Empowering the Elderly: Implementation of Navigation Assistance Application for Public Transportation

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Abstract: When a human ages, the functional abilities could weaken, which can lead to isolation from the society. Applying technological aid for improving the quality of life of the elderly helps them to stay independent and active in their community across their life. This article introduces a system, which is empowering the elderly by aiding them in using public transportation in both rural and urban environments, and helps them in this way to maintain the mobility and activity. The ASSISTANT system provides a simple, yet effective, route info for user and shows only relevant information, at the right time and in the appropriate format. The system is communicating with the user via audio and visual guidance. In addition, it has an error detection functionality, which helps user in case of common navigation errors. End user evaluation performed in Helsinki (Finland), Vienna (Austria) and Donostia-San Sebastian area (Spain) confirms that the service works as intended and helps older people to use public transport by guiding them all the way from the start to the end of their journeys. The system was found to be particularly helpful on unfamiliar routes.

1 INTRODUCTION

Public transportation is perhaps the most important mode of transport among the elderly who live in cities. (Social Exclusion Unit, 2013) Public transportation becomes a primary mode of transport when they lose the ability to drive. To learn how to use the public transportation might be challenging for elders. Utilizing public transportation in unfamiliar places might be stressful even for people with normal cognitive and sensory abilities.

In the ASSISTANT project we have developed a system, which aids elderly in using public transportation in urban environments, and provides simple, yet effective guidance for them. ASSISTANT system provides only relevant information, at the right time and in the appropriate format, and the user interface supports both visual and audio guidance. In addition, ASSISTANT supports safety and security by its error trapping and remediation functionality, which makes it responsive to the user's physical, cognitive and mental capacities and preferences using the ICT already available.

2 RELATED RESEARCH

In the ASSISTANT project Carmien and Obach (Carmien and Obach, 2013) have studied the implications of getting lost and getting back on track in public transportation. They approach the happenstance of becoming lost as a form of error, which anchors it to a long line of error research. Their philosophy is based on Dekker's (Dekker, 2006) suggestion in which errors are to be considered more as a systemic event and not a solely a human error. This makes errors easier to understand and react-to from the system design point of view. ASSISTANT's theoretical background for errors is done by Carmien and Obach whose main research is on error capturing, error classification and error mitigation in public transportation using the mobile navigation systems.

Matthews and Wardman (Matthews and Wardman, 2015) have studied how people with physical mobility impairments would want to use mobile application to help them in public transport and private car setting and how much the users would be willing to pay for different services the mobile application could provide. When using public transport the 59% users would be willing to

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purchase an app in contrast to 42% for car users. For the car users, the most important services of which they are willing to pay were:

- the route directions
- assistance in road breakdown situations, and
- ability to pre-book disabled parking slots

For public transport users the most important services of which they are willing to pay were:

- the ability to pre-book staff assistance in transportation hubs
- pre-book a taxi for continuation of the trip
- information on the next station/stop with the arrival time
- up to date connection information
- accessibility info of the arriving vehicle

The amount of mobile applications which provides public transport navigation support is continuously growing. Even though new services are appearing constantly, most of the newcomers are aimed at public transport users without taking into account specific user groups.

Assist-Mi (assist-Mi, 2014) operates in United Kingdom and is planned for disabled users. It has no journey planning or travel information, but support organization people can see the user location and provide help in difficult situations.

App&Town (App&Town, 2015) is a Spanish (Barcelona, Madrid and Laval) navigation service for users that are blind, partially-sighted, deaf or physically disabled. It has several characteristics that are shared with ASSISTANT, but it has no error mitigation functionality.

GeorgiePhone (GeorgiePhone, 2014) operates in United Kingdom. In the system, the pedestrian guidance is emphasized. In the error situations, a "help me" functionality contacts a garegiver.

Transit App (Transit App, 2015) is a free local transportation planner for mobile phones. It operates in 100 big cities across the USA. They also support Canada and many cities in Europe and Mexico. Transit App does have a support for real-time information. On the other hand, it is not designed for special groups and it does not have error mitigation functionality in it.

Moovit (Moovit, 2015) is also a free, local transit planner app for mobile phones featuring live arrival times, updated line schedules, local station maps, service alerts & changes that affects users' trip. Moovit supports hundreds of cities around the world including many European cities. Moovit presents the planned route in legs and shows the path in a map. It also gives textual information how to walk to the nearest bus stop. While user is in the vehicle, the app gives a list of the stops during a route. There is no error mitigation functionality available in the app.

There are even more mobile apps for public transportation navigation (e.g. TRAFI, Citymapper, Avenue-Public Transport). Many have a pedestrian guidance showing a path in a map or by giving a textual guidance for walking leg, but rarely they do have error mitigation functionality or other aid for supporting user in case they get lost.

3 ASSISTANT PROJECT

ASSISTANT (Aiding Sustainable Independent Senior Travellers to Navigate in Towns) project is a pan-European joint project under AAL Programme (Active and Assisted Living Programme, 2015). In the project there are seven companies from five European countries – Austria, Finland, France, Great Britain and Spain. The project contributes to maintaining the mobility of older people in Europe. Motivation is in safeguarding their social and economic participation in aging society by introducing a navigation assistance service to support their journeys in urban areas.

The ASSISTANT project was divided into three phases. First phase in spring 2013 identified which kind of application would be needed to assist elders in public transport system. Second phase in spring 2014 had a first version of the system that was tested in real world environment with the elderly in three European cities – Vienna, Austria; Helsinki, Finland and San Sebastian, Spain. Test included both the creation as well as the execution of a journey from Point-A to Point-B. To ensure support in case of operational problems or need for help, a person from ASSISTANT project was present all the time during the tests. The third phase in 2015 had a polished navigation assistance system that was piloted in same three European cities with the elderly.

3.1 ASSISTANT Use Case

Main goal of the project was to improve the usage of public transport for older travellers. A user may navigate independently in public transport network using a mobile phone application. The application is connected with back-end system that keeps the status of the traveller and the status of the public transport network up to date. The user plans a route by using a web application and the route is uploaded to the mobile application for further use.

ASSISTANT project has a clearly defined target use case that was laid down at the beginning of the project and consistently pursued. Such use case is split into two parts: *route planning* and *navigation*.

Route planning: When the user decided to go to a theatre. At first, she log in to ASSISTANT website, enter her preferences and fill in if she has any caretakers that the system should contact to in case of an error. On route planner tab, she enters date and time for the journey, her home as a start address and the theatre as destination. A map view shows the route, starting point and the destination. If she is pleased with the plan, she presses 'send to mobile' button and the plan is sent to user's mobile device.

Navigation: Mobile device will acknowledge that it has received the information and then waits until the time for the journey comes up. Application alerts the user beforehand that she should get ready for the journey. When the journey starts, the application will show arrow-based pedestrian guidance to the public transportation stop. When user gets to the stop the application guides user to get the right vehicle and shows how the journey continues while she is sitting in the vehicle. When destination or transfer stop gets closer the application will notify the user. There is an arrow-based guidance from transfer stop to the stop she needs to go to catch another vehicle or from the stop to the destination.

4 DESIGN RATIONALES FOR THE ASSISTANT SYSTEM

The needs of the target group of the elderly users were reflected on to five rationales that were seen as essential for the ASSISTANT system to implement. The five characteristics are:

- Personalization and customization
- Research-based interface for the elderly
- Route planning metadata with accessibility information
- Help for the last kilometre
- Design for failure

These characteristics themselves are not new or unique, but the use of the combination of them makes the system unique for elderly and disabled users. Our main contribution to the field of navigational services is 'design for failure' and it is being discussed in Chapter 5 in more detail.

Personalization and customization was the first characteristic that was chosen. The elderly people have very different kind of disabilities and the ASSISTANT system was designed to be helpful for the people with different needs. When users have disabilities the normal look-and-feel might not be functional enough and the service is thus not usable. To create functional service for disabled users, the system needs to take into account the users' special needs. Here are two possible approaches. System can be split up and design services individually to address different disabilities or it may be designed to be flexible and customizable. ASSISTANT took the latter approach. ASSISTANT's customization and personalization tries to provide only the relevant information, at the right time and using visual, haptic and audio cues to communicate.

The second characteristic is research-based interface for the elderly. There is a large body of research about how user interfaces should be constructed for elderly users. In addition to academic research, we have performed two developmental incremental phases with the target user group, where they have been able to affect which kind of user interfaces they prefer and they have been able to confirm or unconfirm the choices made by the design team. From research we derived several user interface guidelines for ASSISTANT (Carmien and Garzo, 2014). In addition, TELSCAN project provided lots of guidelines how to implement for elderly and disabled. (TELSCAN, 1997)

The third characteristic is using accessibility information in route planning. This characteristic is ASSISTANT's way to create possibility for continuous accessible path of travel. Normal route planning services do not utilize this information when routing people from place to another. For the elderly this might be a deal breaker, because of disabilities they do not want to end up on a train platform where they can't exit for example because of long and steep stairs. This characteristic has proved the most difficult to implement in pilot cities, because getting the accessibility information is difficult as the information is usually not up to date and might not even reflect the real world conditions.

The fourth characteristic is help for the last (and first) kilometre. This means that system will help the pedestrian part of the journey in addition to the use of public transportation system. The grounding philosophical approach in ASSISTANT was that the user will be guided from the doorstep to the destination. ASSISTANT last-kilometer guidance includes both a compass-based arrow guidance and a map-based guidance. Route planners and navigational guides typically only do routing through the public transportation system and maybe add a rough map for the pedestrian part of the journey.

5 CATCHING ERRORS

ASSISTANT system is designed to be able to catch and mitigate the errors during the navigation. An ability to catch and recover from errors is one of the main features of ASSISTANT system and it is the main difference with other similar navigation systems.

5.1 Design for Failure

As mentioned in design rationales for the system in previous chapter (Chapter 4), one of our design principles in ASSISTANT project was the so-called "Design for Failure". Design for Failure in the context of ASSISTANT means, that at some point of use something will go wrong. It might be a human error, lack of network coverage or fault in the public transportation system, but inevitably everything does not go as planned. Because of this, the navigational system needs to be able to react for errors somehow, and be reliable enough so that the user can trust that he or she is not left alone and lost. ASSISTANT has a process to enable recovery from failure.

5.2 Error Detection

In ASSISTANT system there are several ways to detect an error. Our approach to error detection is that the route navigation is based on a state machine. In every state there might be different errors.

5.3 State Machine

In order to be able to give precise and compact guidance to the user, the application needs to have reliable identification of the user state (e.g. walking, in the vehicle or at a stop). When the system detects an error, it categorizes it based on the user's state and then it will try to remediate the situation.

The ASSISTANT mobile application has four main context states: idle, walking, at stop and in vehicle. (See Figure 1). Transitions between the states are identified by different sensors: compass, speed, bearing and accelerometer. State transitions are described here:

- T1 idle to walking
- T2 walking to stop
- T3 stop to vehicle
- T4 vehicle to stop
- T5 stop to walking
- T6 walking to idle

A successful route starts from the home (or other origin) and goes through all of these states. If route includes the vehicle changes, it is possible that state machine cycles between WALKING - AT STOP - IN VEHICLE – states as long as route lasts.

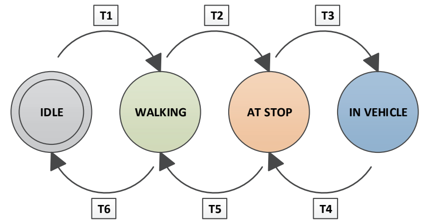

Figure 1: Mobile app state machine.

Errors in the journey itself are easier to catch and recover, because the system itself can work to fix the problem. More difficult problems are those where the system itself does not function as planned. For example loss of network, loss of battery power or weak GPS signal are problems that affect the performance of the system severely. To react these types of problems, the system has a caretaker register in the database. If the system fails, the caretakers are notified that the user is missing and the system cannot help enough. The back-end system will then help the caretaker to its best ability to regain contact with the user. Thus, the user can trust that if everything else fails there still is a person that knows where she was going to and what was the error that happened during the journey.

5.4 Error Remediation

Next we take a look what are the most common errors and how the system recovers from these errors during the route

User is Walking to Wrong Direction
While the user is guided on the First/Last kilometre, she is travelling by walk. Normally she may use the compass to see the direction where to go or use the map to see her route to the next waypoint. However, it might be possible that she put the mobile phone in her pocket, when she may forget the right direction. Now, if she has been walking to the totally wrong direction (the distance to the waypoint is continually extended) for more than 3 seconds, the Assistant app warns (as seen in Figure 2) her by the dialog and also by saying aloud: "You are walking to the wrong direction!"

Missed Stop while Travelling by Vehicle
While user is travelling e.g. by the bus and she is approaching the destination stop, she is informed about this on the second-last stop. When user arrive

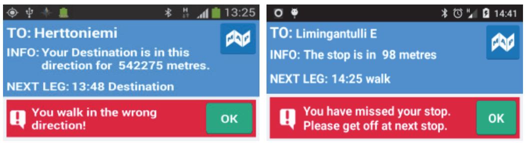

Figure 2: Warning - dialogs.

the destination stop, the user is advised to get off. If the user travels past the destination stop, assistant app informs user (see Figure 2) by a dialog saying: "You have missed your bus stop. Please get off at the next stop." When user has step out of the bus, the system calculates the new route to destination, and the navigation continues as normally.

Missed Vehicle while Waiting the Transport on a Stop

Sometimes user may be a bit late from the stop where she was planned to get on the transport, and her vehicle may have already left the stop. If there is real-time information available, ASSISTANT system could provide information about the next vehicle departure time. If real-time information is not available, system needs to utilize the schedule information for further guidance. Then, the user is asked to refresh the route to see when the next appropriate vehicle will arrive to the stop. Figure 4 shows the dialog to the user.

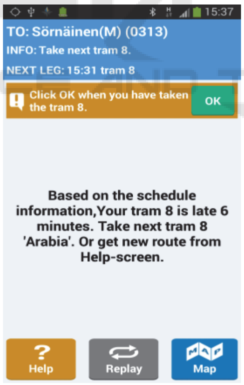

Figure 3: Missed vehicle dialog on the stop.

User Gets Lost during the Route

If user gets lost during the route in any point, he can ask help from the Assistant app HELP-screen which is seen in Figure 5. There are 5 different alternatives:

1. Get a route to destination. This action creates a new route to the planned destination.
2. Get a route to starting point. This action creates a new route to the starting point.
3. Get a route back home. This action creates a new route to the user's home.
4. Connect to the contact person by Phone. This action makes a phone call to the user's contact person for asking more help.
5. Connect to the contact person by SMS. This action send's a SMS message to the user's contact person for informing her about troubles on the route.

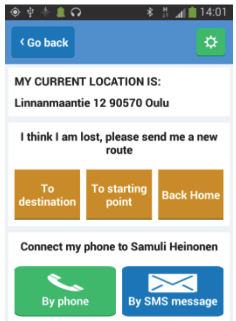

Figure 4: HELP-screen.

GPS Signal Lost

Navigating in urban environment with the help of GPS is sometimes challenging. High buildings form urban canyons, where GPS signal may be weak temporarily. The navigation module in the mobile application tolerates the short and temporary GPS signal lost during navigation without disturbing user about that too sensitively. The user is informed only if the GPS signal has been lost more than 15 seconds by saying: "GPS signal not available!" In addition, Assistant app tells user the next waypoint where she was travelling, so she can try to continue the navigation on her own.

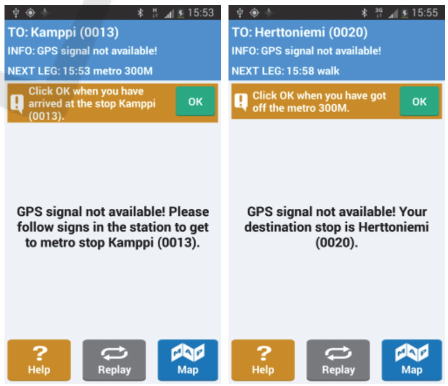

Figure 5: Guidance during the Metro leg.

Metro Leg, no GPS Signal Available

If user travels by metro, it is mandatory to go below the ground, where GPS signal is not available. In the Figure 6 it can be seen how the application informs user about the lost GPS signal, and request to follow the signs in the station to get to the metro stop.

When user has is on the metro, the name of the destination stop is shown. Finally, when user has reached the destination stop by metro and she comes on the ground, the GPS signal comes available and user is guided to her destination as normally.

Mobile Data Connection Lost

While user is travelling, Assistant system keeps track on her progress by sending so called 'I-am-alive'-message to the server every five minutes automatically. 'I-am-alive'-messages include information about mobile phone battery level, current state of the route (walking-stop-in vehicle), and current location. If server does not receive messages from the mobile phone in every five minutes, a SMS message is sent to the user's contact person. The reason for system fail may be a mobile data connection lost or some unpredictable and serious application error. The example of the SMS message is here: "Mobile phone is unreachable for Mr. West. Phone battery level was 50% and Mr. West was travelling by tram. Mr. West has most recently been located at Mannerheimintie 2, Helsinki." When SMS is sent to the contact person, a responsibility to help user is moving to the contact person.

6 SYSTEM ARCHITECTURE

ASSISTANT system follows a traditional client-server architecture, where mobile phone client communicates with back-end server-based application. Server retrieves updated maps, schedules and telematics data from external sources. The system offers a web site with the set of features such as trip planning and caretaker support. The Figure 6 gives a high-level architecture of the system and its relations to the external systems.

The main components of the ASSISTANT system consist of a mobile application running on the Android device carried by the user, and a backend system interacting with the mobile application asynchronously over the Internet. The main role of the backend system is to provide public transport route planning functionality, and profile management services. The server is also used to monitor the systems interactions for storing error states in order that the system can provide error mitigation functions for user.

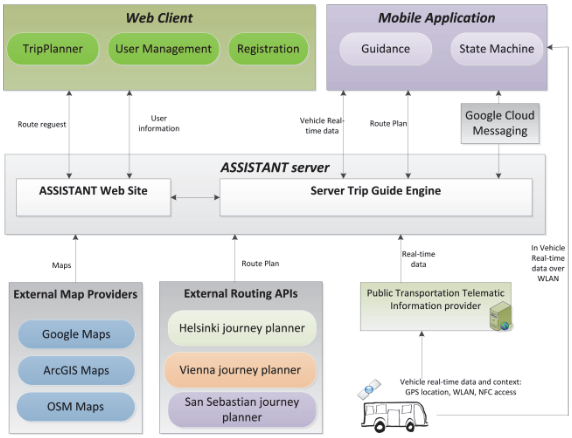

Figure 6: High-level system design.

6.1 Components

There are five main components in the ASSISTANT system: Web Client, Mobile Application, Server, External Routing APIs and External Map Providers. Web client is used for user registration, user management and trip planning. With the web client, user can create user accounts and adjust user preferences, like walk speed, home addresses, telephone numbers etc. More importantly, user can plan public transport routes by using trip planner. The Server hosts the web site, where the web client is installed. There are two ways to get routes for the user: the trip guide engine may request route plans from external routing APIs and modify the route to ASSISTANT-specific format or it can use OpenTripPlanner (OpenTripPlanner, 2014) module (inside of Trip Guide Engine) to create routes from the raw schedule information. When route is created, it is sent to the mobile application, which starts the guidance when the planned route is about to start. External Map providers are used to clarify the overall view of route for user. ASSISTANT server can utilize maps from Google and OpenStreetMap.

6.2 Communication

Communication between server and client is handled using REST API. It means that server is stateless, it has uniform interface, communication is based on client-server architecture and system follows the standard https-based security mechanisms. If the server needs to contact the mobile client, it sends GCM (Google Cloud Messaging) message to the client with appropriate parameters. For example, if user has created a new route by using the web client, the server sends a GCM-message to the mobile client to inform about the new route. The mobile application's GCM-listener notices the message and starts to download route information from the server in pre-determined XML format.

6.3 Real-time Information

The ASSISTANT system is able to utilize real-time information during the navigation. Real-time information in public transportation can be utilized two ways:

1. The local route planner's telematics server provides the real-time information through the web interface. The ASSISTANT server requests the data from the telematics server and delivers it to the mobile application. Real-time information is used to make public transportation guidance more accurate. For example, while user is waiting a vehicle on the stop, she can receive real-time information of the vehicle arrival time.
2. Gathering real-time data in vehicle stops and in vehicles over the on-board vehicle WLAN/Bluetooth. Every vehicle could have their own WLAN/Bluetooth base station, which is used to identify the right vehicle in heavy traffics stops. In addition, the vehicle itself can provide route information, disruption data, etc. for user through the specified API. In metros, user could get exact information about time schedules and upcoming stops.

Using WLAN/Bluetooth hotspot in vehicles will solve the problem of user mistakenly boarding a wrong vehicle. In Helsinki there is a new vehicle on-board WLAN/BT system under development, but other pilot cities (Vienna and San Sebastian) do not offer WLAN hotspots in their vehicles, so the ASSISTANT system did not utilize on-board WLAN for real-time data delivery.

7 GRAPHICAL USER INTERFACE

In this section a Graphical User Interface (GUI) of the ASSISTANT System is introduced. First we go through Web Route Planner GUI, and after that, a GUI of a Mobile Application is introduced.

7.1 Web Route Planner

The use case of ASSISTANT System is was described in section 3.1. If the user is using the system first time, the user should first create and define a user profile in 'My Information'- and 'Preferences'-tabs. The user should give a name, a phone number, an email address and a home street address. In addition, in user can define attributes, like personal walking speed and alert sounds to customize a system to better fit on the user's needs.

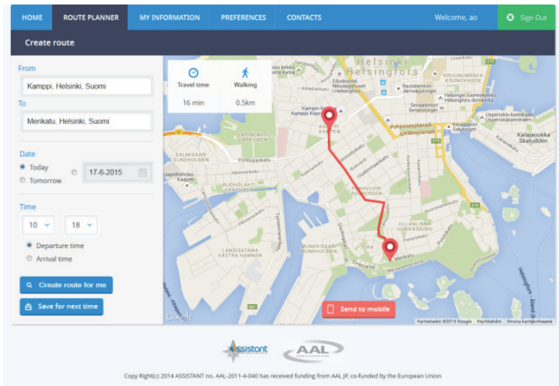

Figure 7: Route Planner-tab on ASSISTANT web site.

When the user has finished creating a user profile, it is possible to plan a route by using 'Route Planner'-tab. The figure (Figure 7) is a screenshot from 'Route Planner'-tab. In this screen, the user gives start and end addresses, and desired time for the route. This makes the system to calculate a new route and which can be seen in a map. The route can be send to the mobile client by "Send to mobile"-button.

7.2 Mobile Application

Currently Loaded Routes – Screen
The main screen of the mobile application can be seen in Figure 8. Screen lists all the routes which are loaded to the mobile client. In this screen user can delete old routes, or see the details of the route. In addition, user has an option to get help in any moment by opening the HELP-screen.

Navigation – Screen
This screen shows all the textual information on the top of the screen. There are three kind of information available: 1. TO-field telling user the next goal of the route; 2. INFO-field giving user a textual advice how to reach the next goal, and; 3. NEXT LEG-field which prepares user for the next leg of the route. In the bottom of the screen there are three buttons, which gives different kind of assistance for user during the navigation: Help-button opens the HELP-screen, Replay-button reads aloud the INFO-field text again, and

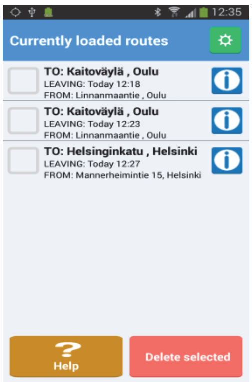

Figure 8: Currently loader routes - screen.

Map/Compass-button is used for switching between map/compass views. Navigation screen can be seen in Figure 9

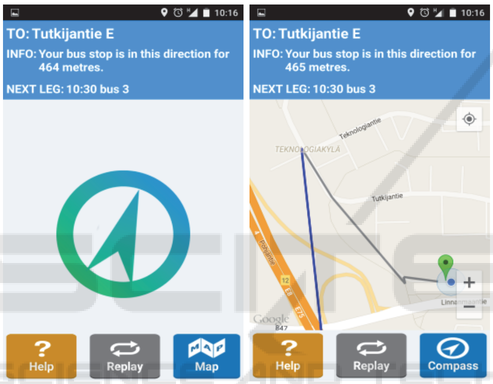

Figure 9: Navigation-Screen (Compass- and Map-view).

Help – Screen

Figure 5 is showing the screenshot from the HELP – screen. Mobile application utilizes the GPS signal to locate user, and by taking advantage of the geocoding, the app tells user the current location as street address. In addition, there are buttons which helps user to create routes to three different destinations: 1) To destination, 2) To starting point and 3) Back home. In the bottom of the screen there are two buttons, which makes it possible to connect with the user's contact person by making a phone call or sending a SMS message.

8 END USER PILOTS

In ASSISTANT project we had two evaluation phases: the first one was arranged in spring 2014 and the second one was arranged in spring 2015. The system was improved based on the analysis of the first pilot's results. The general objective of the second evaluation phase was to gather feedback from the representatives of the target user group (mobile older adults who are over 65 years old) not only to evaluate the usability and the usefulness of the system but also to track system bugs and errors for future development.

8.1 Organization

End user testing in spring 2015 was organized in three cities simultaneously: Helsinki (Finland), Vienna (Austria) and San Sebastian (Spain). The test users were outfitted with smartphones for two weeks, and it was ensured that everybody have a personal computer with internet connection at their home. The test users were asked to use the ASSISTANT system in their everyday life and not to change their mobility habits for the testing period.

The project partners have a common methodology for the testing sessions ensuring that the results from the three testing sites are comparable and that all the test participants are treated in an equal manner. At each testing site, one project partner was responsible for organizing the testing sessions, recruitment of the testers, acquisition of the testing material and carrying out the tests by applying the testing methodology.

The test users participated in an initial workshop, which ensured that they understood their role in the evaluation and learned how the system functions. Then, during the two weeks, they used ASSISTANT system to guide their routes in the local public transports. The testers recorded their user experiences in a specific diary. In the end of the test phase, the participants were gathered for a final discussion where they were able to exchange their user experiences with the test administrator.

8.2 Results and Analysis

As a result of end user testing, some testers used the system more often than the others. Furthermore, some of the users were more comfortable with the system than others, and in consequence some requested help from the test administrator and the others did not. The Table 1 below demonstrates statistical information from the end user pilots 2015.

Even though some system bugs and some usability difficulties occurred during the two-week autonomous testing, the general attitude of the users were very positive and they consider that once they trust ASSISTANT system, it would encourage them to be more mobile and to take the public transports more often. Furthermore, several participants said

Table 1: Statistics from the second end user pilots.

CITY	A number of created routes	A number of routes sent to the Mobile client	A number of finished routes
HELSINKI	315	162	23
VIENNA	271	150	14
SAN SEBASTIAN	465	-	22

that this service is helpful when taking unknown route or when travelling in previously unknown city.

The essential recommendation that the testers gave is that ASSISTANT system should interact more with the user's needs; all functionalities should be optional so that the user could adapt them according to their ICT-skills and functionality needs.

Another important feedback from the testers was that the users need the possibility to change and create routes on the mobile phone too. People want to be flexible: they cannot plan their entire journey ahead and they don't carry a computer with them. It is nice to have the possibility to send routes from a computer but when people get used to handling a smartphone, they can use the service with a smartphone more efficiently. There was quite much discussion of enabling route planning in mobile application in early design stages of the project, but in the end we limited it to the three choices of 'to original goal', 'to home' and 'to route start'. The design rationale for these was twofold:

1. We decided early on to eliminate the need to use on-screen keyboards, because elderly may have difficulty of using tiny keyboards on mobile phone, and
2. When the screen is divided into data display and keyboard / text input areas the data must be displayed in much smaller font making the use of the system difficult for elders.

This evaluation confirmed that the system provides a helpful service for the end-user when using public transportation and notably when taking new unknown routes where the user needs to trust the guidance provided by the system. The general reaction was that the system is relatively easy to use in the context of both devices. As a conclusion, it was noticed that based on the evaluation the ASSISTANT project fulfilled 85 % of the initial user requirements (14/17 items achieved).

9 FUTURE WORK

Even though the current version of the ASSISTANT system is a well-functioning service, it is not completely ready yet. There are a couple of missing features which needs some development work before the system is ready for markets.

One of the features missing in the current system is its inability to recognize the right vehicle while user was waiting it on the stop. As mentioned on section 6, on-board WLAN/Bluetooth hotspots could help with this challenge. Furthermore, there has been recently published new devices on markets called Bluetooth Beacons. In essence, Bluetooth Beacon technology allows mobile applications to understand their position on a micro-local scale, and deliver hyper-contextual content to users based on location. In that sense, Bluetooth Beacons could be utilized in ASSISTANT as follows: Beacons could be mounted in public transport vehicles. While the user is waiting a vehicle on a stop, the application can detect the arriving vehicles by listening the vehicle Beacon signals. When the signal is strong enough, the user can be guided to get on to the right vehicle.

Another missing feature in ASSISTANT is its inability to plan new routes on-the-fly during the navigation. This feature is easy to implement, and a test version of that is existing already.

In order that the system could be taken into use in other cities, a specific server module and a couple of configuration files should be updated and tailored to support the local transportation operator's route format. Finally, all the GUI text labels on Mobile Application and Web Route Planner must be translated to the host country language.

10 CONCLUSIONS

In this paper we introduced The ASSISTANT system, which is developed in ASSISTANT project. System can be used by the home PC and smartphone and it helps older travellers plan public transport journeys and then provides guidance during their journeys. ASSISTANT includes:

- A web browser based on-line means of planning a trip
- Guidance on making multi-step journeys
- Alerts which tells the user when it is time to leave or board the vehicle
- Error detection and mitigation during the trip

ASSISTANT system helps older people to travel safely and independently by public transport. The system offers a seamless support for the entire length of a journey in urban environments.

An ability to catch and recover from errors is one of the main features of ASSISTANT system and it makes the difference with other navigation systems.

End user evaluation confirmed that the ASSISTANT system provides a helpful service for the end-user when using public transportation and notably when taking unknown routes where the user needs to trust the guidance provided by the system.

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