, because this text is meant to be read by screen readers and is only considered for the target group of blind persons. Fig. 3c finally gives an impression of an editing tool enabling its users to create or update those navigation instructions (self-organization).

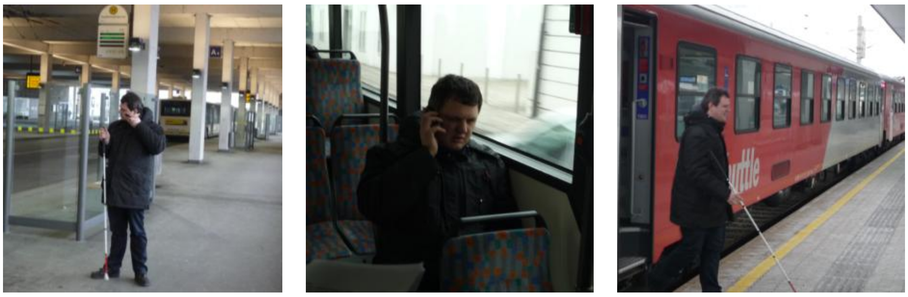

Fig. 4: First experiments: (a) blind person instructed by VIATOR, (b) announcement during journey, (c) finding tactile lines

At this time of writing, the project consortium has conducted first experiments using VIATOR by either blind persons or wheelchair users. Fig. 4 shows impressions caught during those tests, where a blind person is acoustically instructed by VIATOR regarding his next means of transport (Fig. 4a), actively informed about his next steps during the journey (Fig. 4b), and prepared to find the tactile lines when leaving the transportation vehicle (Fig. 4c).

6 CONCLUSION

VIATOR is an approach of integrating both provider-related transportation information and barrier-free navigation instructions based on a location-sensitive platform. It does not apply complicated rules for providing up-to-date information and announcements, but uses the mechanism of location-based action control from its underlying core Digital Graffiti for initiating calculations regarding a user's destination, his current whereabouts and disabilities. A first prototype implementation has proven applicability in the course of several tests (improvements due to experienced weak points are still to be incorporated) conducted by the target group of disabled persons.

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