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Title

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PP	Restricted to other programme participants (including the Commission	
RE	Restricted to a group defined by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

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Abstract:

The INSPEX system intends to provide safer navigation by obstacle detection (and therefore free space assessment) in various situations, especially of low or bad visibility. Several application domains could benefit from the Integrated Spatial Exploration system INSPEX is developing. Among them, restricted vision condition (Visually Impaired and Blind community), restricted mobility (e.g. wheelchair users) or reduced visibility (smoke, dust, sand, fog, heavy rain/snow, darkness or combinations of these). As a demonstrator, the INSPEX partners have chosen obstacle detection for Visually Impaired and Blind (VIB) people with the objective of integrating the INSPEX system into a white cane.

Deliverable D1.3 is focusing on identifying users' needs and users' requirements that will be used as constraints for the development of the INSPEX system as a whole (Workpackages 2 to 5) and its validation in laboratory conditions and with potential end-users (WP6). Particular emphasis is set on identifying scenarios where mobility is a challenge, obstacle detection is required, sensors need to operate in harsh environmental conditions and the reliability of the Integrated Smart Spatial Exploration System is paramount.

Deliverable D1.3 is organized in two parts. The first one takes a user viewpoint. The current situation is shortly summarized. Then results from an end-users survey are provided. Scenarios of use using the concept of Persona are given. Lastly, user requirements and deployment use cases are given. The second part adopts the vision of a development process named HOE2 (Highly Heterogeneous, Object Oriented, and Efficient Engineering). Hence the boundaries and limits of each *System Under Design* (SUD) are meant to organize the development. The number of systems, their limits and relationships are organized according to HOE2 whose goal is to efficiently drive the development process.

Keywords :

User needs, end-users survey, scenario of use, persona, user requirements, high-level use cases, functional use cases

Disclaimer

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Revision History

The following table describes the main changes done in the document since it was created.

Revision	Date	Description	Author (Organisation)
V0.1	01/05/2017	Document creation + ToC	Loïc Sevrin (GoSense)
V0.2	23/05/2017	Initial content	Loïc Sevrin (GoSense)
V0.3	09/06/2017	Exploitation of inputs provided by partners from the user survey	Loïc Sevrin (GoSense)
V0.4	15/06/2017	ToC review, organisation of sections 5 and 6 High level use-cases from CIT, Tyndall	Suzanne Lesecq (CEA) Susan Rea (CIT) Alan McGibney (CIT) Cian O'Murchu (Tyndall)
V0.5	19/06/2017	Revision, editing	Loïc Sevrin (GoSense)
V0.6	28/06/2017	Extra high level use-cases	John Barrett (CIT)
V0.7	30/06/2017	Functional use-cases	Christian Fabre (CEA)
V0.8	30/06/2017	Internal review	Julie Foucault (CEA)
V1.0	30/06/2017	Final editing and validation prior submission	Suzanne Lesecq (CEA)

The INSPEX Project

The INSPEX Consortium consists of:

Participant no.	Participant organisation name	Participant short name	Country
1 (CO)	Commissariat à l'énergie atomique et aux énergies alternatives – Laboratoire d'électronique et des technologies de l'information	CEA	France
2	University of Manchester	UNIMAN	UK
3	Cork Institute of Technology	CIT	Ireland
4	STMicroelectronics SRL	ST-I	Italy
5	Centre Suisse d'Electronique et de Microélectronique SA-Recherche et Développement	CSEM	Switzerland
6	University College Cork - National University of Ireland - Tyndall (UCC)	Tyndall	Ireland
7	Université de Namur	UNamur	Belgium
8	GoSense	GoSense	France
9	SENSL Technologies Limited	SENSL	Ireland

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1. Introduction

1.1. Purpose of Deliverable D1.3

The INSPEX system intends to provide safer navigation by obstacle detection (and therefore free space assessment) in various situations, especially of low or bad visibility. Several application domains could benefit from the Integrated Spatial Exploration system INSPEX is developing. Among them, restricted vision condition (Visually Impaired and Blind community), restricted mobility (e.g. wheelchair users) or reduced visibility (smoke, dust, sand, fog, heavy rain/snow, darkness or combinations of these). As a demonstrator, the INSPEX partners have chosen obstacle detection for Visually Impaired and Blind (VIB) people with the objective of integrating the INSPEX system into a white cane.

WorkPackage 1 (WP1) has a strongly user-centred view starting with an overview of the State of the Art (Task1.1, deliverable D1.2) through an analysis of products already present in the market for obstacle detection and spatial exploration and of the relevant patents and papers. The focus on the actual scenarios of use (based on the experience of the Visually Impaired and Blind community) user's needs and user's requirements is analysed in Task 1.2, which will also explore other potential application domains. Moreover, Legal and Ethical issues are important to guarantee that the development of the INSPEX system is compliant with regulations. Legal and Ethical related topics are in a central position in WP1 (Task 1.3).

Deliverable D1.3 "Use cases and applications, preliminary version" is focusing on identifying users' needs and users' requirements that will be used as constraints for the development of the INSPEX system as a whole (Workpackages 2 to 5) and its validation in laboratory conditions and with potential end-users (WP6). Particular emphasis is set on identifying scenarios where mobility is a challenge, obstacle detection (and free space assessment as well) is required, sensors need to operate in harsh environmental conditions and the reliability of the Integrated Smart Spatial Exploration System is paramount.

Deliverable D1.3 is organized in two parts (delivered in two documents):

- the first one (D1.3 (part 1)) takes a user viewpoint. The current situation is shortly summarized. Note that deliverable D1.2 provides a state-of-the-art overview, with a patent landscape regarding "Assistive Device and Technologies for Visually and Hearing Impaired people"[1], and overview of existing smart cane and obstacle detection solutions. Then, results from an end-users survey are provided. Scenarios of use using the concept of Persona are given. Lastly, user requirements and deployment use cases are given;
- the second part (D1.3 (part 2)) adopts the vision of a development process named HOE2 (Highly Heterogeneous, Object Oriented, and Efficient Engineering). Hence the boundaries and limits of each *System Under Design* (SUD) are meant to organize the development. The number of systems, their limits and relationships are organized according to HOE2 whose goal is to efficiently drive the development process.

[1] http://www.wipo.int/patentscope/en/programs/patent_landscapes/

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Note that overlaps may exist between the deployment use cases presented in section 5 part 1 of D1.3 and in part 2 of D1.3. However, as the objectives are different, overlaps should be minimised.

1.2. Organization of D1.3 (part 1)

This document shortly presents (section 2) the current situation regarding mobility for Visually Impaired and Blind (VIB) people, as well as the status of the solutions available to facilitate this mobility. Note that deliverable D1.2 has provided an overview of various solutions already on the market with their advantages and disadvantages.

Once the application context is clearly established, a synthesis of the potential end-users' feedbacks clarifies the real expectations and needs of the VIB community in terms of mobility enhancement (section 3). Note that this study has been performed following the Informed Consent procedures and templates delivered in D1.1. This understanding of the user needs is completed by the use of six personas, staged in various scenario characteristics of their usual journeys (section 3.4.).

The analysis of users' needs leads to a complete description of the user requirements (section 4), with ranking on their priority and implementation in INSPEX prototypes.

Finally, the so-called "deployment use cases" are described in section 5.

Note that a number of terms and diagrams are used with different meanings in the literature, especially in the context of requirements and modelling. Among them, one will find "use case" or "scenario". Although each field defines it with a precise meaning, there are a limited number of synonyms, hence their use with different meanings across communities. In the present document, we have several meanings for these terms:

- in section 5 of D1.3 (part 1), a use case is a coarse grain description of an environment together with the expected behaviour of the system within this environment;
- D1.3 (part2), the objectives are different. The goal of this chapter is to drive a development process named HOE2 (Highly Heterogeneous, Object Oriented, and Efficient Engineering). Hence the boundaries and limits of each *System Under Design* (SUD) are meant to organize the developments. The numbers of systems, their limits and relationships are organized according to HOE2 whose goal is to efficiently drive the development process.

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2. Current Situation

2.1. Potential users

During the proposal stage, INSPEX partners have already identified several application domains where an integrated light-weight small size spatial exploration system could be of interest in order to detect obstacles and assess free space for further navigation. INSPEX use applications include mobility for the Visually Impaired, safer human navigation in reduced visibility conditions (smoke, dust, fog, heavy rain/snow, darkness or combinations of these), small robots and drones.

The first targeted users of the Integrated Smart Spatial Exploration system (named "INSPEX system") INSPEX is developing are the Visually Impaired and Blind (VIB) people, as reported in objective O.8 (INSPEX demonstrator) of the Grant Agreement. Indeed, Visually Impaired or Blind (VIB) people face obstacles, crowds, civil work in their everyday trips, leading to many difficulties in having a smooth and safe navigation experience. Even in known areas, an integrated spatial exploration system as envisioned by INSPEX system could highly improve their autonomous navigation.

Basically, human beings' needs for safer navigation in reduced visibility conditions (e.g. in the case of rescue brigades or firefighters) or for Visually Impaired can be expressed in the same way, leading to the very same functionalities the INSPEX system must provide. This is fully compliant with INSPEX objective O.7 (A modular architecture) that advocates for modularity in the design of the system. However, due to specific scenarios of use, *the INSPEX system, even if generic in its concepts, must be adapted to the targeted end-users*. For example, when targeting firefighters as end-users, the helmet could be used to fix the range sensors, whereas for VIB people, wearing a helmet is not acceptable at all (user acceptance issues). As a consequence, and because INPEX partners have committed to deliver their findings as a demonstrator targeting the VIB community, this document focuses on their specific needs, requirements, and finally on the derived use cases.

Starting for the user's needs is critical for INSPEX partners to create a demonstrator that will lead to a really useful and accepted product. This is even more essential when dealing with VIB people since their perception of the world is different from the one of sighted people. Therefore, understanding the real needs of the VIB people in terms of obstacle detection (and free space assessment) to ensure a safer navigation is a real challenge for non-VIB people. Accordingly, this document focusing on user's needs starts from exchanges with VIB people who were asked to share their needs and experiences so that the Research and Innovation work conducted in INSPEX is valuable for the whole VIB community.

According to the WHO[2], 285 million people are estimated to be visually impaired worldwide, with 39 million being blind and 246 having low vision. A white cane can be used for two main reasons. The first one is to be visible and identified as a VIB person while the second one is to detect obstacles on the person's path. The second function of the white cane can also be transferred to a guide dog.

[2] http://www.who.int/mediacentre/factsheets/fs282/en/

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2.2. Existing solutions

The white cane itself, as well as the guide dog, is not able to detect all hazards on the way, especially for head level obstacles. Hence, extra assistance devices have been developed.

Nowadays, even if several systems created to improve the autonomous mobility of VIB people exist, the adoption rate is very low[3]. Indeed, the expectations of the potential users are not matched in term of reliability and usability. Most systems reported in the state of the art review (deliverable 1.2) together with their advantages and disadvantages, scan the environment without interpreting it.

These systems provide raw feedback to the user which is hard to analyse, leading to long learning periods. Moreover, they create a high cognitive load. These circumstances often lead to the rejection of the existing solutions by most of the VIB people.

Hence, the INSPEX integrated spatial exploration system in its demonstrator implementation that targets the VIB community, will have to overcome these limitations. This advocates for an extensive analysis of users' feedbacks, needs and daily scenarios of use as reported in section 3.

[3] Official figures are quite difficult to be found. It seems that most of the Electronic Travel Aids fail to meet users' needs and expectation, leading to a low rate of adoption. See for instance "J. Pleis, J. Lucas, and B. Ward. Summary health statistics for us adults: National health interview survey, 2008. *Vital and health statistics. Series 10, Data from the National Health Survey, (242):1, 2009".*

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3. Synthesis of end-users feedback

3.1. End-users survey

In order to be fully in accordance with the end-users' expectations, a study has been conducted to understand the VIB community needs. This study is based on a survey which has been submitted to several people among several countries, taking advantage of the European status of the INSPEX project.

This survey is divided into three parts, namely:

- **mobility questions** focusing on how the questioned person goes around is his daily life, and the potential limitations to a desired mobility;
- **INSPEX system questions** focusing on the requirements he/she has on a system which would help them improve their autonomous mobility;
- **personal questions** (without privacy concerns) softly categorizing the person to be able to provide a better analysis of the responses.

The survey and the complete description of the procedure followed to guaranty full anonymity to the respondent are described in deliverable D1.1 - Informed Consent procedures & templates.

Once the survey is completed, there is no reasonable possibility to identify the respondents. This commitment as well as the survey objectives and the INSPEX project context were fully described in a *Project Survey Notice of Information* provided to the persons that took part to the survey. To provide a better accessibility, this Notice of Information was also provided on request as a pdf file usable by screen readers.

3.2. Outlines of the survey

3.2.1. Mobility questions

1. Do you have or did you have a white cane? Folding or telescopic? An electronic one? A guide dog?
2. How much time do you spend walking per day?
3. How far do you walk per day?
4. Do you walk around by yourself?
5. Do you tap or sweep your cane?
6. What is your walking speed, approximately? For easy comparison with a known trip, 3 km/h correspond to 500 m in 10 min.
7. Do you need extra assistance to detect these obstacles (please describe the most important ones when possible):
    a. at the ground level (steps up, pole, car tires, tactile strips, puddles, etc.)
    b. at waist level (work barriers, truck back, restaurant tables)
    c. at head level (tree, ladder, scaffolding)
    d. under the floor (holes, steps down, fountains, manhole cover)
8. Have you ever had an accident while walking? Under which circumstances?

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9. Is your city equipped with accessible traffic lights (audio signals)? Do you have a special remote control to activate them?
10. Would you be interested in having an electronic device that assists you in avoiding obstacles?
11. Do you have a smartphone? Which one?
    a. Do you use navigation applications on your smart phone? If so which ones?
    b. Are there any other support services you use on your smart phone? If so which ones?

3.2.2. The INSPEX system

1. Would you accept a system on your white cane of: 100g, 150g, 200g, 250g, 300g?
2. Would you accept a system on your white cane of: 100cm³, 150cm³, 200cm³, 250cm³, 300cm³?
3. Would you prefer to have a device on the cane or around your waist/torso? Both would be visible, not hidden under your clothes or inside your cane.
    a. If on the cane, would you accept a wire linking the cane and a backpack?
4. Can you recharge the system once a day/twice a day?
5. Would you accept to recharge the system once a day/twice a day?
6. Considering you only get an alert when there is an obstacle on your path, would you like the system to indicate the obstacles
    a. with sound (3D augmented reality, intuitive but needs special extra auricular earphones),
    b. with vibrations (less intuitive, especially to describe how far or how high an obstacle is, hardly working with gloves, but the feedback can be given on the cane without earphones),
    c. with both kinds of feedback, other?

3.2.3. Some more information

1. In which categories do you belong: <30yo, 30-50yo, >50yo? (Please choose the good category – please do not indicate your precise age)
2. Are you visually impaired or blind? How long have you been visually impaired or blind for?

3.3. Interviewed end-users' responses summary

Twenty-seven VIB people from Belgium, France, Ireland, Italy and the United Kingdom were interviewed using this survey. From their responses, the following statistics were extracted.

3.3.1. Age categories

In this survey, a wide spectrum of ages was covered, including people below 30 years old, between 30 and 50 years old, and above. However, since visual impairment affects more elderly people (if one is not blind since birth, the older he gets, the more chances he has to be affected), it seems logical to have more people of 50 years old and above answering the survey.

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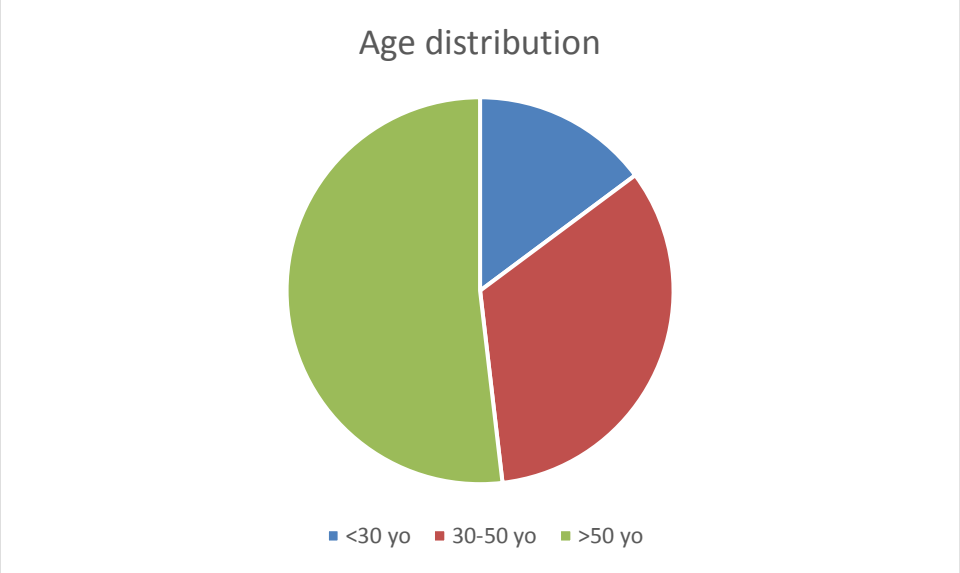

3.3.2. Autonomy

Almost every interviewed person is able to walk alone. That does not mean they are very confident, but at least that they want to keep some autonomy in their everyday life when they need to go away from home.

3.3.3. Type of white cane

The interviewed people were asked about the type of white cane they use when moving around. More than 75% use a folding cane (sometimes alternatively with a telescopic one). Therefore, this should be the kind of white cane the INSPEX system should target, even if being adaptable to other kinds of white canes would be preferable.

Considering only the VIB people having a white cane, the majority uses also either a guide dog or an electronic cane to facilitate their walks.

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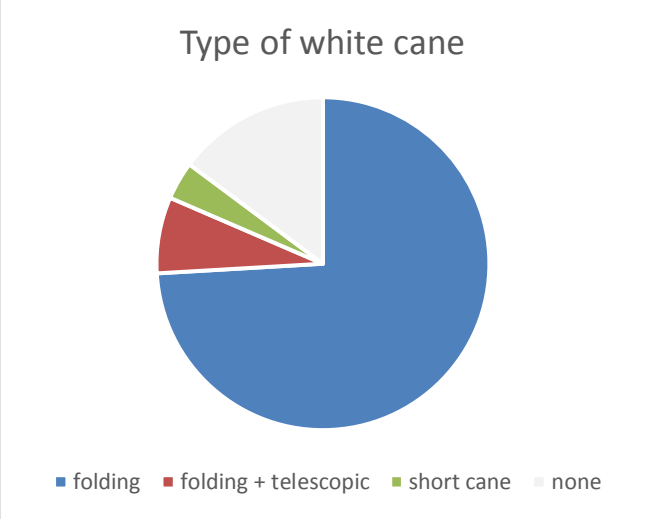
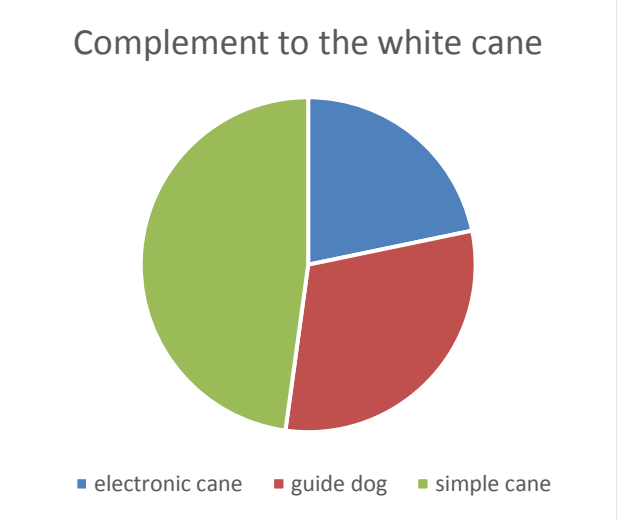
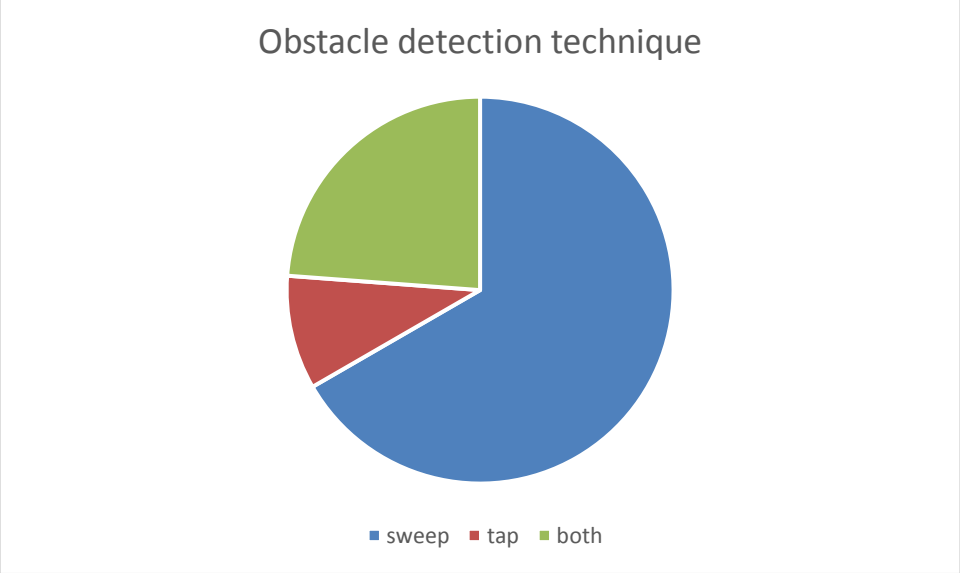




3.3.4. Obstacles detection technique

Considering the VIB people using a cane to detect obstacles, a large majority sweeps the cane on the floor. The other technique is to tap the floor. As sweeping could be much easier to manage for the INSPEX system, at least this way of detecting obstacles should be considered.



3.3.5. Walking time per day

People were questioned about their average walking time per day, as well as their maximum walking time. The results are presented in the following figure. It shows that most of the people usually walk between 0:30 and 1:30 hour every day. When looking at the maximum walking time per day, the answers go up to 5 hours. 4 people out of 27 said they sometimes walk more than 4 hours a day. Those trips can be associated to occasional hikes but they should not be ignored. From these results, the INSPEX system must last at least 2 hours, and it would be even better if lasting 4 hours or more.

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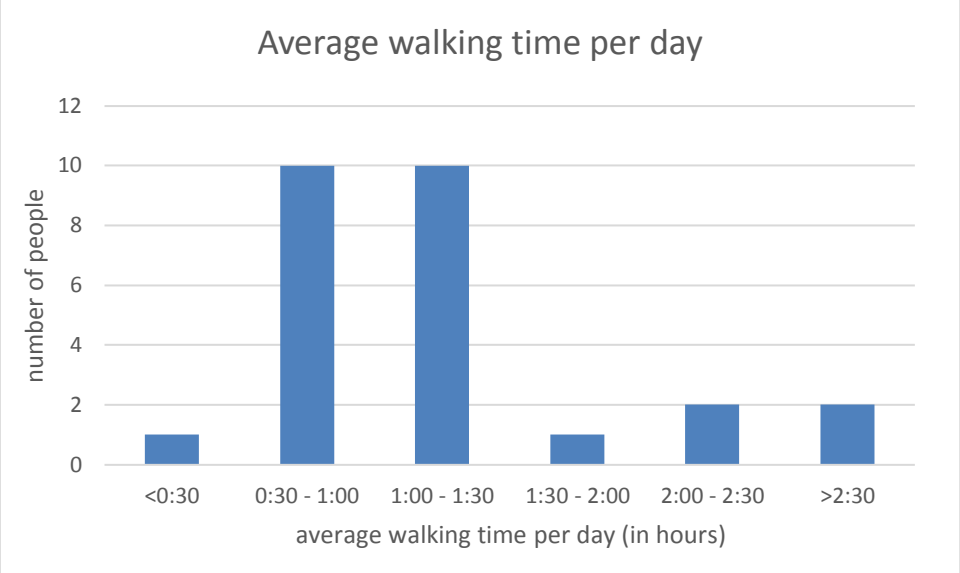

3.3.6. Walking speed

The walking speed was one of the hardest question to answer without any experience. Hence the results should be considered carefully. The main result is the estimated average walking speed, which is of 3km/h (about 1.9 miles/h). It shows VIB people walk more slowly than sighted people, even if some VIB people are able to walk fast enough, especially in known areas.

3.3.7. Detection height

In order to focus on the needs not already covered by the white cane, people where asked about the height of obstacles for which they need assistance. The following figure shows if people want assistance to detect various kinds of obstacles. The assistance level is classified as follows:

- 0 – no assistance needed;
- 1 – assistance could be helpful;

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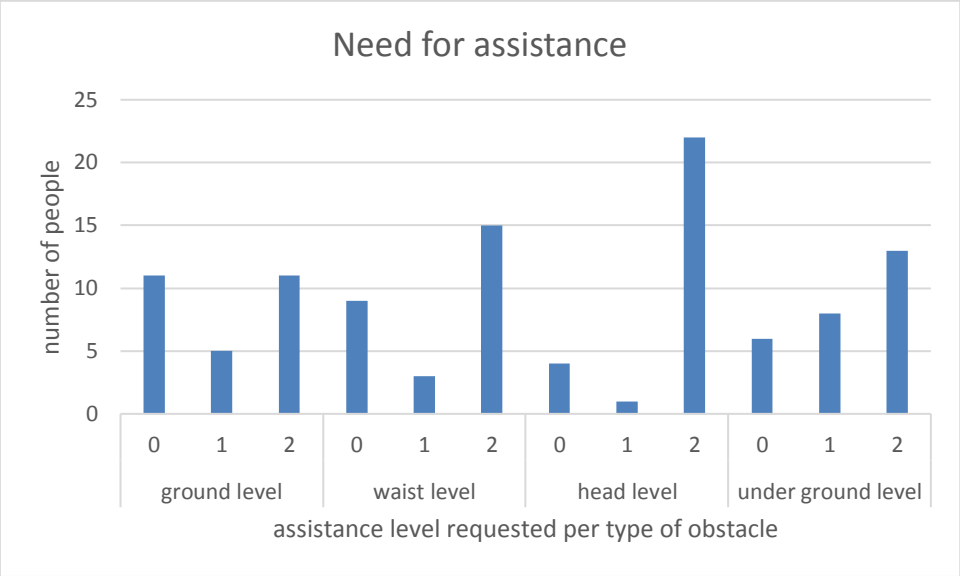
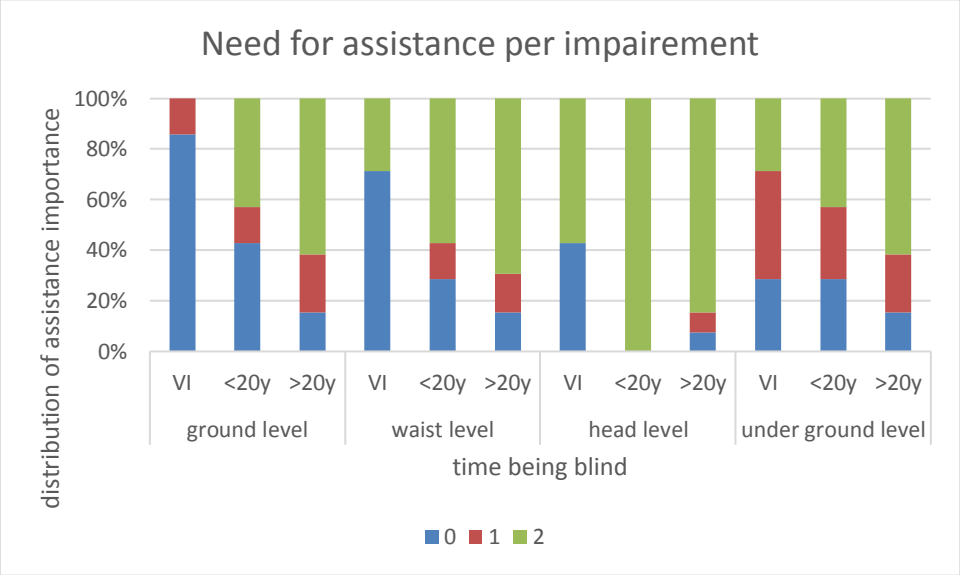
- 2 – assistance needed absolutely.



The most important kind of obstacles is by far head level obstacles (tree, ladder, scaffolding, etc.). Indeed, these obstacles cannot be detected by the standard white cane (even by a guide dog in most cases) while they can be very painful when hit. An assistance is also widely asked for the waist level (work barriers, truck back, restaurant tables) and the underground obstacles (holes, steps down, fountains, manhole cover).

A first distinction can be made between the categories of interviewed people. When crossing the answers with the time being blind, the following figure is obtained.



This figure shows that the visually impaired people want less assistance (greater part classifying the needed level of assistance to 0 compared to the blinds) for all kinds of obstacles. Another observation is that people being blind for a longer period of time seem to request more assistance (people blind for 20 years or more classify the needed level of assistance to 2 more often than the other ones). This observation can also be

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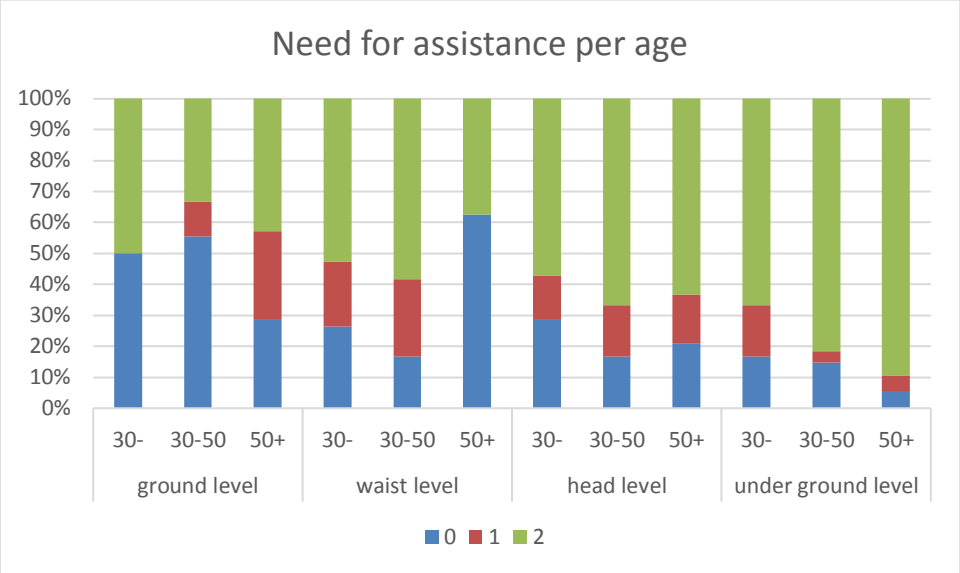
applied when the threshold is 5 years of blindness instead of 20, but the number of people per category is not relevant then.

One could notice that the age could be of great influence on the time being blind, hence on the correlation between the need for assistance and the time being blind. When crossing the answers with the age categories, the following figure is obtained.



It shows that people over 50 years old want more assistance for under ground level, but this observation is not very clear for the other kinds of situation. The previous correlation between the time being bling and the need for assistance seems even more relevant.

From these results, we can consider that the head level obstacle is the most important, but waist level obstacles and under-ground obstacles are also very important, especially for blind people. Even the floor level obstacles, directly targeted by the white cane, would be requested by people being blind for a long time.

3.3.8. Expectations from technology

When asked if they want assistance from an electronic device, the answer is quite unanimous from the blind people. Many VIB people would be interested, but some would prefer to keep trusting their remaining sight, sometimes combined with a cane.

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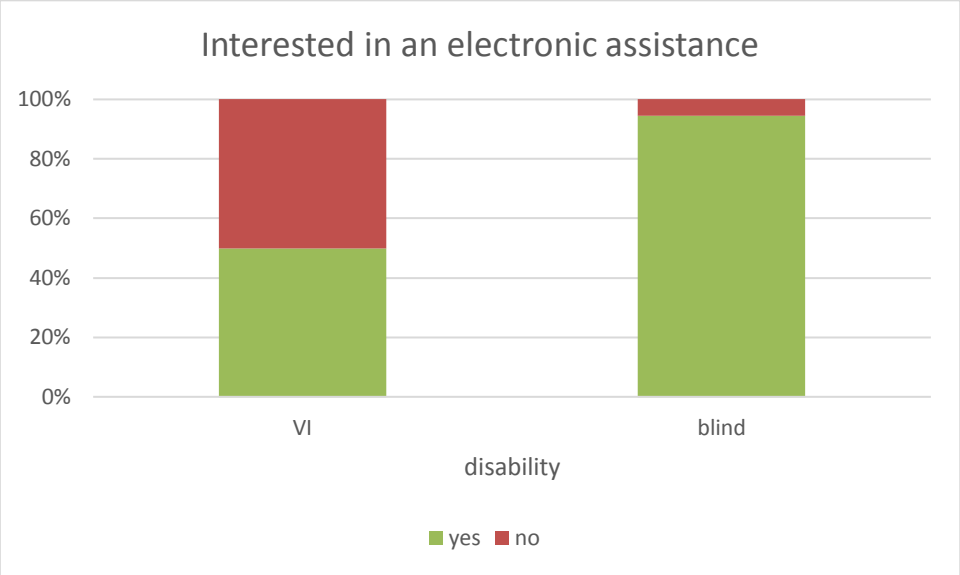
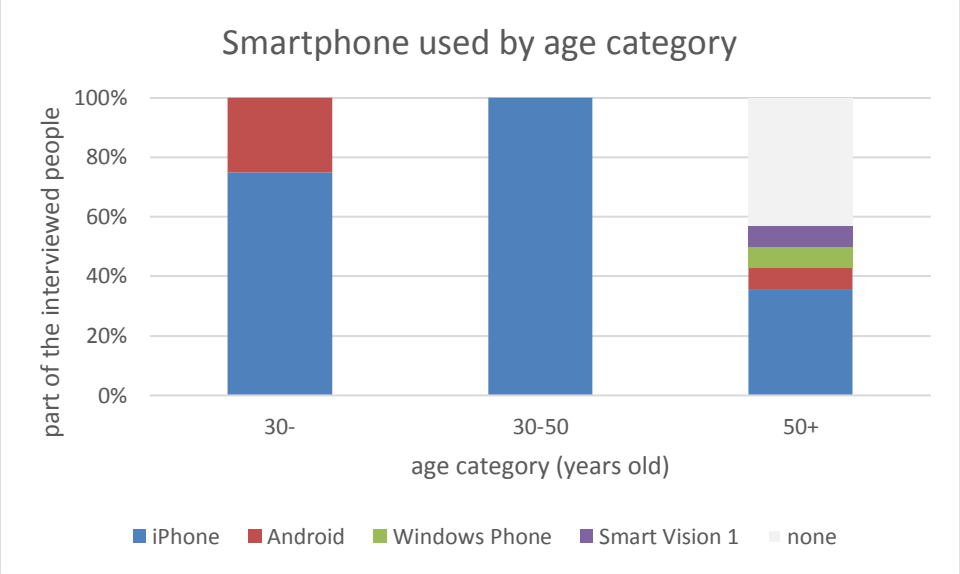


3.3.9. Use of a smartphone

A smartphone can be very useful as a computational resource, an interface, a connected device, etc. But it can only be used if most VIB people have one. Hence, people were asked if they have a smartphone and which one. The results are summarized in the following figure.



These statistics show that all people below 50 years old have a smartphone, and that about 60% of the people above 50 years old already have a smartphone (this number is known to be growing). Moreover, most VIB people use an iPhone rather than Android, Windows Phone, or and adapted phone, because of the applications that are already developed for such decives.

Half of the users of smartphone use a navigation application on it. The following applications were cited at least once:

Google Maps, Apple maps, Blindsquare, Wizigo, Waze, Movit, City Mapper, Transit, Claria Vox GPS.

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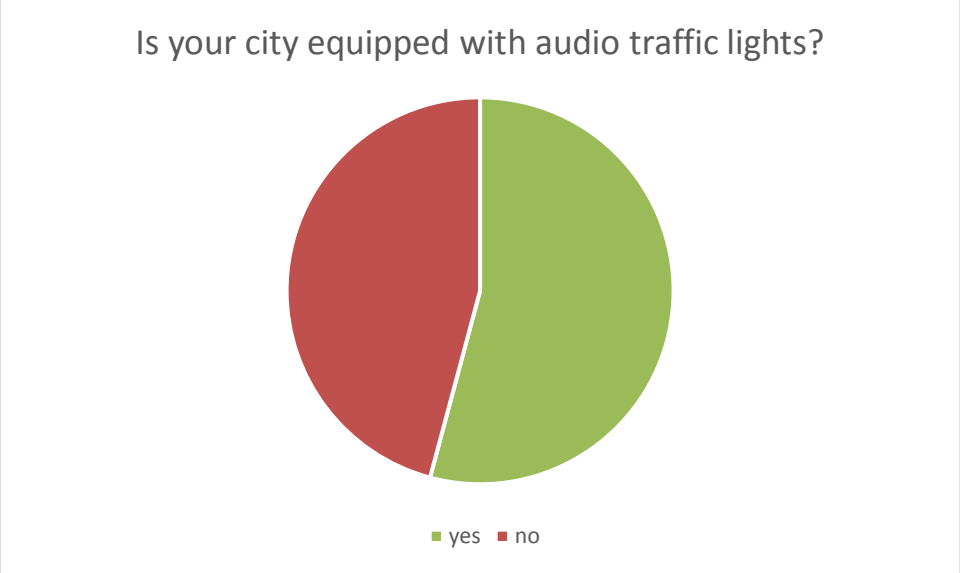
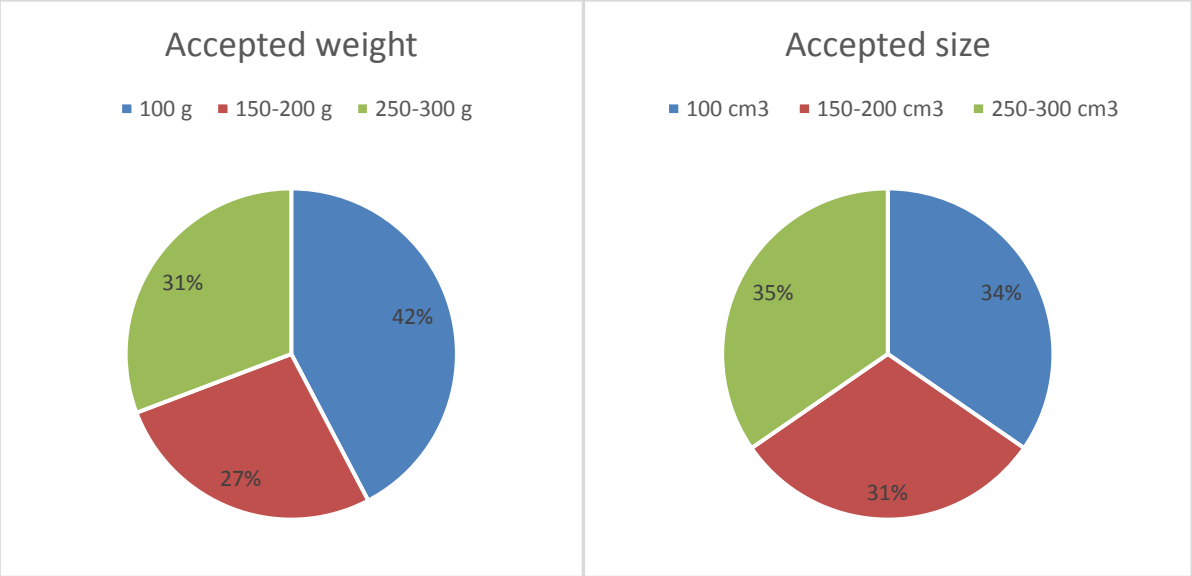
3.3.10. Adapted city

The questionnaire showed that some cities in Europe are equipped with audio traffic lights, but it is no yet widely developed. Also, even when the cities are equipped with audio traffic lights, this audio signal is often played all the time, without the need of a remote control. This can be very annoying for sighted people and may limit its adoption over Europe.



3.3.11. The INSPEX system

The interviewed people were asked a series of questions concerning the INSPEX system itself. The first questions asked dealt with the size and weight that seem acceptable for the system if plugged on the cane.



The results are not clear. An important part of the interviewed VIB people want the system to be as small and light as possible, hence they chose the lowest proposed answers (100 g, 100 cm3). A third of the people would accept a system up to the maximum weight and size we proposed, considering the advantages of such

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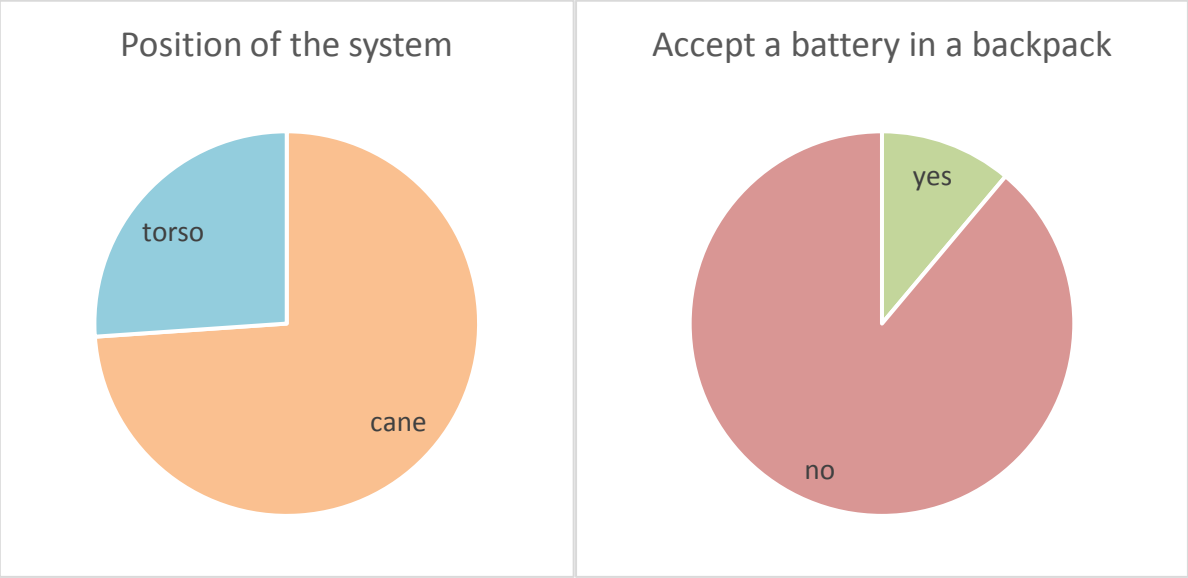
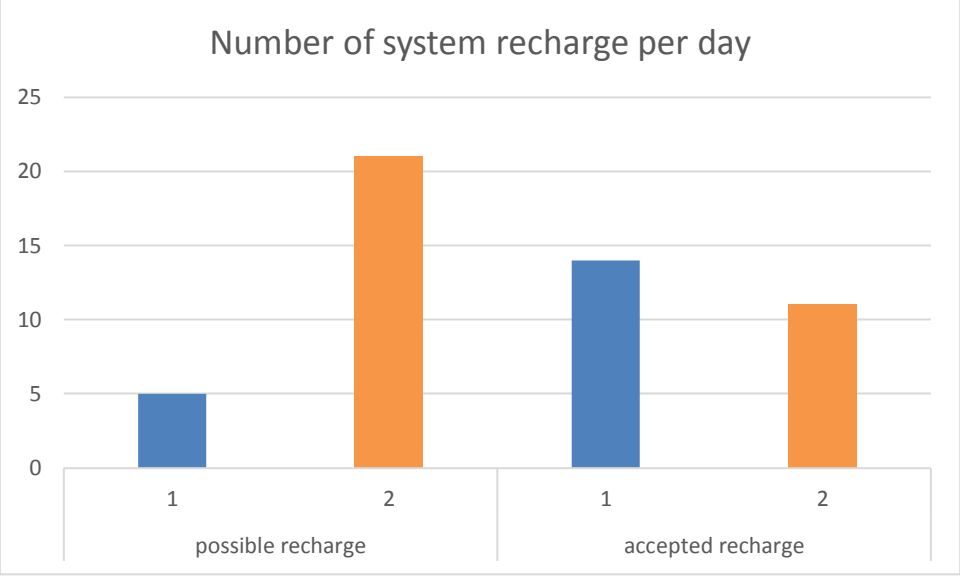
a system would make a critical difference. More people asked from a low weight than size, showing the weight seems to have more impact on the usability of the system when plugged on the white cane.

From these results, the targeted weight should not exceed 200 g. Also producing an even lighter system would be very beneficial to reach a larger audience. The targeted size seems to be 200cm3, even if this requirement seems weaker.

A large majority of interviewed people would like to have the system on a cane, without the need to carry a battery in a backpack.



When asked about how many times they would agree to recharge the system per day, many people say they would be able to recharge it twice a day, but they would not agree to do it. Hence, the lifetime of the system should be of at least one day on normal usage (see above the average walking time).



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Lastly, people were asked about the kind of feedback they would prefer to locate the obstacles on their path. The sound through 3D audio is more pleaded than the haptic feedback (vibration), but half of the interviewed people asked for both feedbacks.

From these results, it appears quite clearly that the choice between the two proposed kinds of feedback is not clear to the potential users. Hence it would be very beneficial to the project to be able to handle both kinds of feedback in order to test them, either combined or separately, to finally chose the most appropriate way to locate an obstacle (and assess free space) for a VIB person.

3.4. Scenarios of use

3.4.1. Concept of persona

A persona, (also user persona, customer persona, buyer persona) in user-centred design and marketing is a fictional character created to represent a user type that might use a site, brand, or product in a similar way[4].

Here, the objective is to use several fictional characters, representing various profiles of the targeted end-user community. Being fictional, these characters can be described and analysed deeply without any concern about privacy. They are also realistic enough in order to create empathy. Thus, one can feel the life of a persona to better understand his/her needs.

Hence, the persona is a powerful tool to better understand and describe the end-users needs' and requirements.

[4] William Lidwell; Kritina Holden; Jill Butler (1 January 2010), Universal Principles of Design, Rockport Publishers, p. 182, ISBN 978-1-61058-065-6

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3.4.2. INSPEX personas

The first potential end-users targeted by the integrated spatial exploration system developed in the course of INSPEX are from the VIB community. Hence, six Visually Impaired or Blind personas were created. In order to make them more realistic, their stories were partly based on several real people stories. These latest were mixed and modified to make sure the link with any real person could not be made. Many of these story mixings were performed by **Franck Drevet, responsible of accessibility at GoSense**, and blind himself. His years of experience helping Visually Impaired people in associations give him an extensive knowledge of VIB people daily life.

Each persona is located in a different country, matching all the countries of the INSPEX partners, so as to include them all in the creation process. In this way, each partner will deeply know his persona to be able to defend his interests during the creation process.

The six personas are:

- Alain, 68 years old, blind, from Switzerland;
- Rupert, 45 years old, blind, from the United Kingdom;
- Charlotte, 38 years old, blind, from Belgium;
- Ludivine, 15 years old, visually impaired, from France;
- Mike, 50 years old, visually impaired, from Ireland;
- Nicoletta, 29 years old, blind, from Italy.

They are described in the following parts.

3.4.2.1. Alain (Swiss)

Disabilities in the family:
Alain is a man of 68 and completely blind since the age of 35. He was born with intact vision and gradually lost it successively resulting from a genetically provoked glaucoma. The fact that he has experienced intact eyesight during his youth remains a big advantage aiding his visual imagination in spite of complete blindness. With the exception of some remaining ability to differentiate complete darkness from bright environment, he is unable to see or identify any object by eye without visual aids.

He is married to a woman who is 7 years older, yet completely without any impairment. She has been a great help throughout his life in making his life both easier and enjoyable. They have found a good way to live their lives and integrating the frictions of visual impairment into their joint activities with what they say acceptable disturbance. They have two adult children who both have children themselves, so they enjoy a life of happy grandparents. The fact that Alain is the only family member with serious disablement at least allows him to be embedded in a supportive social network.

Technology:
Alain is a great fan of advanced technology. Unfortunately, in his early years of developing blindness, the smartphone was not yet invented and personal computers had just appeared as vague possibility to provide future benefits, they were too limited in functionality. Yet this did not stop him from embracing all technology advancements such as audio aided digital document readers and other PC tools helping blind people interact with the internet and society in general. Today he is the typical early adopter new technology innovations

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desperately needed to make smooth transitions into the market. He is eager to stay up-to-date with all developments offering increased value of life for the disabled and is also actively encouraging both training and knowledge transfer to his peers. Within the limitation of sensing, he enjoys an active live and also attends cultural events such as music concerts or even movies that support background information for the blind to understand the story.

Job, associations, hobbies:
He no longer works in an employed position as he now enjoys retirement. In his professional career he was engaged for many years in leading positions with the largest association for the blind in Switzerland http://www.sbv-fsa.ch/de where he currently supports a training centre for blind and visually impaired people who wish to use the smartphone creatively and extensively. In symbolic reference to the most popular smartphone by Apple, iPhone, the school is called “Apfelschule” (Apple School) and their website http://apfelschule.ch/ explains the scope of his current main activity. He can now enjoy more spare time before and enjoys this with his grandchildren and his wife.

Mobility:
He lives in a small town in Switzerland yet travels extensively to pursue his activity to other cities in Switzerland by public transport as he is comfortable in using this infrastructure in Switzerland.

Money:
He earns the regular pension for Swiss citizens together with his wife, corresponding to average monthly income of 3500 CHF per month.

3.4.2.2. Rupert (British)

Disabilities in the family:
Rupert is about 45 years old and is totally blind. He lives in the suburbs of Manchester. He is divorced from his wife and has no children. He is quite sociable, and enjoys the company of a diverse collection of non-VIB family and friends.

Technology:
He uses a screen reader for his computer at work, and sometimes voice over on his iPhone. His is not very interested in new technologies, even if he understands it can be of some help to make his life less restricted and safer. He will not tolerate having his ears covered in day-to-day activity. He is definitely against devices/approaches that are too cluttered and/or stigmatizing.

Job, associations, hobbies:
He is a mid-range manager in a small branch of a bank in Manchester. He is not interested in VIB associations, which he considers ghettoizing, and positively relishes a lifestyle which is as non-VIB-identifying as possible.

Mobility:
He uses trains, trams and buses, every day to go to work. He needs to navigate a main road between the train station and his place of work, which is quite risky due to heavy traffic and remodelling of the road. He uses a white cane when moving around. He prefers a telescopic cane as its behaviour when collapsing and extending is more restricted and predictable. He tends to get grumpy if he's interfered with by members of the public.

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Money:
He earns about 50K GBP a year. At that income level, he is not eligible for any assistance from the government.

3.4.2.3. Charlotte (Belgian)

Disabilities in the family:
Charlotte is a small, slightly hefty, 38 years old woman. She was born blind and she lives in Namur with her two boys who are respectively 7 and 9 years old. She is divorced from her husband and her children are both visually impaired. She has no sense of orientation. If someone shows her the way towards a place, she will not be able to find her way back home.

Technology:
Charlotte is interested in new information and communication technologies but she is not really found of it. She tried a specialized pedestrian pocket GPS for blind person which can be bought in Belgium (Kapten Mobility) but she is not happy with it because of the itinerary recalculation which she finds really perturbing. Hence, she does not find it very useful.

She uses an iPhone and she tested the Apple Maps application. Nevertheless, she is no more confident with this system than with the Kapten Mobility application. Indeed, she thinks the application is not reliable due to too many errors and she finds its use too complex.

Job, associations, hobbies:
Charlotte works part-time as a secretary in a private company. She is a member of a VIB association but rarely takes part in any of its activities because it is too difficult for her to go the meeting place. However, she is eager to go out more often especially to the city centre where she likes practicing shopping at the FNAC store (a French retail chain selling cultural and electronic products). There, she can find her preferred audio books.

Mobility:
Charlotte uses the Handicap & Mobility bus to go to work. This is a specialized private transport service is provided by a non-profit association. She can use it for free thanks to her TEC discount card (the TEC is the public transport company in the Walloon Region).

According to the 1954 Belgian Act on the protection of the white cane, Charlotte is allowed to use a white cane. She heard about the electronic cane. She is a bit reluctant to get one because she thinks it gives way too much information about her. Still, she hopes to find, one day, the appropriate electronic cane which will meet her privacy concerns.

Money:
She earns a salary of 592€ net per month, and receives the Replacement Income (790€) and the Integration Income (878€). She also gets the Family Income (+/- 1.300€ per month taking into account the impaired vision of her children). The total amount is about 3500€ net per month. She can also benefit from other social aids.

3.4.2.4. Ludivine (French)

Disabilities in the family:

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Ludivine is 15, and is in the Pierre Brossolette high school in Villeurbanne. She lives in Vaulx-en-Velin near Lyon, France. She is visually impaired since birth, with a visual acuity of 1/10 for the right eye and 2/10 for the left one. This asymmetric sight creates a difficulty to see the landforms (steps, sidewalks, etc.). She wears glasses with big lenses. These glasses are hard to wear and give her complex towards her friends. She is often a target of mockeries about her physical aspect. She has one sister with no disabilities, as her parents.

Someone is dedicated to help her at school (AVS: school assistant for disabled in France), but this person is not present every day, sometimes without noticing. While the AVS is supposed to help her only, she often does other things instead, which Ludivine doesn't like and prevents her from improving in her studies.

Technology:
She has an asset; she is found of new technologies. It saved the day in many situations and permits her to be in the spotlight and be considered as gifted by her friends. In class, she likes to work in braille (she learned it at a specialised institute in Villeurbanne, near Lyon), which is faster since she can handle graphics rapidly. Her braille notepad is better than a computer for her since it is lighter, faster, and attracts her friends. She is admired for mastering braille with her notepad.

Job, associations, hobbies:
She is a musician – she plays the piano. She takes lessons at her teacher's place (not far from her place so she goes there by foot with her cane). She is in a band, with friends (some are visually impaired, and some aren't). When she needs to meet her band for rehearsals and concerts, a parent of a friend picks her at home and drives her back.

She isn't in any VIB associations.

Mobility:
She takes the bus and the metro to go to high school. She uses a white cane inside and outside of the school, even to go from class to class. She is not at ease with her cane in front of her fiends (big complex). She uses a GPS application on her Android smartphone (Galaxy S7): Blindsquare. It helps to locate oneself and to know what is around. She also uses other public transport applications: transit and movit, which are not specialized, but are accessible. She feels comfortable moving around on her own.

She hasn't tried any electronic white cane. She has had some bad experience with orientation and mobility specialists, and thus hasn't look much into it. She usually tries to manage things by herself. She has never had any serious accident, but she sometimes hit a pole, a mailbox, etc.

Money:
Her parents get the AES (specialized aid for the education of disabled children) of 250 euros. They both have a job and earn about 3000 euros net per month, together.

3.4.2.5. Mike (Irish)

Disabilities in the family:
Mike is in his 50's. He is 1.70m tall, weighs 90Kg and walks with a severe limp following an accident some years previously on his small hill farm in West Cork. He is widowed and has one son, Jim aged 27, remaining at home while his other children have emigrated abroad. Retinitis pigmentosa, which began to affect his vision two years ago, made him lose his sight in only one year. Now, he can only slightly perceive light. He

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still finds this very difficult after a lifetime of working his farm. He is a very independent man, does not like relying on others for support and he strongly objects to using his white cane as he views it as a visible indicator of disability. He has no interest in joining a VIB association.

Technology:
Mike worked his farm in a traditional way, mainly raising cattle and sheep with some tillage. Except for his farm machinery and his Nokia 3310 phone, he has little experience with technology and completely relies on Jim for anything more complex. Jim has more knowledge of technology and there is an internet connection in the old farmhouse. Jim has read about obstacle detection technology for people with impaired vision and he wonders if it might help his father. However, he is not sure how to go about this as his father does not like Jim to even mention his "difficulty", as Mike calls it.

Job, associations, hobbies:

Mike misses working the farm, looking after his farm animals and using his farm machinery. He tries to accompany Jim as he does the farm work but Jim is constantly worried about his father's safety and is frequently distracted from his work by having to take care of his father. He knows it would make his father much happier if he could move about the farmyard, barns and farmland independently. However, the nature of the work on the farm means that obstacles change every day, there is frequent movement of farm vehicles and animals, and surfaces are often very mucky and slippery.

Work on the farm has meant that Mike had no real hobbies but he enjoyed going to the local town each week to go to the mart and to meet other farmers, some of them friends of many years. However, the complex layout of the cattle mart, the large number of vehicles and the very noisy environment mean that Mike now relies on Jim to guide him around and to find his friends. Mike finds this enormously frustrating.

Mobility:
Mike's farm is by the sea, west of the rural town of Skibbereen. The farmland is hilly and there are also dangerous sea cliffs. There is no public transport so he relies on Jim or neighbours to bring him to the town. Skibbereen is very progressive and has launched a major business hub for digital technologies with the aim of making Skibbereen a "smart town".

Money:
Mike's farm is small and barely supports Mike and Jim financially. Mike is on an Invalidity Pension of €190 per week but, because of the additional financial income from the farm, this pension is taxed and Mike receives only €150 each week.

3.4.2.6. Nicoletta (Italian)

Disabilities in the family:
Nicoletta is a 29 -years old. She lives in Pomigliano D'Arco (near Naples), she became completely blind when she was a child after an accidental fall. Nicoletta is married and has two sons. She reads and writes braille very well.

Technology :

Nicoletta is open to technology and uses an iPhone (especially Siri) and a computer every day.

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Job, associations, hobbies:
She works half time at the National Health Service as telephone operator. She graduated in Psychology and she is going to graduate in Clinical Psychology. She is very active as a volunteer physiotherapist in two associations for people with disabilities.

She likes reading and writing verses, and plans to publish a poem book in the coming years.

Mobility:
She uses a white cane for short transfer and she goes at work by car (his husband or son driving). For 8 years she had a (beloved) dog guide. For other transfer, she has a helper.

Money:
Nicoletta receives a salary from his job at the National Health Service (800€/month) and an additional "Indennita' di Accompagnamento (= Disability compensation) for blind people (512€/month). Hence her total revenue is 1312€/month.

3.4.3. Definition of Scenarios of use for each persona

The six personas were used in a creativity session during a Face-to-Face meeting located in Cork Institute of Technology in March 2017. All partners were involved and actively participate to this session in order to create scenarios describing a complete journey of these personas. These scenarios include the preparation of the journey and the arrival to understand the full picture of the potential mobility limitations.


Creative session during Cork Face-to-Face meeting on 10th March 2017.

3.4.3.1. Scenario for Alain (Swiss)

- Persona: Alain
- Date and time: July 14th, 8:00
- Location: Bienne (small town)
- Weather: sunny
- Objective: go to a meeting in another town, the meeting is close to the railway station
- Context: he has to meet someone in the railway station. His correspondent will be waiting at the end of the platform. Rush hour time.
- Preparation:

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  - He checks with his wife that the train ticket is uploaded and the platform number on his smartphone.
  - He prepares his back pack: smartphone, water, paperwork, ID, money, keys
  - He takes his earphones, smartphone and white cane as Ludivine.
  - He leaves home.
- Journey:
  - Walk 200 m to the first cross along a road with a lot of traffic
    - Follow the pavement
    - Avoid the trash cans and trees and uneven ground
  - 1st crosswalk, wait for the audio signal
  - Cross the road, enter in the railway station
  - Head towards the stairs
  - In the underway, he counts the stairs to go to platform 3
  - He follows the 3D white line
  - Wait for the train and use his cane to find the door
  - Enter the train
  - Ask for help to find a free seat
  - Listen to the information
  - Check time with his special watch
  - Wait for information from his smartphone
  - Stand up to anticipate the next stop
  - Wait for the door to open
  - Follow the crowd flow, trying to follow the 3D line (difficult).
  - Most people pay attention to him
  - 3D line end, he waits his contact
  - Use his smartphone to call his contact, one hand holds the cane, the other his smartphone.

3.4.3.2. Scenario Rupert (British)

- Persona: Rupert
- Date and time: March 10th.
- Location: Centre of Manchester
- Weather: drizzly
- Objective: going to London for a meeting at the bank HQ
- Context: He takes a taxi to the train station. It is a one day round trip. He will take a taxi back home. The Manchester train station is under heavy renovation. The taxi stop is one block further away from the train station. He usually plans to be 20 min early as the train station. The train is at 8am and he will be back at 8pm.
- Preparation:
  - He is at home (taxi booked a previous day)
  - Gathers stuff/documents
  - Initialises INSPEX system
  - Taxi arrives. The driver sees he is blind and gets out to help.

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    - Rupert gets in the taxi. Driver explains about Piccadilly station renovation, and taxi are displaced by one block.
- Journey
    - Arrives at Piccadilly station
    - Taxi stops, Rupert gets off and uses INSPEX system to find the non-standard entrance, following the temporary tracing in place.
    - Enters train hall
    - Follow passengers who guide him to his seat
    - Train goes to London
    - Same for return journey
- Arrival
    - Arrives at Manchester Piccadilly at 7:30, finds a member of staff who asks if he needs instructions on how to exit, he asks about where taxis are.
    - He locates the temporary station exit following these instructions and using the temporary barriers.
    - He needs to avoid hurrying passengers who change velocity rapidly.
    - He follows the instructions to the taxi station
    - There is no taxi at first, he wonders if he has reached the right place. He confirms by asking another passenger.
    - Eventually, a taxi arrives and he explains to the driver how to bring him back home

3.4.3.3. Scenario Charlotte (Belgian)

- Persona: Charlotte
- Date and time: a Wednesday in March, 3pm.
- Location: downtown Namur
- Weather: 8 degrees Celsius, raining lightly
- Objective: collecting kids from school
- Context: leaving from work using handicap and mobility bus.
- Preparation:
    - Phones bus to book and arrange collection point
    - Sets phone to inform her when collection time arrives
    - Puts on her coat and packs her bag
    - Takes out her white cane from her bag which is under her desk
    - Leaves her office avoiding new delivery photo-paper
    - Meets the bus in front of the building
- Journey
    - The bus stops outside school
    - Children are waiting with the teacher who calls charlotte to alert her
    - Charlotte and her 2 children walk 10 min to go back home
    - There are 4 pedestrian crossings with audio enhancement
    - Avoids the missing stones and cracks on path
    - Avoid the walls (some parts are off the ground and will not be detected by sweeping cane)

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  - They walk passed a busy street with shops and customers entering and exiting.
  - Avoid the chains on the path, outside a pub.
  - Avoid bollards with chains across on the entrance to a pathway.
  - Go up 5 steps to the door of the home building.
- Arrival
  - Open the front door of the building
  - Open the apartment door
  - Place, cane, bag and coat on the coat rack
  - Take off kids coats
  - Begin preparation of the dinner

3.4.3.4. Scenario Ludivine (French)

- Persona: Ludivine
- Date and time: a Saturday in October, 7pm.
- Location: Lyon
- Weather: rainy (showers), floor is wet
- Objective: join her band for a concert
- Context: She is at home, a friend's parent picks her up at home and brings her close to a pub where she will play with her band. Her friends will help carry the instruments, so they cannot guide her. Hence she focuses on obstacles.
- Preparation:
  - She receives a message that her friend's parent is outside the house
  - She takes her synth (instrument) and put it on her back, bag, phone, and cane to the door
  - Friend helps put her stuff in the car (short distance, 20 m)
  - She wears heavy boots because of the rain
- Journey
  - Car travel to the city centre (25 min) in old City-centre, Lyon, which is very much pedestrian
  - Car parks close to the river
  - Her friends carry instruments, Ludivine manages her journey by herself to walk to venue. Distance from the car is 300 m.
  - Pathway is cobbled, much harder to use the cane
  - A delivery truck is blocking the normal pathway
  - Has to come across 2 crossroads which are equipped with sound signal
  - There are puddles along the ways from the rain
- Arrival
  - Ludivine arrives at the pub/venue, so need to walk down a flight of stairs to the basement
  - Sets up her instrument, needs to place her cane, bag, etc. and remember where these are.

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3.4.3.5. Scenario Mike (Irish)

- Persona: Mike
- Date and time: July 12th, 9am
- Location: Skibbereen
- Weather: wet
- Objective: visit the local mart and meet friends
- Context: He leaves the farmhouse with his son, Jim. Jim drives to the mart and mike goes in search of his friend while his son sells some cattle. As Mike has only been blind for 2 years he can still remember the mart layout.
- Preparation:
    - Mike wakes up, gets dressed, and makes his way downstairs, avoiding the various pets in the farmhouse.
    - His son prepares the breakfast for him. After breakfast, he puts on his wellington boots and coat and gets into the car.
    - He uses a walking stick due to his limp
- Journey
    - He crosses the farm yard to barn entrance
    - He may have many obstacles in his way:
        - Many puddles
        - Drain cover may be loose
        - Farm vehicles + machinery
        - Farm animals (dogs, cats, hens)
        - Ice
        - Low hanging branch
    - His son drops him at the gate of the mart
    - The car arrives at the cattle mart and after 10 minutes trying to find parking, they park 500 m away from the mart
    - His son takes care of the cattle. Mike has to walk to the mart by himself.
- Arrival
    - Having arrived at the gate, he makes his way to the front railing ensuring that he doesn't fall through the railings.
    - The ground is very slippy and care needs to be taken.
    - He climbs three step to find a seat

3.4.3.6. Scenario Nicoletta (Italian)

- Persona: Nicoletta
- Date and time: Friday, 10/03/2017.
- Location: Pomigesano
- Weather: Sunny, 15 degrees Celsius
- Objective: Working day
- Context: At home in the morning, go to work by car (husband is driving), go home by public bus, go to the association by foot, go home walking

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- Preparation:
  - Charge the white cane (known to be fully charged with vibrations)
  - Breakfast
  - Nicoletta goes to work by car (husband driving)
  - Then she goes to her office with her white cane
  - Usually, she uses an elevator (her office is on the second floor), but it is out of service, hence she goes by the stairs.
  - On the way back, she walks with her white cane to the bus station

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4. User requirements

4.1. User Requirements template

The requirements are noted as follows in the user requirement section: **ID - Name - Priority**

- **ID** is the unique ID of the requirement, prefixed with UR (User Requirement), telling if the requirement is functional (F) of non-functional (NF)
- **Name** is the name of the requirement;
- **Priority** is the level of implementation priority of the requirement, ranging from Nice to have, Optional, to Mandatory:
    - **Mandatory requirements** are those which are absolutely needed otherwise the core value of the system is missing.
    - **Optional requirements** bring in added value if present, but does not hamper the value of the tool if absent. They nevertheless augment the pertinence of the tool and reinforce its potential success.
    - **Nice to have requirements** could bring in some added value if present and may increase the pertinence of the tool.

For a mandatory requirement, the prototype that will first demonstrates the answer provided by the INSPEX system to this requirement is also given. This provides a first reference draft for the validation activities performed in WP6.

4.2. Non-functional requirements

Id	Name and description	Priority, implementation in prototype (P1, P2)
UR-NF-01	Sweeping cane Detect obstacles even if the user sweeps his cane	Mandatory, P1
UR-NF-02	Work in most conditions The system should be able to detect obstacles is most environmental conditions (dark, bright sun, rain, fog, snow)	Mandatory, P2
UR-NF-03	Light-weight The device on the cane (if any) should weigh less than 200g to comply with request from most users. Several users even asked for a device of less than 100g. The headset used for the audio feedback should also weigh less than 100g.	Mandatory, P2
UR-NF-04	Long battery life The system should last a full day since most users accept to recharge it once a day, but hardly more. According to the walking time estimations, a battery life of 2h (walking) would cover most people needs.	Mandatory, P2
UR-NF-05	Data Protection If the system needs to store personal data, the user privacy should be respected, following EU regulations.	Mandatory, P2

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UR-NF-06	Ease of use The system should be easy to use. Someone who knows how to use a smartphone and a white cane should be able to use the INSPEX system after half a day of training.	Optional
UR-NF-07	Adaptable to all white canes The system, if on the cane, should adapt to all kinds of white canes. It could be reduced to all folding white canes at it is predominant.	Optional
UR-NF-08	Small size The system on the cane (if any) should be smaller than 200cm3.	Mandatory, P2
UR-NF-09	Low cost Since the system should be at TRL4, further cost reduction could be foreseen for the industrialization. Nevertheless, the target price of the device should remain below 1000 € to be comparable with high-end competitors.	Nice to have
UR-NF-10	Usable without a cane The system should work even if held by hand or maintained on the waist or torso.	Optional
UR-NF-11	Fast charging The system should charge in less than one hour. This requirement can be useful when someone exceptionally walks more than 2 hours a day (considering 2 hours as the battery life).	Nice to have
UR-NF-12	Discrete, “cool”, customizable The final device should be customizable and fancy as it reduces the induced social marginalization.	Nice to have

4.3. Functional requirements

In the following table, the “safe box” is a zone in the environment of the user which is covered by the INSPEX system to detect obstacle (and assess free space). It is defined by its dimensions, typically 4 m in front of the user, 2 m height (from 20 cm below the ground), 1 m width. In this way, the full body is covered and the distance ahead for anticipation is sufficient whatever the user walking speed is.

Id	Name and description	Priority, implementation in prototype (P1, P2)
UR-F-01	Head level object detection in the safe box The system should detect obstacles in the safe box at head level, including tree branches, ladders, and scaffoldings.	Mandatory, P1
UR-F-02	Waist level object detection in the safe box The system should detect obstacles in the safe box at waist level, including work barriers, hatchbacks, restaurant tables.	Mandatory, P2
UR-F-03	Under ground level object detection in the safe box The system should detect obstacles in the safe box under the ground, including holes, steps down, fountains.	Mandatory, P2
UR-F-04	Early obstacle warning The position of the obstacles must be transmitted to the user early enough to enable its avoidance.	Mandatory, P1

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UR-F-05	Provide audio feedback The system must provide 3D audio feedback to enable the user to locate the obstacles and the free spaces.	Mandatory, P1
UR-F-06	Adapt audio volume The system sound level should be adjustable by the user	Mandatory, P2
UR-F-07	Ground level object detection in the safe box The system should detect obstacles in the safe box at ground level including steps up, poles, cars, puddles.	Mandatory, P2
UR-F-08	Provide haptic feedback The system must provide haptic feedback to enable the user to locate the obstacles and the free spaces.	Optional
UR-F-09	Moving obstacle detection The system should detect moving obstacles in the safe box like pedestrians, bicycles, or cars.	Optional
UR-F-10	Cane lit up in the dark The cane should be easily visible by others, even in the dark. A special lighting should be used.	Optional
UR-F-11	System status The system should be able to send its status (battery, obstacle detection on/off) on start-up and when requested by the user	Optional
UR-F-12	Automatic adaptation to background noise The system should automatically adapt the sound level to the background noise level.	Nice to have
UR-F-13	Cane location The system should help the user find his cane, especially when the cane is on the floor, after a fall, or after it has been put down.	Nice to have
UR-F-14	Portable charger The system should be rechargeable while on the go to extend the battery life	Nice to have
UR-F-15	Interact with adapted objects Some traffic lights, shops, special places are equipped with accessibility tags. The system should be able to interact with these tags	Nice to have

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5. Deployment use cases

This section presents the so-called “deployment use cases”. They are organised in three main categories, namely “Context Awareness”, “System Charging”, “System in Use”. This latter is split in “Regular Use” and “Hand-Free Use”.

5.1. Definition of “use case”

As already stated, a number of terms and diagrams are used with different meanings in the literature, especially in the context of requirements and modelling. Among them, one finds “use case” or “scenario”. Although each field defines it with a precise meaning, there are a limited number of synonyms, hence their use with different meanings across communities. In the present document, we have several meanings for use case:

- in section 5 of D1.3 (part 1), a use case is a coarse grain description of an environment together with the expected behaviour of the system within this environment;
- D1.3 (part2), the objectives are different. The goal of this chapter is to drive a development process named HOE2 (Highly Heterogeneous, Object Oriented, and Efficient Engineering). Hence the boundaries and limits of each System Under Design (SUD) are meant to organize the developments. The numbers of systems, their limits and relationships are organized according to HOE2 whose goal is to efficiently drive the development process.

Note that overlaps may exist between the deployment use cases presented in section 5 part 1 of D1.3 and in part 2 of D1.3. However, as the objectives are different, overlaps should be minimised.

5.2. Context Awareness

Use Case #1.1	**User & Environment Interactions**
Actors	INSPEX System, VIB Person, Smart Environment Operator.
Causality	Secondary
Objectives	Provide a mechanism that offers VIB users a customised, intuitive, and independent way of getting around urban areas.
Expected Result	INSPEX system comes into range of a beacon and beacon signal is received providing contextual Information which is sent to occupancy grid (environment model) and/or VIB person (via headset or phone).
Termination Condition	INSPEX system is out of range of beacons.
Pre-condition	Beacons are deployed in the environment and configured with appropriate protocol.
Post-Condition	No further beacon signals are received.
Main Scenario Outline	Beacon technology deployed in smart cities is typically used for advertising and commercial products. This use case will investigate how to leverage this technology and refocus it for the needs of VIB people. A VIB person is moving around the city Beacons are deployed in an area and are configured with context information A beacon is received by the INSPEX communications submodule

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	The beacon is decoded and processed by the INSPEX firmware The output is generated and sent to the appropriate submodule and/or device

Use Case #1.2	**User & Third Party Apps Interactions (location, navigation, maps)**
Actors	INSPEX System, VIB Person, Mobile App
Causality	Primary
Objectives	Demonstrate how the INSPEX system can interact with third party applications to enhance the user experience - specifically look at reusing the INSPEX communications module to ensure the VIB person does not misplace their cane, user can invoke a “find me” command via their mobile phone.
Expected Result	Location of cane and guidance
Termination Condition	User locates their cane
Pre-condition	User has BLE enabled mobile phone User has INSPEX app installed INSPEX System is powered on
Post-Condition	VIB person continues to use cane for normal operations
Main Scenario Outline	A VIB person is in a public place They place their cane down The VIB person moves around the public place and lose position of their cane The VIB person takes out their mobile phone and opens the INSPEX “find me” phone app The phone sends advertisement beacon in the environment The INSPEX module receives “find me” request and broadcasts a ping message The phone receives the message and executes an algorithm to calculate the distance and proximity of the cane. The user is provided a prompt and moves in the direction Steps 5 -8 are repeated until the user locates the cane

5.3. System Charging

Use Case #1.1	**Charging the Box at home or in the office**
Actors	INSPEX System, VIB Person
Causality	Primary
Objectives	Provide an easy-to-use (for the VIB) permanently-located Docking Station for storage and charging for the INSPEX cane at the end of a day of use.
Expected Result	The INSPEX cane is fully-charged and ready to use when the VIB needs it next
Termination Condition	The INSPEX cane is removed from the Docking Station
Pre-condition	The Docking Station is in a known, convenient, permanent location for use by the VIB in the home or office.
Post-Condition	The INSPEX cane is in use by the VIB

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Main Scenario Outline	The Docking Station allows the INSPEX System to be docked and charged whether it is attached to the cane or removed from it (e.g. so the VIB can use the cane as a normal cane); the Box can be easily removed from/replaced on the cane with one hand but the Box attachment mechanism is mechanically secure so that the Box does not move relative to the cane. The {INSPEX System} or {cane+INSPEX System} can be docked and undocked from Docking Station with one hand. The Docking Station beeps to confirm successful docking and starting of charging.

Use Case #1.2	**Charging the Box away from home or office**
Actors	INSPEX System, VIB Person
Causality	Primary
Objectives	All the VIB to charge the INSPEX System without a docking station
Expected Result	The INSPEX cane is fully-charged and ready to use when the VIB needs it next
Termination Condition	The INSPEX cane is disconnected from its charger
Pre-condition	The VIB has a portable charger for the INSPEX System
Post-Condition	The INSPEX cane is in use by the VIB
Main Scenario Outline	The VIB does not have access to a Docking Station. The Box has a waterproof micro-USB port that allows charging from any USB-compatible charger. The VIB inserts the micro-USB connector into the Box either on or off the cane. The Box beeps to indicate starting of charging.

5.4. System in Use

5.4.1. Regular Use: the "Box" in use

Use Case #1.3	**The "Box" in use**
Actors	INSPEX System, VIB Person
Causality	Primary
Objectives	The Box is ergonomic to use, can be used in all weathers, is mechanically robust against impacts that can be expected in reasonable daily use, and is easy to clean.
Expected Result	An INSPEX System that is ergonomically suitable and robust for daily use.
Termination Condition	-
Pre-condition	The VIB is using an INSPEX cane
Post-Condition	The VIB does not reject the INSPEX cane because of ergonomic or reliability reasons.
Main Scenario Outline	The VIB uses the cane for a full day but, because of the ergonomic design of the Box, does not experience enough extra fatigue or soreness to make them reject the INSPEX System. In typical expected weather conditions, the Box does not fail due to environmental causes. Even though the Box becomes dirty, it is easy to clean because there are no hard-to-access-for-cleaning areas on the outside of the Box. If the VIB drops the Box on the ground from waist-height or, when using the INSPEX cane, accidentally

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	knocks the Box itself against a hard surface, the Box is sufficiently mechanically robust not to fail under these typical daily mechanical stresses.

5.4.2. Hands-Free Use

Use Case #1.1	Hands-Free
Actors	INSPEX System, VIB Person, Other users (firefighters and drones)
Causality	Primary
Objectives	Provide a mechanism that offers VIB users with ranging information without the use of a cane e.g. mounted on dog, helmet, glasses etc. The layout of the system must be designed in such a way that it can be modified to reflect the use case (wearable)
Expected Result	Full mapping of the environment without recourse to cane.
Termination Condition	Battery runs out.
Pre-condition	The navigation subsystem is running and provides real-time information on the user environment
Post-Condition	When user reaches destination, system shuts down to extend battery life
Main Scenario Outline	Hands free application of INSPEX system enabling the user to use their hands for other purposes than navigation A VIB person is moving around the city or a firefighter is moving around a building The system is mounted on the person or on a guide dog Hands are free for other uses

Use Case #1.2	Hands Free (above waist)
Actors	INSPEX System, VIB Person, Other users (firefighters and drones)
Causality	Primary
Objectives	Provide a mechanism that offers VIB users with ranging information for objects above waist height only. Requires use of a cane or dog in addition to device
Expected Result	Full mapping of the environment above waist height
Termination Condition	Battery runs out.
Pre-condition	The navigation subsystem is running and provides real-time information on the user environment
Post-Condition	When user reaches destination, system shuts down to extend battery life
Main Scenario Outline	Hands free application of INSPEX system in combination with a cane or dog. The function of the hands free application is to detect obstacles above waist height. The cane/dog can be also used as a backup if battery dies. A VIB person is moving around the city or a firefighter is moving around a building The system is mounted on the person. The cane is used for low level object detection

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6. Conclusion

In this document, a complete analysis of the mobility needs for Visually Impaired and Blind (VIB) people was conducted. It was based on two pillars, namely, a survey which was answered by VIB people from several European countries, and six personas for whom scenarios of autonomous walks were created. These two pillars led to a better understanding of the users' needs. This analysis includes the type of obstacles the INSPEX project needs to focus on, the battery life span, etc. From a development point-of-view, this analysis is essential since the whole design of the system will be guided by these needs in order to develop a system fully valuable for the VIB community.

The expressed needs, once summarized, were used to create a list of user requirements. This list includes the implementation priority for each requirement, from *mandatory* to *nice to have*. Since these requirements will be included progressively as features in the prototypes delivered by the project, the prototype associated with each mandatory user requirement is also defined. This timeline will be used as an initial starting point in the validation activity in WP6.

Furthermore, deployment use cases were given to define the way the user will interact with the INSPEX system. These deployment use cases, together with the functional use cases developed in D1.3 (part2), are taken into account in the definition of the system requirements, reported in D3.1.

Note that D1.3 (part 1) and D1.3 (part 2) are two sisters' documents that complete each other as the first one takes a user viewpoint while the second part adopts the vision of a development process named <HOE>^{2} (Highly Heterogeneous, Object Oriented, and Efficient Engineering).

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