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Passenger information using a sign language avatar

Individual travel assistance for passengers with special needs in public transport

Public transport, passenger information, travel assistance, information and communication technology, reduced mobility, accessibility, inclusion

Public transport operators are legally obliged to ensure equal access to transportation services. This includes equal access to information and communication related to those services. Deaf passengers mostly prefer to communicate in sign language. For this reason, the specific needs of deaf and hard-of-hearing passengers still are not adequately addressed – despite the tremendous efforts public transport operators have put in providing accessible communication services to their passengers. This article describes a novel approach to passenger information in sign language based on the automatic translation of natural (written) language text into sign language. This includes the use of a sign language avatar to display the information to deaf and hard-of-hearing passengers.

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Public transport operators provide real-time passenger information via electronic information systems in order to keep passengers up to date about the current status of the public transport system [1]. Information provided to the passengers may include predictions about arrival and departure times at stations, as well as information about the nature and causes of disruptions [2]. The passenger information system may be used both physically within a transportation hub as well as remotely via mobile devices used by the passengers. In the design of such passenger information systems (PIS), public transport operators are legally obliged to consider the special needs of persons with disabilities. For example the UN Convention on the Rights of Persons with Disabilities oblige all ratifying countries to ensure that persons with disabilities have the opportunity to live independently and participate fully in all aspects of life. This includes that persons with disabilities should have equal access to public transportation systems as well as all information and communication related to the use of trans-

portation services [3]. In the design of PIS this means that all information provided should be made available to the users by addressing two perceptional modes in parallel. This can be achieved, for example, by combining both tactile and audible elements to convey information to blind passengers. However, as deaf people mostly prefer to communicate in sign language the needs of the deaf and hard-of-hearing currently are not adequately addressed in the design of PIS. The project aim4it (accessible and inclusive mobility for all with individual travel assistance) develops a solution to make passenger information accessible for deaf and hard-of-hearing passengers.

Distribution of incident and disruption information to deaf and hard-of-hearing passengers

With the use of mobility apps and communication via journey planning platforms, passengers perform their initial route planning based on time-table data. During operations the initial route will be updated based on available information about timetable deviations or changes in the status of the network infrastructure (real-time data). Real-time data also includes incidents and disruption information due to their mostly short-term nature. Conventional approaches to making this incident and disruption information available to deaf and hard-of-hearing persons are not suited to the special requirements of passenger information in public transportation.

One possibility to provide audible passenger information to hard-of-hearing passengers is the use of *assistive listening technology*. With this technology a physical cable loop is placed in a station area in public transport systems. The cable generates a magnetic field throughout the looped station area that can be picked up by a hearing aid or Cochlear Implant (CI) processors. This approach allows the sound source of interest (e.g. public address system messages) to be transmitted to the hearing-impaired listener clearly and free of distracting noise in the environment [4]. However this technology is only suited for individuals with reduced ranges of hearing, but not for deaf passengers. In addition to this, providing full coverage with assistive listening technology in all stations and vehicles is not economically feasible given the tight budgets of public transport operators.

An alternative way of providing passenger information to the deaf and hard-of-hearing is to make all audible information routinely accessible visually by the use of *captioning*. With captioning the text version of speech is usually displayed at the bottom of a video screen. Captions are considered useful by people whose hearing has been damaged after they had learned how to speak (so called late-deafened). Furthermore, also hearing persons who are viewing content in a noisy environment benefit from captions. In contrast to this, people born deaf mostly prefer to communicate in sign language. Sign language has a grammatical structure that is completely different from that of spoken language. The written form of their national language is usually the second language learned by deaf people. As the written form of a spoken language is highly abstract and as deaf people have never ever heard the language spoken, they have a hard time learning the written form. For this reason most of them have low reading skills [5, 6]. A passenger information system that is easy to understand and accepted by the community of the deaf and hard-of-hearing should therefore provide both captioning (for hard-of-hearing and late-deafened persons as well as for hearing passengers – in line with the "design for all" concept) and information in sign language (for deaf people).

Sign language is the only possibility to provide information in a barrier-free and understandable manner for deaf people. Translation of spoken or written information into sign language can be achieved either by *human interpreters* (signers) or *sign language avatars*. The signer hears the voices of the spoken text or reads the text and translates the message into sign language. A video camera captures the translation, which can then be displayed to the deaf users. With the use of a signer, sign language can be used on TV or video. The signer usually appears at the bottom of the screen, with the main content being shown full size or slightly shrunk to free space in the bottom corner. However, this approach is expensive and time-consuming and therefore not feasible when it comes to addressing the need for real-time passenger information. Furthermore, given the great variety of reasons of disruptions of public transport operations as well as associated impacts, it is not possible to pre-record messages for all circumstances in order to have them displayed immediately when this particular situation occurs.

Integration of incident messages in sign language in the travel assistance application

With the increased availability of smart phones, passengers can use routing applications to send queries about possible routes between their start point and their final destination to Intermodal Transport Information Systems (ITIS). Especially for disabled persons, conventional routing applications are complemented by additional features that are required to give them unobstructed access to the public transport network. Once passengers have started their trip, the route they have decided to use will be monitored so that they can get updates on all incidents relevant to their individual trip. Besides transmission of incidents, this service also includes the calculation of a new route for the passenger once the initially chosen route becomes impractical (e.g. due to service irregularities). Making incident information accessible to deaf and hard-of-hearing passengers follows three steps:

Capturing incident information: With the incident capturing system (ICS), information about irregularities in the public transport network are typically captured by the staff in the operations control center. Subsequently public transport operators publish messages in their network via different media (including mobility apps). In order to adapt this process to the special case of passenger information for deaf and hard-of-hearing passengers, a new tool chain is introduced in the background systems of the public transport operators. In order to ease subsequent translation of written text to sign language, translation-oriented authoring is applied in the ICS. This means that the user can configure structured incident messages with less complex syntax and a controlled vocabulary. This not only facilitates the subsequent automatic translation process, but also makes understanding the text messages easier for all other (hearing) passengers.

Translation of incident information: Once the structured incident message is available, a video featuring a sign language avatar will be automatically created and stored in a database. The sign language avatar is able to display all elements of sign language that convey the meaning of the incident message. This includes the simultaneous combination of hand movements as well as the orientation and movements of hands, arms and the entire body. In parallel, facial expressions can be displayed to convey further meaning (e.g. emotions). *Figure 1* shows an example of an incident message in sign language developed for the public transport operator of the city of Vienna (Austria). Currently all incident messages are translated into Austrian Sign Language (Österreichische Gebärdensprache, ÖGS). In order not to exclude hard-of-hearing and late-deafened passengers, captioning is added to the incident information displayed in sign language.

Distribution of incident information: The Intermodal Transport Information System

Figure 1: Example of an incident message of Wiener Linien using a sign language avatar combined with captioning

(ITIS) identifies the passengers in need of the information and uses a push service to distribute the relevant message to the smart phone of any deaf or hard-of-hearing passenger. Once the passengers have been advised of a service disruption along their route, they can click on a link and see the incident message presented by a digital avatar. The avatar can convey the content of the incident notification by simultaneously combining hand shapes, orientation and movement of the hands, arms or body as well as facial expressions to fluidly express the speaker's thoughts.

As new standards of Internet protocol-based communication with the passengers' smart phones allow for bidirectional communication, a flow of information towards the passenger can be considered [7]. Also feedback possibilities for the traveler can be included [8]. Using the travel assistance application to gather passenger feedback allows public transport operators to continuously improve the service quality perceived by the passenger.

Conclusion and outlook

The project aim4it builds on interfaces using IP-based communication for passenger information in public transport as standardized by the Association of German Public Transport Companies (VDV, Verband Deutscher Verkehrsunternehmen). By using IP-based web services, passenger information can be provided via different channels, with their personal device being the most individual and convenient channel for the customers.

The project aim4it develops additional functions and services, which have not been part of the initial standardization project. Furthermore, prototypical operation of the new passenger information system for deaf and hard-of-hearing passengers in the test fields Vienna (Austria) and Karlsruhe (Germany) will help to gain valuable practical experience, which will be fed back into the standardization process. The aim4it interface descriptions agreed on within the project consortium will result in work item proposals for subsequent standardization performed by VDV. The use of existing standards along with their amendment makes sure that the project results can be easily transferred to other cities. Current work is directed towards the adaptation of the digital avatar to other sign languages.

Future work in machine-based translation of incident information aims at the transfer of the sign language avatar to other national sign languages. Every country has its own sign language, which significantly differs from other variants. In the future, Signtime GmbH intends to extend the current approach of information display in Austrian Sign Language to the display of German Sign Language (Deutsche Gebärdensprache, DGS). ■

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