ARGUS: Assisting personal guidance system for people with visual impairment

Newsletter N. 3
August, 2013

Editorial

After the successful test of a Preliminary Proof of Concept prototype, the main progress has been the development of the basic elements and features of the ARGUS system, aiming to complete a first functional prototype that will be tested in the third quarter of 2013.

This issue describes some key features of the system under development. It also describes our participation in various conferences and other dissemination activities.

The ARGUS team.

Summary

The project at a glance

Acronym: **ARGUS**

Name: **Assisting personal guidance system for people with visual impairment**

Co-funded by EU under **FP7-ICT**

Objective: **ICT-2011.5.5**

(ICT for smart and personalised inclusion)

Contract No. **FP7-28841**

Start: **October-2011**, End: **March-2014**

Project type: **Collaboration Project**

Project status: Execution

Project website: http://www.projectargus.eu

SEVENTH FRAMEWORK PROGRAMME

e-inclusion Be part of it!

Small scale user tests

Goal of the small scale tests

The user centred design approach plays an important role in the ARGUS project. The rules of the user-oriented design process are therefore significantly considered during all development phases of the project. This procedure is a guarantor for the implementation of a tailor-made and user-friendly solution which really fits the needs of the target group of blind and partially sighted users.

Against this background, the ARGUS team decided to perform several small scale user tests to underline the selection of appropriate 3D navigation sounds in terms of:

- individual user acceptance;
- expected perception rate, in particular in relation with ambient noise;
- appropriate audio quality of the guiding sounds which answers the needs of the target group in noisy environments;
- static (and therefore safe) user tests introducing the different guiding principles.

With refer to the above mentioned guiding principles, the ARGUS consortium offers two different navigation mechanisms to the target group. The users then are able to decide which one fits better for them.

User recruitment

The tests took place in May 2013, carried out by expert teams of the project consortium at five different locations. The team recruited by 425 at Southsea involved two blind users. The Accessibility Competence Center of Siemens recruited 10 pupils of the LWL-Berufskolleg Soest, a school for blind and visually impaired pupils in Soest, located 40 kilometres away from Paderborn. The tests carried out in Madrid by OK-Systems involved 3 blind users associated to the Spanish Blind Organization ONCE. 4 users participated in the test performed by Vicomtech in San Sebastian. CEIT ALANOVA did the tests with 3 potential users of Vienna.

Tests in Soest (Germany)

The tests in Germany took place at the facilities of the LWL-Berufskolleg Soest to ensure the most comfortable and safe environment for the involved pupils who made their first experiences in this kind of tests. Two accessibility expert interviewer teams from Siemens therefore prepared the required equipment for the small scale tests in different laboratory rooms of the LWL-Berufskolleg Soest.

All interviewer teams accomplished their small scale tests completely independent from each other to obtain unbiased and sustainable results for the further development of the ARGUS prototype.

Tests in Madrid (Spain)

The tests carried out in Madrid by OK-Systems were done considering the availability and preferred location of the users involved. Two users were selected considering their previous participation and knowledge about the project (they were involved in the preliminary none disturbance hearing test). Another user was selected considering his complete ignorance of the project and about binaural sounds. Even considering the different starting position of the users, tests realization was accomplished resulting into valuable and coherent results.

Small scale user tests (cont.)

Tests in San Sebastian (Spain)

In San Sebastian Vicomtech performed tests with the collaboration of ONCE and the participation of 4 users with different visual impairs. Although there was a high variability of perception among all users, all of them were able to navigate autonomously with the system if sufficient training is provided. So, training is a key element and should be a key part for the final tests of the ARGUS prototype. Another important conclusion is that users prefer a simple one sound guiding instead of 3 point based virtual path concept. They liked the concept but they found that for guiding they do not need much information. They also stated that 3 rings could be suitable for particular situations such as object avoidance.

Tests in Vienna (Austria)

In May 2013 CEIT ALANOVA made tests with 3 potential users in the Vienna: two blind males and one partially sighted female, all with good hearing abilities. Two users had good computer skills, one user already participated in similar testing. The tests were done in cooperation with the Hilfsgemeinschaft, Austrian Association in Support of the Blind and Visually Impaired. In general, all users couldn't really identify a clear direction by using the sounds.

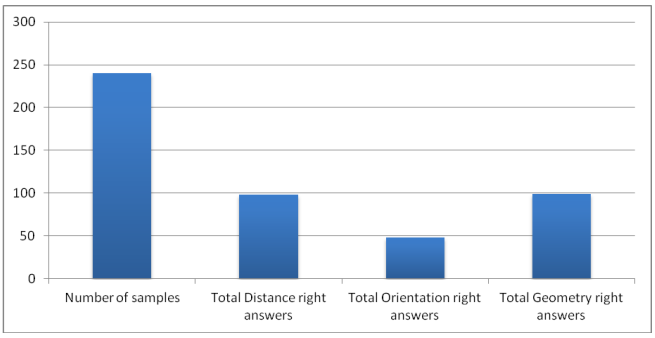
Tests in Southsea (UK)

The 425 company conducted ARGUS Small Scale Tests aiming to get feedback on the binaural concept of ARGUS. The tests were made in the quiet static environment of the Southsea library, taking quite a long time for each person. The ARGUS system used was not optimised for each user and training was necessarily limited.

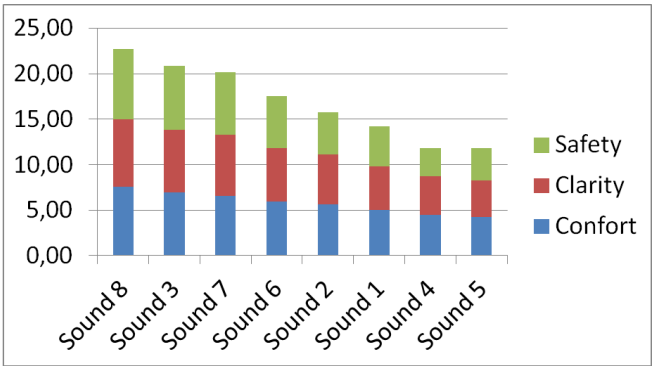
Results of the tests

The main objective of the small scale test was to define and pre-validate some operational parameters of the Acoustic Module in order to provide the final user a right distance, orientation and geometry perception base on 3D sounds. As far as those results could be tightly related with the sound nature, 8 different sound where tested and scored.

Distance, orientation and geometry perception was evaluated during the small scale tests. The obtained results show some system weakness in terms of spatial perception. New issues are now been considered for reinforcing those aspects in the final system implementation.



8 different sounds where evaluated during the small scale test. In general terms the obtained results showed some diversity in terms of safety, clarity and conformability of the different sounds. The ARGUS final system will include the sound better rated by the users.



Other conclusions were obtained not only in terms of operational parameters. Proper training seems to be the key to ensuring that users interpret the sounds as intended.

Positioning Unit

As portable mobile device, ARGUS users do not want another device and prefer using their Smartphone. Due to the fact that current Smartphones do not support the position accuracy and integrity required in ARGUS, a separate localization and navigation module (Positioning Unit) is developed as a black box without any visual user interface. The Positioning Unit is aimed at providing information like the high accuracy position, heading and velocity to the Smartphone supplying the precision needed by the ARGUS device.

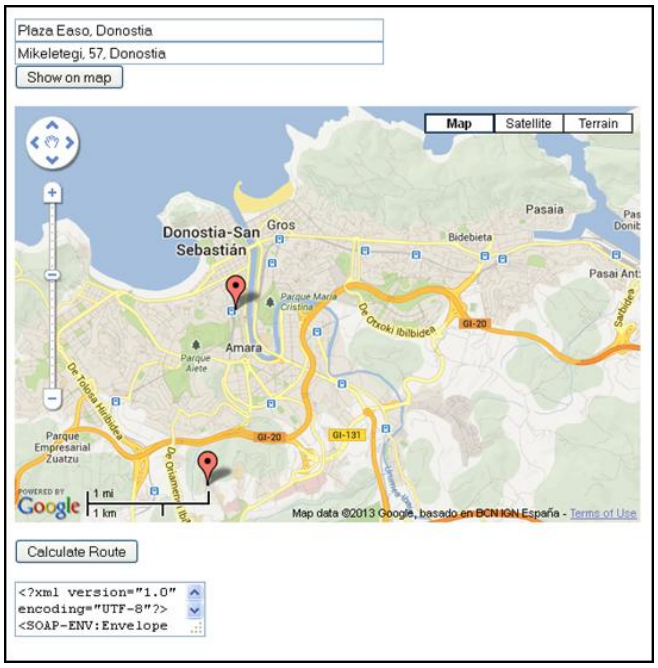
The determination of these quantities is ensured by coupling GNSS (Global Navigation Satellite System) measurements and measurements provided by an Inertial Measurement Unit (IMU).

Nowadays, GNSS serves as key enabler for navigation, for pedestrian users as well. GNSS allows position determination with adequate absolute accuracy, but it suffers from the line-of-sight requirement between GNSS antenna and satellite. If an obstacle blocks one or more satellite signals, the position accuracy decreases, and in worst case, no position solution is possible if less than four satellites are visible. Especially in urban canyons, signal obstruction occurs and influences the navigation performance significantly. Furthermore, it is difficult to determine the attitude of the user with GNSS, using only one GNSS antenna.

Remedial measures can be given by the use of autonomous sensors that provide additional observations for position calculation. Typically, inertial sensors are used in order to enhance the availability of the position. Those measurements can bridge short GNSS observation gaps. Motion sensors such as accelerometers and gyroscopes can be used to compute relative positions, velocities, and orientation changes. Often, triads of accelerometers and gyroscopes, with an orthogonal alignment of axes, incorporate an IMU. The use of an IMU is a challenge due to their large errors, extreme stochastic variances, and quickly changing error characteristics. However, used together with GNSS, they complement each other. The short-term accuracy of GNSS is low but the long-term accuracy of GNSS is high. An IMU is characterised by a complementary behaviour: the long-term accuracy is very low due to the sensor errors, while the short-term accuracy is high. Different properties of GNSS and INS qualify both systems for a combined use. The disadvantages of the one system will be overcome by the advantages of the other system. Such a combination in the area of navigation is usually performed with a Kalman Filter, which is an optimal tool for the sensor fusion of different sensors.

The Kalman filtering leads to an enhancement of accuracy, availability, and integrity, concerning the user's position and attitude. On the one hand, the observations of a GNSS receiver serve as absolute positioning information. On the other hand, acceleration and angular rate measurements provided by an IMU are used for attitude determination and for calculation of the user's velocity. Accelerations are used to derive the user's velocity based on reliable step detection.

Routing Application



The ARGUS routing application is designed to calculate routes in GPX format, according to the origin and destination specified by the user. Additionally, previously uploaded tracks can also be downloaded. This application enables the user to prepare new routes before being guided by binaural sounds.

The first version of the routing application was established by the integration of OpenStreetMap (OSM) data. It is covering the cities of San Sebastian (Spain), Soest (Germany), Vienna (Austria) and Portsmouth (United Kingdom). Concerning this data, a routing network was established based on the available pedestrian and street network data of OSM. Additional information like Points of Interests (POIs) were added. The route calculation is influenced by obstructive and helpful POIs that the users can add into the ARGUS system using the web interface or via track upload, by the help of the Multilayer Information Management module. Therefore, a dynamical user defined routing network is created to get the best suitable path from a starting to a target point. The weights of the routing network additionally are calculated based on the available suitable point information in OSM. ARGUS users will also have the possibility to subscribe to other user points from the community which influence the calculated path as well. Prior to the integration with the rest of ARGUS modules such as the accessible user website, a simple web interface was created for internal tests of the calculated paths.

Next steps of the routing application will be an exhaustive evaluation of the route generation, potential integration of additional detailed pedestrian city data and the potential revision and extension of the routing calculation algorithm.

Acoustic Module

The ARGUS acoustic module is the main responsible for the provision of specific binaural sound stimuli that will support the user for performing a specific navigation.

Apart from other specific requirements based on user requirements, and results obtained from the non-disturbance hearing tests and the preliminary Proof of Concept done in Paderborn, in the final design of the acoustic system, many different issues related with binaural sounds perception have been considered.

Binaural sound localization

Humans distinguish the front, back, left and right, through three types of differences (ILD, ITD and ISD) between what is heard with one ear and what with the other. When the sound source comes from the vertical axis, only the reflections created by the pinna and the various folds of it are acting to pinpoint the sound. The three differences are limited in this case to just one. For that reason, humans are not good at trying to distinguish front and back, when the object or source of the sound is precisely in the person's vertical axis.

Psychoacoustics

Many of the sounds that we hear cannot be measured directly; the perception of pitch and loudness (volume) does not bind directly to the measurement of amplitude and frequency of the signal. Nor all the sounds are collected entirely; a lot of them are lost in the internal process of the ear-brain system. The sensitivity of the human ear is frequency dependent. The frequencies heard best are mid-high, where the human voice is. Much more sound pressure to start listening to the low frequencies than mid-high ones is needed. These differences can be easily appreciated in the equal loudness contours.

Age hearing loss

The hair cells closest to the oval window are the first to die, which means that humans are becoming with age less sensitive to high frequencies. Humans lose an average of 2 KHz every 10 years naturally. A tone control and a balance control are often used in most of the sound equipment to compensate this.

Hass effect

When two identical sounds reach the ear, one with a slight delay relative to the other, the brain will judge the first sources and ignore completely the second even if it is stronger than the first. When natural binaural sounds are used, early reflections must be controlled at every stage.

Binaural sound masking

The ability to detect a signal in a masking background signal is greatly improved when using "two ears". When listening binaurally, only very loud signals or two signals coming from the same direction will be masked. Binaural hearing makes a great advantage in noisy environments, where sounds can be interpreted as different sources thanks to their different position in space.

Binaural sounds selection

The small scale test (SST) affected the final playback parameters managed by the Acoustic Module, including the sound selection to be used in the final system. From a predefined list of 27 different possible sounds, eight sounds where selected to be tested by the users. Those sounds were evaluated in terms of comfort, clarity and safety by listening to them alone and with environmental noise.

Synthetic 3D Sounds

An advanced version of the acoustic module will implement an independent 3D audio engine to render real time binaural sounds. The synthetic side of the Acoustic module is a software module that receives a mono-aural sound file and outputs a *binauralized* sound at the exact desired location. This technology allows exploring the benefits of manipulating the sounds actively while the user moves, producing synthesized 3D sound during the guiding.

Website & Social Networks

The ARGUS User Website is being designed as the main entry-point for new users, who should be able to register into the ARGUS system, learn about ARGUS and how to use it and download the applications that they can install in their mobile devices.

The User Website will be accessible from any standard browser without requiring to install any custom software, and is being designed to be fully accessible by all users, including visually impaired persons (who will be the main target users of the ARGUS system). The first version of the Website will be available in English, but soon it will be also translated to other languages (starting with German and Spanish).

The User Website will also include additional features, allowing the registered users to generate new itineraries between selected locations, or to download stored itineraries from the ARGUS repository. Users will be able to download the itinerary files (including POIs and other complementary data) and then install them in the User Terminal so that the ARGUS system will allow them to navigate along the itineraries with the assistance of 3D sounds.

Users will also be able to link their account in ARGUS with their profiles in different social networks (Facebook, Twitter and others) so that they can use them to share their itineraries and experiences with other users. The extended collaborative environment provided by social networks can be used by the ARGUS users to request support from their friends or other ARGUS users, either to prepare new itineraries or to ask for help during their navigation tasks.

After completing an itinerary, users will be also able to upload their actual itineraries and the POIs that they may have recorded, and share them with their friends.

Integration and validation

The first ARGUS prototype will be integrated and evaluated in Soest (Germany) during mid October. Integration and performance tests will be carried out first, so that all modules are correctly integrated and working according to required functionalities. On the other hand, user tests with 4 expert blind and visually impaired users will be done. The main tasks considered for this validation involve those regarding the registering and login of the user, downloading an existing itinerary, creating a new itinerary, loading it into the smartphone, executing the itineraries and uploading them into the system after the journey. For these tests, the mobile device application will be integrated over Android 4.2 that supports all the features needed for ARGUS functionalities. Previously to the tests, both technical and binaural training sessions will be done. The objective of the technical training is that the user can learn using the web site and mobile application; the main objective of the binaural training is that the user can understand the principle of the 3D sound guidance. Short user interviews based on a questionnaire will be conducted immediately after the tests to validate the functionalities. Accessibility, usability and user satisfaction will be also checked for both the web user interfaces and the interface of the smartphone application.

After this test, by the end of the year, a second testing phase will be carried out to validate the final version of the prototype. These final tests will be done in different cities, representing the different countries of the members of the consortium: Soest (Germany), Vienna (Austria), Portsmouth (UK), San Sebastian and Madrid (Spain). This final testing phase will include the whole functionality of the ARGUS prototype and more than 70 end users will participate. Final user tests will be arranged in collaboration with the end user organizations that are supporting the project: ONCE, FTS, RNIB, VIIAG and several Austrian and German Blind Associations.

Dissemination activities

Participation in events

ARGUS was presented at the **9th ITS European Congress** celebrated in Dublin (Ireland) between 4th and 7th of June. This congress allowed the public to discover and experience Europe's latest advances in Intelligent transport Systems and innovative transport solutions. This year's theme was "Real Solutions for Real needs".

The ARGUS team participated also in the following events during the past months:

- **SightCity**: 24/26-April, Frankfurt (Germany)
- **ENC 2013**: 23/25-April, Vienna (Austria)
- **REAL CORP 2013**: 20/23-May, Rome (Italy)
- **AGIT25:** 03/05-July, Salzburg (Austria)

SAG and TCA presented the Argus 3D sound navigation concept at the **InMoBs workshop** in Braunschweig, which took place at the 28th - 29th May of 2013 in the facilities of the Deutsches Luft- und Raumfahrtzentrum (DLR) which is located in the northern area of Braunschweig. The workshop goals where the networking and communication among German and European project partners focussed on the development of navigation solutions for the target group of blind and partially sighted users. The SAG accessibility team made a presentation on the user-centered design approach followed by a stirring plenary discussion dealing with questions about the 3D sound guidance principles of ARGUS. Some presentation materials were distributed to all involved participants. A successful networking with other German and European partners was accomplished. Guide4blind decided to support Argus with high-accuracy map data for the upcoming user tests in Soest, scheduled for October 2013.

Internet

Check the project **Website** for continuous updates and news: www.projectargus.eu

ARGUS channels in **Social Media**:

- facebook.com/ProjectArgus
- twitter.com/projectargus
- linkedin.com/groups/Project-Argus-4467131
- vimeo.com/argusfp7
- youtube.com/user/ArgusFP7

Audio versions of the previous issues of the ARGUS newsletter were published in the ARGUS **podcast** channel and embedded in the project's Website.

Publications

- An article was published in **Navigation News**, magazine of the Royal Institute of Navigation (May 2013).
- Several papers and presentations have been delivered at different events.

Media

- Broadcast in Austrian radio (only available in German): science.ORF.at (22th July)

Organization of events

- Siemens organized another Workshop in Paderborn (Germany), where the ARGUS system was presented.

Next steps in the project

Main tasks

In October 2013, the implementation of a first functional prototype of the ARGUS system will be ready to be tested and evaluated.

The initial results of the evaluation will be presented to the European Commission reviewers at the second review meeting in November.

Based on the results of the evaluation, the work will continue refining and completing the development of the ARGUS system.

In the final phase of the project additional efforts will be made to disseminate the project results and prepare for their future exploitation.

Participation in events

For the next months, the ARGUS team will also participate in the following events:

- **AAATE 2013**: 19th Sep, Vilamoura (Portugal)
- **ION GNSS 2013**: 19th Sep, Nashville (USA) Please come and see us in Session F4: "New Products and Commercial Services". You can view the full program online at: http://www.ion.org/meetings/pnt2013program.cfm
- **ICT 2013**: 6th Nov, Vilnius (Lithuania)

Subscribe to the newsletter

http://projectargus.eu/newsletter.asp

Contact information

Oihana Otaegui
VICOMTECH-IK4 (www.vicomtech.es)
Mikeletegi Pasealekua 57
Parque Tecnológico
E-20009 Donostia - San Sebastián, SPAIN
Tel: [+34] 943 30 92 30
contact@projectargus.eu
http://www.projectargus.eu

Consortium partners

vicomtech
IK4 Research Alliance

SIEMENS

TeleConsult AUSTRIA

4 2 5 Company Ltd

CEIT

OK-Systems

Collaborators

RNIB · ONCE · Hilfsgemeinschaft der Blinden und Sehschwachen Österreichs · Blick Kontakt