SENSE-PARK

FP7-INFSO-ICT-288557

Name of deliverable: D2.4 Final report about the requirement. Detailed requirement specification

Due date: 31 October 2013

Start date of the project : 1.10.2011

Duration: 36 months
Responsible of the deliverable: Partner 3 (UNN)
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Target Dissemination Level: PU
Status of the Document: Final

Google doc URL (view only):
https://docs.google.com/file/d/0B21Sxp2223uwenZKcnZNUWFselE/edit?usp=sharing

Project web site : www.sense-park.eu

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Executive Summary

In this document we report from two tests performed in UK, one in April 2013 and one in August/September 2013. During 2012 focus groups meetings with people with Parkinsons' have been identifying requirements and these requirements have been communicated to the work packages responsible for the design of the products. In order to test the products mockups that have provided at least part of the functionality and design of the Sense-Park system have been produced. In April 2013 3 users tested 3 sensors (wrist, leg and night sensor) for one hour, and our major interest was to test the usability of the sensors. The test revealed that the foot sensor can be uncomfortable to wear. Only data from the night sensor was displayed on a PC, but initiated a discussion about how to visualize the sensor measurements. During the second test in August/September 6 persons with Parkinson's' tested the sensors day and night (24 hour). This test represents the way people will be using the Sense-Park products in the future. The usability of the sensors was evaluated by using a questionnaire. The users commented the fasteners, problems with fastening of the sensors, and how to fasten the sensors so that the sensors registered reliable data.

Introduction

The objective of the Sense-Park project is to design and develop technologies that enable measurement of Parkinson's symptoms. Today measures and scales used for assessing Parkinson's in clinics provide information regarding the status at a specific time. Such snapshots will normally not reveal the whole picture of the scope of a person's Parkinson's. Sense-Park aim at producing sensors than enable a continuously and long-term measurement of some of the symptoms related to Parkinson's.

The Sense-Park project is a three year EU financed project (2011-2014). The project involves partners from 4 countries: Germany, Norway, Portugal and UK. Members from these countries represent different expertise and have different roles in the project. These expertises include medical and technological professions and expertise in involving potential users in the design process. The goal was to design sensors that record information that are medically relevant both to health care professionals and people with Parkinson's (PwP's). People with Parkinson's will be wearing the sensors and in order to design sensors that to could fit into the daily life of PwP's the initial idea was to invite representatives of people with Parkinson's to come together and talk about the how the solutions could look like and perform.

In order to reach the goal the project activities has been organized into work packages. These work packages have been responsible for specific activities and the activities have been planned to take place according to a time schedule. During the first two years specific activities have been carried out regarding which symptoms to monitor and how the system should be designed, the hardware well as the software. A number of symptoms were identified and ranked by people with Parkinson's. A first ranking

of symptoms was made by people with Parkinson's who answered a web-based questionnaire. 198 respondents answered a question regarding subjects related to their everyday life living with Parkinson's and which symptoms they would like to monitor. The analysis of the data resulted in a combined ranked list of symptoms that the PwP's wanted to monitor. The list of symptoms was discussed in meeting with members of the evaluation team people together with people with Parkinson's. During this meeting the group identified 3 symptoms that could be the basis for development of sensors. Later this group of people arranged a meeting with representative for the medical staff. The rationale behind this meeting was to include symptoms that are highly relevant from the medical staff's point of view. During the meeting 3 more symptoms from the list ranked by PwP's were included so that the total list of symptoms was 6: 1) bradykinesia, 2) sway, 3) tremor, 4) cognitive functions, 5) gait and 6) sleep.

During the second year of the project the goal was to design and produce sensors that the Pwp's can attach to their bodies, unobtrusive solutions that will provide the Pwp's with reliable data regarding the status of their Parkinson's. These data can be transferred to relevant health care professionals. The PwP's and the health care professionals will then have access to the same data via the Sense-Park interface.

It's been a stated goal of the project to include potential primary users (people with Parkinson's) in the process of designing of the products. The users should not just give feedback to a fully functional system but be included in the whole process of designing the Sense-Park products. The PwP's were to be included as co-designers in this process; they were invited to identify requirements as the basis for the design of the product as well as give feedback to mock-ups and prototypes. The professionals have been expertise in different relevant areas, medicine and technology, while the PwP's, in this context, offer an understanding of how sensors can be designed to be usable and useful to a large group of PwP's. To achieve this communication and knowledge sharing between different types of expertise, lay expertise and professional expertise, a set of arenas have been established. Most important in the context of involving lay persons in the design of Sense-Park products has been the focus group meetings with PwP's, project meetings where representatives for PwP's have met, and PwP's individually testing of the Sense-Park products.

Relation with other deliverables and documents

ID2.1 "The Sense-Park Methodology" (internal document, UNN, 2012). This document describes a user centered design methodology.

ID 2.2 “Testing procedures for the Sense-Park system products” (internal document, UNN, 2013). This document describes the test procedures for test done in August/September 2013.

The Evaluation Form. Testing the SENSE-PARK Hardware. Test Phase 1 (internal document, CPT). This is the questionnaire that was used during the test in August/September 2013.

Summary of results from 24 hour testing of sensors by test pilots. CPT August/September 2013. (Internal document, CPT). This documents describes the test results.

D2.3 “Interaction activities with developers and PwP’s” (M12, 2012). This deliverable defines the strategy for the following steps on updating and iteractively incrementing the user requirements based on the coordinated action between PwP’s and developers and the inputs extracted by the activity in Work Package 2.

Sense-Park User Requirements specification.gseheet. (Internal document, 2012-13, UNN). This documents contains the list of requirements obtained during the two first years of the project.

D5.1 ”Demonstration of sensor system prototypes regarding the levels ‘being’, ‘belonging’ and ‘becoming’” (M18, 2013). This is an important deliverable to guarantee a correct match between user requirements and system development.

1. The Sense-Park system

The aim of the Sense-Park project is to design and produce a fully functional system that the PwP’s can use on daily basis, day and night (monitoring of sleep pattern). The Sense-Park system is a complete solution that includes ***sensors***, ***docking station, system consoles, software program and instructions*****:**

- **Sensors:** this refers to technologies that are used to monitor the parameters to be measured. In this document we are referring to the three types of sensors used, namely, the wrist sensor unit, the waist sensor unit and the foot sensor unit. Five of the chosen symptoms will be monitored via sensors. Different solutions may be used for fastening the sensors to the body.
- **Docking Station:** a device used to charge the units and to upload the data from the system to the PC system console through a standard USB connection.
- **System consoles:** the PwP’s will have access to the data and tests via a computer.
- **Software programs:**
    - Measuring of the cognitive functions is based on a different approach than the other ones. The PwP’s will be using a software program to evaluate cognitive functions.
    - In order for the users to get access to the information registered by the sensor as well as data from the cognitive tests they will need to install a software program on their computer. There is also a diary section. The program is developed specifically for the Sense-Park project and both PwP’s and health care professions will use a Sense-Park user interface.
- **Instructions:** a manual to tell how to use the Sense-Park system.

2. Data collection and methods

The aim of work packages 2 has been to work together with the users in order to ensure that the products meet the users' needs. The process of identifying and mapping of users' needs and requirements has been inspired by the *living lab* approach. The approach is based on systematic involvement of the users as co-creators contributing to the exploration of ideas, scenarios and artefacts. The living lab approach has also inspired us to involve users in the testing of mockups of the artefacts (hardware and software) in real-life scenarios. The aim of the testing was to gather data that could help us in refining the Sense-Park products. The identification of requirements has been based on guidelines described in the Volere method[1]. According to the Volere method there are two types of requirements:

- Functional requirements: these requirements describe what the product is to do and are the fundamental or essential subject matter of the product.
- Non-functional requirements are the properties that the functions must have, such as usability, look and feel, performance, support etc.

During the first phase of identifying requirements the process has been based on ideas and images rather than on prototypes. There are pros and cons of organizing the process this way. The pro is that the thoughts and wishes by the users are not restricted to reflecting on something presented by others, like a prototype. The con is that it can difficult for the users to present clear ideas on what a new solution should look like and how it should perform.

During the second year of the project the potential end-users have been presented prototypes of the Sense-Park system. The PwP's have been testing some of the Sense-Park products on two different occasions. 3 potential end-users tested three of the sensors for short period (one hour) in April 2013 during a 2 days' workshop in UK. Feedback from the users was collected in group meetings during the 2 days' workshop. In late August and beginning of September 2013 a more formal test was performed in UK. The test included more functions to be tested (both hard ware and software components), included more people and took longer time than the first test. The users were wearing the sensors for 24 hours, day and night (the night sensor), and they were given an opportunity to download parts of the Sense-Park interface and cognitive tests. This time a questionnaire was used to identify individual feedback from the users. The results from the second test was presented and discussed in a meeting in Tubingen late September 2013, a meeting were representatives of people with Parkinson's attended.

[1] http://www.volere.co.uk/

3. Evaluation session at the Sense-Park partner meeting in UK 11-12. April 2013

The first test took place at a partner meeting in UK, 11.-12. April 2013. The objective of the test was to evaluate just some parts of the Sense-Park system. In April there was no fully functional Sense-Park available. However there were at least part of the functionality of a system available that made it possible to test or evaluate both hardware and software components.

The Sense-Park sensor

A prototype of the 3 sensors, namely wrist, ankle and waist (night sensor), were used in the evaluation. The aim was to test the sensors in real life situations and with real users. Each user was to test only one of the sensors, and they were testing it for one hour. The users can be described as super-users as they have a lot knowledge regarding living with Parkinson's and are interested in new ways of coping with the disease, including the use of technologies. They were all male. Two of them live in UK and one of them in Spain.

As the users were only to test the sensors for one hour there had to be some kind of test procedures. The person who was testing the ankle sensor was to go for a walk. The person who was testing the waist sensor was to lie down for an hour (like an afternoon nap). The wrist sensor was tested with no specific task to be done.

Feedback: the sensors

After the one hour tests a meeting was arranged to get feedback from the test persons. Even though it's important to notice that the test persons only used the sensors for one hour, and in real life people are to use sensors day and night, the test provided us with some interesting insights. The wrist and the waist sensors were easy to use and provide expected features. The ankle sensor proved to be uncomfortable. In less than 20 minutes the user complained of pain and the cause of blister. As a result the test was interrupted.

Feedback: visualization

The resulting data from the tests were extracted from the sensors into a PC, but only for the sleep data there was a visualization prepared and shown. The presentation of the sleep data gave incentive to a discussion about how the results can be visualized to be meaningful and helpful for ordinary people.

Different ways of visualizing the results was presented. There was some interest in investigating ways of displaying the result in a simple way; figures or colours to represent the pattern that the sensors have been detecting for a day, a week etc. or a graphical presentation. There is growing concerns among the PwP's regarding how the results should be visualized and specially how to report bad results, e.g. that your health status is declining.

Marking - activities of daily living and symptoms (ADL&S)

The software system provided by Hasomed is able to receive markers from the users. This feature will be used in future testing.

The procedure is to include several pre-defined labels for tasks, such as cutting bread, ironing or brushing teeth. The user can then mark specific points in time with these labels, indicating that at that precise moment he or she started the activity. He or she can then also mark the end of the activity. This allows for cross-referencing with sensor data. The markings can then be used in the visualization of the data extracted from the sensors. Specific icons relating to the various markings can be used to overlap the visualised data.

Technical issues on marking data

For the user to be able to mark the activities and symptoms on the PC using the Hasomed application, the internal clocks of the PC and of the sensors must be synchronized. The technical members guaranteed that this synchronization is possible with a precision much higher than the minimum required for the mentioned functionality.

Additional testing

The sensors were tested for comfort and additional personal feedback from all the participants. Below are some of the notes made:

- Velcro should be used instead of buckles for easy put on and take off.
- Non-allergenic materials should be used
- Great concern was shown regarding battery charge duration. At least 14 hours between charges should be achieved for day sensors and 10 hours for the night sensor.

User Requirements

All the notes from this meeting were transformed into formal requirements. A part of the list of requirements is presented in table 1.

Table 1: List requirements obtain during the London test in April 2013.

Requirement type	Requirements	Rationale	Fit criterion
Functional	All data collected should be time stamped	Necessary for several functionalities, medical purposes and research analysis	Existence of a label wit date and time for all the recorded data
Usability	Velcro should be used instead of buckles	For easy put on and take off	Existence of velcro straps in all sensors used
Usability	Non-allergenic materials should be used	For health reasons	All materials that are in contact with the skin should an approval as non-allergenic
Performance	Battery charge should last for the whole day (day sensors) and whole night (night sensor)	No need to re-charge batteries in the middle of the day or the night	In normal use at least 16 hours between charges should be achieved for day sensors and 10 hours for the night sensor.
Functional	Visualization techniques should be developed to better convey the meaning of the collected data to non-technical people.	Some questions were raised on the understanding of the data from a non-technical person.	95% of correct results should be achieved in a questionnaire about the meaning of the displayed data acquired by the sensors.
Functional	The software system provided by Hasomed is able to receive markers from the users. This feature should be used in the Sense-Park system and made available to	The marking of symptoms during data acquisition provides additional information about the events for their identification (e.g. a symptom like tremor or an ADL like brushing teeth)	The user must be able to marl ADLs and symptoms while using the device. This will be done with the PC. The PC clock is assumed to be synchronized with the sensors clock.

	the users to mark activities of daily living and symptoms (ADL&S).		
Usability	All sensors should be comfortable to use	The ankle sensor proved extremely uncomfortable. In less than 20 minutes the user complained of pain and the cause of blister. This cannot happen as the user will not be able to wear the sensor during the period of time foreseen.	10 out of 10 users must be able to use the sensor during the average intended period (14 hours during the day and 8 hours during the night)
Functional	The ADL&S markings should be visible in the displaying of the sensors data.	The inclusion of the markings with a specific icon to be seen overlapping the visualized data was considered useful.	Icons are present in the displaying of sensor data representing the ADL&S markings done by the user (see req #19)
Performance	User PC clock and sensors internal clock must be synchronized at all times.	For the user to be able to mark the activities and symptoms on the PC using the Hasomed application, the internal clocks of the PC and of the sensors must be synchronized.	Two test guarantee this fit criterion: 1) The clocks are automatically synchronized when the sensor is connected to the PC for data download. 2) During 1 week without synchronization the maximum deviation between the clocks should be less than 1 second.

4. Testing of the Sense-Park products in UK August/September 2013

The testing in August/September was a more formal test than the test in April. The test was based on a description of test procedures and a questionnaire was used to get feedback from the users.

The test persons: 6 persons in total have been testing parts of the Sense-Park system. They were all people with Parkinson's and both genders were included.

The test persons were not at this moment to test a fully functional Sense-Park system. There were three types of items or functions that the users were to test:

1) Instruction leaflet: The leaflet describes how to use the Sense-Park system (the placement of the sensors, connecting the sensors to the docking station, loading Sense-Park games and tests etc.) All of the test persons have tested the leaflet.
2) Type of sensors/kit tested:
   - 4 persons have been testing **sensors** (Hasomed and HSG-Imit sensors)
   - 2 persons have been testing **sensors** and the **docking station.**
3) Interface disk to test cognition, games and diary section

The test was organized as series of tasks to be done by the users:

1. Go through the instructions leaflet
2. Download the interface program and try the games and tests
3. Put on the sensors (hip, leg, wrist and night sensors)
4. The test persons were to test the sensors for 24 hours

The evaluation of the Sense-Park products was done by using a questionnaire that the users were to fill out. The questionnaire consisted of fixed answer categories and open ended questions were the test persons were to state their reactions in their own words. The questions regarding the instructions leaflet were focusing on understandability of the instructions. Then there were questions regarding the usability of the Sense-Park system, including the docking station. There was a special focus on the straps, fasteners and placement of the sensors as well as major interests in getting a picture of the comfortability of using the sensors, both sensors which are to be used during daytime (waist, leg and wrist) and night time (waist).

The users have had problems with downloading the interface program completely. Some of the users have been able to download parts of the interface program and extract some information and games.

The results from the test in August/September were presented in a project meeting in Tübingen in late September 2013. Representatives for the medical professions and technological expertise were present at the meeting, as well as representatives for people with Parkinson's.

The test in August/September has been focusing on the non-functional requirements according to the Volere method. The aim of the test was to get feedback from potential end-users regarding the look and feel, the usability and human requirements, and some of the operational and environmental requirements. The test was done by CPT and is documented in "Summary of results from 24 hour testing of sensors by test pilots. CPT August/September 2013" (Internal document, 2013, CPT). The findings in the document were translated into requirements and some of them are presented in table 2. These don't represent all the findings during the tests as we are only reporting the findings that could be the bases for new requirements.

Table 2: List of requirements based on the test in August/September 2013.

Type	Requirements	Rationale	Fit criteria
User documentation	The instruction leaflet should describe how to fasten the sensor to the body	The users should know how tight the straps fasten the sensors to the body in order to get reliable data	Words and illustrations that describe how to fasten the sensors. 90% of the users should be able to understand the instructions without needing help.
Performance	The sensor should be damp or water proof	The users should be able to engaged in activities that involve damp or water	The sensor should be damp or water proof
Usability	The fastener should be easy to use	People with more severe PD may have problems with fastening the sensors to the body	90 percent of PwP's should be able to fasten the sensors
Usability: Personalization	The wrist strap should be available in different lengths	People with different body mass need different sizes	Different wrist straps are available
Usability; Personalization	The waist strap is to long	People with different body mass need different sizes	Different waist straps available
Usability	The ankle sensor should be comfortable to wear	For the user to wear the foot sensor for a whole day without feeling a need to take it off	90 percent of the users should be able to use the ankle sensor for a whole day without feeling uncomfortable
Usability	The wrist devise should not become sweaty	The users should be able to wear the wrist device without feeling uncomfortable	The wrist device should not become more sweaty than when using an arm watch
Usability and humanity requirements	The night sensor should not interfere with the sleep pattern	The night sensor should register the users' sleep pattern without interfering with that same pattern	This requires a testing of the night sensors for several nights. 80 % of the users report that the night sensors has not interfere with the sleep pattern

During the test in August/September the users didn't test the Sense-Park data report system because the report functions were not available at that time. The PwP's have been reporting interest in the way that the data from the sensors are to be displayed. They are focusing on needs or requirements that the Volere method defines as "understandability". These requirements specify how the product is to be designed to be understood by its users. The users are communicating a need for symbols or graphs that are more or less naturally understandable by the user or for some guidance to help them interpret the report on the symptoms pattern.

5. Conclusion

This report describes the results from testing of the Sense-Park products. On two occasions potential end-users, people with Parkinson's', have been testing parts of the Sense-Park system. The first time, in April 2013, users in the UK tested the sensors (wrist, waist, and foot) for an hour; the users tried one of the sensors. The users gave feedback immediately after the test and were also invited to comment the displaying of the test results. The second time, in August/September 2013, users in the UK tested the sensors for 24 hours. And this meant that the test persons were using the sensors like future end-users are meant to. This time the test persons were to download the interface program and try the cognitive test and game program, and also to test the instructions leaflet.

There are two things that have been of special interest during the testing of the Sense-Park products; the use of the sensors and the displaying of the data. The potential users of a Sense-Park system commented the practicality of fastening and wearability of the sensors. People with Parkinson's have problems controlling the muscles in the body so the practicality of fastening the sensors should be taken into consideration when designing the fasteners. And as the end-users are going to wear the sensors for the whole day and during the night (only the night sensor) the usability of the sensors is of special importance. During the test users came up with a list of requirements regarding usability of the sensors, including the need for personalization of the products. The potential users have reported that the foot sensors can be uncomfortable to wear. During the second test the users were given an opportunity to download parts of the Sense-Park software program but unfortunately the test revealed that most of the test persons had problems with downloading the software. The second test also represented an opportunity to test the instructions leaflet. And although a fully functional Sense-Park interface has not been tested, the presentation of raw sensor data in April 2013 and the presentation of the results from the second test in August/September 2013 at the partner meeting in September represented opportunities for the end-users to discuss how the data from the sensors should be presented.

6. Next steps

The next steps involving work packages 2 have already been planned. The following lines of actions have been proposed.

Lines of action:

1) The designers and technologists will produce high fidelity prototypes based on the primary (Pwp'S) and secondary (clinicians) users' requirements. The different part of the Sense-Park system (the sensors, the charger and the user interface) will be integrated into one functional system.
2) Test persons will be recruited in UK. The test persons will be testing a Sense-Park system for a longer period (1-3 weeks) in November/December 2013.
3) Eventually additional requirements will be produced and fed back to the technologists.