# ARGUS: Assisting Personal Guidance System for People with Visual Impairment

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## 1 ABSTRACT

Visually disabled people have striking needs for trustfully navigation systems enabling for efficient mobility services, mainly considering safety and autonomy. In this context, satellite-positioning and navigation technologies available are being implemented in innovative personal navigation devices. But existing products and solutions based on GNSS (Global Navigation Satellite Systems) fail because they lack accuracy and intergrity, they do not provide a suitable and efficient man-machine interface adjusted to this user segment, or rely on costly infrastructure.

The ARGUS project focuses on a satellite based navigation (GNSS/EDAS – EGNOS Data Access System) terminal for people with impaired visually capabilities, guiding them along pre-defined tracks using specifically designed HMI (Human Machine Interface) such as tactile, acoustic and haptic signals. It introduces the opportunity to develop an innovative guidance support system for visually impaired people based on the provision of a virtual-lead-line perception to the end user that can be perceived and followed. This will provide "track navigation" instead the classical "waypoint or route navigation" which is used for car navigation or people with all visual capabilities.

This system will be also usable for professional, scientific and sport activities developed in reduced visibility scenarios that could require accurate guidance on normal or emergency situations, as well as for other people working in reduced visibility environments needing guidance and assistance.

## 2 INTRODUCTION

Almost 300 million people in the world are visually impaired. About 90% of the world's visually impaired live in developing countries, and about 65 % are aged 50 and older, with an increasing elderly population in many countries, more people will be at risk of age-related visual impairment.

The global response to prevention of blindness have had specifi results in areas of progress over the last 20 years including prevention, eye care servicies, development of policies and strategies, campaigns to raise awareness, and stronger international partnerships with engagement of the private sector and civil society.

But this global response have also had one of the main areas of progress on the developmentet and implementation of technical assistance to the users. Despite the technology state of the art many questions remain open concerning autonomous navigation, acuracy, integrity.

## 3 MAIN OBJECTIVES OF THE PROJECT

The ARGUS project focuses onto the development of a service platform and a satellite based navigation terminal for people with impaired visually capabilities, to guide them along a pre-defined track, using acoustic and audio-haptic signals. In this sense, the ARGUS system provides a virtual guidance rope for blind and partially sighted persons or people working in environments with low visibility (emergency and rescue services, etc.). Based on GNSS systems, ARGUS acts as a leading climber providing a safety rope to the persons following, leaving for them a secure path.

The main goal of the project is to develop a GNSS based mobility service for people with impaired visually capabilities, to guide them along a pre-defined track, using acoustic and audio haptic signals, which meets the level of accuracy, integrity and reliability they need in urban and outdoor environment for improving their day to day life autonomy.

ARGUS project primarily retrieves benefits from satellite navigation services and technologies to increase the level of positioning accuracy and reliability as well as the level of service availability. But the ARGUS project will also develop a whole set of services aimed at pragmatically support visually impaired people in their day-to-day life mobility. For this purpose, some specific objectives are considered:

- To build up a commercial navigation product for visually impaired people which guides them with acoustic and audio-haptic signals along a secure, pre-defined track. The positioning component uses satellite based positioning
- To develop tactile signals, acoustic and audio-haptic ones, for providing a non-visual track perception and mental map of the path, and supporting the guidance of visually impaired people along a pre-defined track.
- To develop an application for authorised third parties. With the application software, stored pre-defined tracks can be transmitted to the user terminal on demand. Furthermore, the application software uses the positioning information from the user terminal to compute protection levels and re-transmit alerts in case of emergency (e.g. degraded positioning accuracy, etc.).
- Provide an intelligent guiding portable device to support ageing population and visually impaired people.
- Provide updated data through a public Web services sharing information collected by ARGUS users with other ARGUS users or with general public

## 4 HOLOPHONIC SYSTEM

Throughout history, multiple solutions have been designed to help in guiding blind or visually impaired people, based on different technologies. Speech based techniques, as well as more sophisticated devices based on handheld haptic display using verbal and non-verbal communication technologies for visually impaired pedestrians have been developed and compared. However, the ARGUS project will focus on a specific audio-haptic signal, which is holophony, providing spatial information through three dimensional sound perception.

Therefore by using the holophony the users perceives 3D sound positioning. Based on this holophonic sound perception, the main goal of this project is to guide the visually impaired person through a preselected route. This route can be selected over previously recorded tracks (natural routes: no multilayer cartography available) or selecting origin and destiny (city or urban scenarios, multilayer cartography available). This route is a series of continuous geolocated points in 2D, therefore this geographical map has to be translated into a sound map (holophony) as it is shown in the next figure.

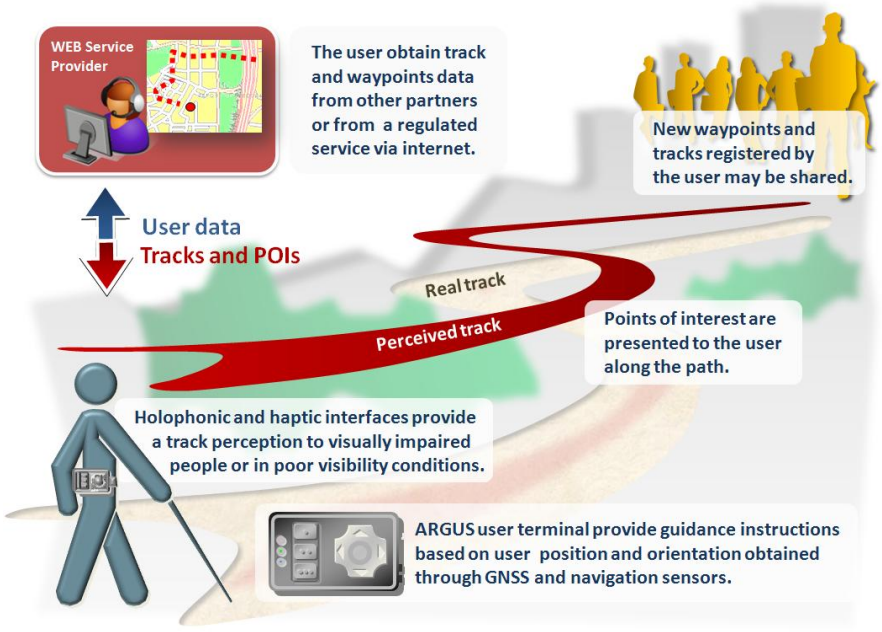


Fig. 1: Navigation based on track perception

Holophony technology record the wave sounds, the way those are received at the tympanic membrane. For that purpose, holophony use auditory system dummies, capturing even the slights differences perceived by the ears caused by direction of the coming sound. Then, holophonic sound recorded may be reproduced by a stereo headphone creating the illusion that sounds come from specific directions and distances.

## 5 SYSTEM ARCHITECTURE

The ARGUS system will be compound by the next elements:

- A user terminal that corresponds to a portable GNSS based navigation terminal capable of guiding the user along a pre-defined track, using acoustic and audio-haptic signals, and allowing internet access for remote service supply and navigation augmentation.
- A service platform corresponding to the assistance and service platform based on a client-server architecture which will offer services all along the three travel stages i.e. before (planning), during (visiting destination) and after (remembering and sharing experiences).
- Personal user software that corresponds to the software for personal usage to configure the user terminal or load particular navigation information to the user terminal.

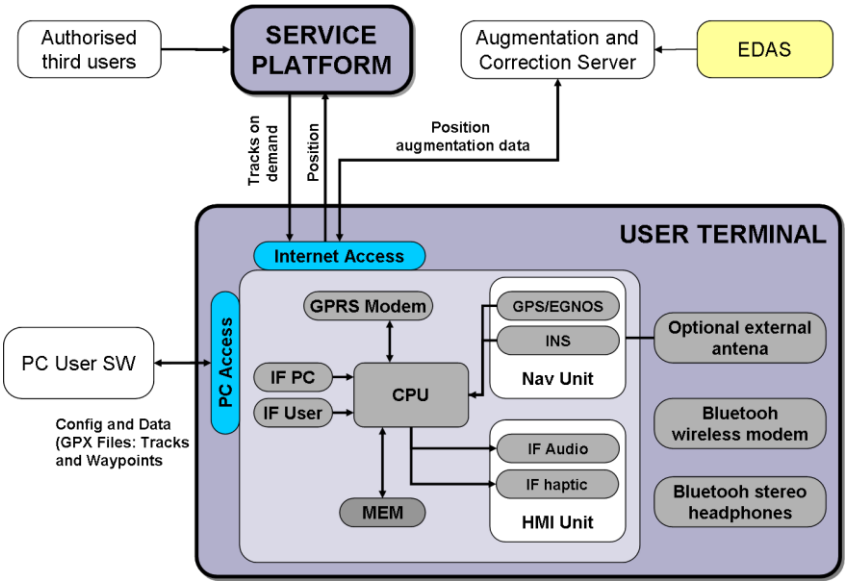


Fig. 2: ARGUS system architecture

### 5.1 Service platform

Assistance and service platform will be based on a client-server architecture which will offer services all along the three travel stages i.e. before (planning), during (visiting destination) and after (remembering and sharing experiences) in order to:

- Prepare their itinerary at home, taking into account specific scoring processes enabling the integration of route safety in the itinerary calculation.
- Manage their itinerary in real-time, with an accurate positioning.
- Contact the call centre for any technical or practical request (such as programming a modified itinerary or new track request).
- Share experiences with other users, improve the system and enrich the locations database with personal comments and points of interest (POI), trough the community website (social network).

### 5.2 Multilayer database structure

For routing calculation GIS (Geoinformation system) information is required, therefore different kinds of GIS systems will be tested. On one hand commercial cartography such as Teleatlas and/or Navteq and, on the other hand, local GIS information if it exists. Additionally OpenStreetMap cartography will also be tested since this is an open source initiative and could be added to the product with no extra cost.


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Nevertheless ARGUS is not a replacement for the white cane so the accuracy of the positioning for guidance is important but is not necessary in the cartography where map matching techniques will be used.

Geodata strategy is based on database interconnected layers. Three different layers (data based structured) will be used (TBC) to tackle the objective of the project. This data bases are queried by the algorithms to get the required information so that the accurate itinerary can be defined

- City GIS Database, OpenStreetMap, or commercial database Teleatlas/Navteq
- General information layer
- User generated personal data based: accessible through a web based social network

### 5.3 ARGUS Website Structure

The project includes setting up and maintaining a public Website providing different services to the users of the ARGUS device, and a collaborative environment open to any persons and organizations that can participate in a social network to help improving the experience of the main users.

The main functionalities implemented in the website will be:

- POIs management: This block allows the users to manage personal Points of Interest and share them with other people.
- Route Calculation: The application to calculate routes from one location to another. Information about the trip, including POIs, will be send to the server where an algorithm will calculate the optimal route taking into account the restrictions of the POIs. Finally the algorithm gives back a file containing the indications to be followed by the user. This file can be stored in the computer and /or loaded into the embedded device.
- Web 2.0: It is dedicated to share experiences of the user and acts as a social network for visually disable people. Any other person (not only visually impaired) could also register in the system so that they can collaborate with auxiliary tasks such as collecting data to feed the system, validate the quality of the data and ensure that there are no changes that could imply risks to the users, or communicate with the users of Argus to share experiences.

## 6 CONCLUSION

The technical challenges comprise the overall development of a guidance system, which enables the users to follow a pre-defined path autonomously without seeing it by using tactile, acoustic or audio-haptic signals. One main challenge is the tailor-made development of a suitable Kalman Filter for the application under consideration in order to adapt it most suitable to the dynamic behaviour and thus the so-called dynamic movement model. Thus, extensive work will have to be spent onto this issue. Furthermore, the protection level algorithm has to be tailored carefully taking into account the target environments and ways of the potential users. The HMI which integrates multisensory actuators (acoustic, audio-haptic, and visual) is also a very challenging part of the development because of the necessity to integrate the different actuators in a most suitable strategy.

In order to accomplish the track guidance, it will be necessary to develop the holophonic sound map. It will allow accomplishing an innovative solution for the user perception of a non visible track path, and the development of the system that will allow visual impaired people to navigate the track in a safe way.

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## 8 REFERENCES

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