Continuous Monitoring and Digital Systems for Elders

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Abstract: Ageing of the European population raises issues both socially and economically, creating major challenges for the traditional care and healthcare paradigm. Recent technological developments generate a favorable environment for a paradigm shift in the way care and healthcare is provided, by promoting the inclusion of the elders in the digital society. This paper presents an approach to promote elders inclusion, based on a RWD platform, capable of being used in multiple devices (including SmartTVs), and in wireless sensor networks. Studies involving end users have shown how well-adjusted interfaces ease the process of inclusion of IT in elders' life. This work has been developed within the frame of the European project HELASCoL.

1 INTRODUCTION

The ageing of the European population is an essential finding of nowadays and the resulting increase in the dependency ratio of the elderly leads to a financial charges exacerbation at national health system (NHS) level.

Portugal is currently facing problems related to this demographic change, caused by (FCT, 2014):

- Decreasing birth rate,
- Structural problems in rural areas, related to migration of population to the coast,
- Given retirement age extension in some countries, population remains active and productive for longer.

Following this demographic trend there will be an increase in the number of people with physical limitations along with the population isolation, raising new challenges to the traditional health system, which will have to be replaced by pension schemes, in many states in Europe.

The elderly population, age group most affected by loneliness in today's society, should not be ruled out in advance of mobile technologies and the development of applications for this type of devices, given all the potential that can be used for this type of audience (Cunha, 2012).

A solution for boosting the speed of assistance in emergencies and reduce costs associated with treatment is the challenge that enables timely prevention of diseases and which will therefore reduce the costs of health services.

2 MOTIVATION

The inclusion of older people in the digital society must begin with the communication route and the most common interface such as television, and then extended to all types of communication devices.

The project HELASCoL – Helping elders to live an active and socially connected life by involving them in the digital society – addresses some of the problems observed and aims to offer a 360 degrees methodology involving the elderly in an enriched communication experience, anywhere, anytime and to any device with accessible, intuitive, easy to use, multimodal User Interfaces that allows the study of a new approach towards this issue (HELASCoL, 2012).

This consortium developed a solution to facilitate the provision of relevant services in a relevant channel - Internet - for elderly and their families.

The goal is to allow the elderly and caregivers to share their daily experiences and help them make use of existing multimedia services, developing the sense of closeness and community integration they seek. This enriched experience that allows users to share their emotions and experiences in a lively and interactive way, requires a new approach, both for services and technologies that support it and can

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easily be updated with security and clinical features.

This document intended to describe the work and the results obtained with the development of 3 parts of the project:

- A general description of the full architecture of the developed system and application services.
- Technical description of the Services developed.
- Sensors integration with systems, components and services completed.

The ultimate goal of this document is to report the results achieved. These results will be validated through pilot studies to be carried out in the following stages of the project.

Figure 1: HELASCoL overview.

2.1 Technologies

The project was developed based on the platform KeepCare® (Sousa, Alves, & Gonçalves, 2013) which already had implemented the engine for monitoring features and was included an open-source responsive frameworks that incorporates the principles of responsive web design (RWD) described by Ethan Marcotte (2011), mostly based on CSS and JavaScript. The key benefit of using these frameworks is a reduction in development time.

The Sensor network is achieved by setting up a central wireless gateway that provides a communication protocol for sensor devices, which retrieves bio-signals and environmental data. In order to increase comfort and mobility, we gave preference to the use of wearable sensors for health monitoring (Oliveira, Gonçalves, & Sousa, 2013).

Some of the provided services are supported by external APIs. These services are ensured to be secure and reliable.

2.2 Elderly User

Elders are affected by physical decline but also by mental decline. The ageing process involves a more delicate psycho-physical balance. This means that people are more fragile in dealing with personal or environmental changes. Without proper preparation, you can put at risk the balance and disorienting person in everyday life. Here we try to summarize the most important points of these aspects.

Physical Aspects

- Visual impairment – difficulty seeing small details and hearing impairment
- Limited manual skills – limited sense of touch and reduced fine motility

Psychological Aspects

- Afraid of unknown devices, go into a panic easily
- Difficulty with complicated procedures and learning new tasks
- Confused by too many information
- Strong connection with past life in family, memories and personal objects

Personas are a proven design tool that, when coupled with user-centered and participatory design techniques, can ground the design process to model the specific needs of the targeted elderly. We set out to iteratively define two personas (male and female) through a combination of observations, past team experience and field pilots to better adjust and predict some needs in terms of user experience.

John is eighty-nine years old who raised three sons in the same house where he lived for his entire marriage. He was able to take care of himself and was autonomous until recently when he moved to a retirement community. He now needs to see his doctor routinely every few months to take care of diabetes and high blood pressure.

John's diabetes is currently well controlled with diet and exercise, although sometimes he feels light headed and tired from his blood pressure medication, so as part of his daily routine he takes a daily 2 mile "constitutional". Luckily, the retirement community is not too far from his family and friends who are with him during these walks.

Jane, an eighty-three-year-old came from upper socio-economic status. Both John and Jane have a positive attitude towards technology in that they believes technology may help them assess their own wellness, although they present a sense of oddity towards devices and wires.

Neither expresses concerns about potential privacy risks regarding their personal information, and both believe that the potential benefits of health IT outweigh potential privacy concerns.

Each is a member of a retirement community that has regularly scheduled social events.

Habits

Research also suggests working with scenarios: User scenarios are “informal narrative descriptions” (Carroll, 1999) about a persona or personas (hypothetical archetypes of actual users) and their activities, emphasizing the goals the user wants to reach with a specific product, the persona’s expectations concerning particular systems and the most critical tasks that she wants to execute. Scenarios can be described in different ways including text, speech, photographs and video clips (Isacker, Slegers, Gemou, & Bekiaris, 2009).

The daily activities and habits of the people are aimed at maintaining their mobility and autonomy. Services developed to perform certain operations on line could imply a decrease in the mobility and autonomy of the persons.

Environment

One important place in the elderly apartment is the location of the agenda or the calendar where the activities are scheduled and clearly visible.

The living environments are a small space in the sheltered flat that makes it difficult to envisage the introduction of a device that integrates the environment becoming "seamless" after a certain time of use.

The idea of placing the points of access in the common areas could help to perceive a degree of comfort between the user, the device and services thanks to the mediation of the institution staff. These “common stations” could help elderly people less familiar with the technology to access the IT solutions, bringing themselves a step closer to desire a personal device.

RWD has improved multi-device, multi-browser visual layout but it’s only the first step in building responsively.

2.3 Requirements

When a new object comes in the daily life of people, they have to recognize their property. This task is accomplished through the association between the new object with other similar artifacts in use. The new object has to find a place in the experience of every day habits and common artifacts that are usual for the user (Campbell, 2015). For example, for many elderly a tablet or a computer is an artifact only to receive information, share information or pass a call and that is a task that demands a particular kind of effort in the transfer process to link the screen to other type of artifacts like the phone. This might be done only by cooperation between the user, the interface, the other persons and the objects involved in the telephone activity.

Biographical connections between actors, human and non-human (Latour, 1994), that exist in the world of the user must communicate in a fluid manner. That is, interfaces, must communicate in a common language and give a clear feedback to the user. The aim of feedback to the user is to increase the control and knowledge of the person over this world, not to control him.

This way, feedback to the user must integrate the physical and psychological aspects that we wrote above and find sense and place in the environment of the user. Also, find and analyze the link that the user makes with past experiences and integrate the same logic into the new artifact. The number of tasks required for an activity with a new artifact must be lower than the common sequence already in place.

3 MAIN GOALS

We intend to define a set of standards for elderly users’ interfaces and achieve this by developing a web application based on two areas of use by the elderly – Social and Monitoring (health and environment).

Health monitoring aims to daily monitor clinical values associated with chronic diseases that most affect the elderly, to increase the immediate perception of the state of the user and to facilitate the reading and communication of these values to formal or informal caregivers as well as the veracity of these values.

The social module of the application aims to be able to reduce the isolation arming the elderly with cognitive and physical stimulation tools, by including serious games targeted for this purpose, as well as the encouragement of communication through synchronous and asynchronous conference mechanisms, making use of the system steadier.

It's a final goal the improvement of advanced features for this platform in terms of interfaces, the user's perspective, optimizing access to visually intuitive way to these features.

It is expected feedback collection form field pilots, which should provide the discovery of the main difficulties in use of the application and allowing us to assess the degree of satisfaction of goals. The main objective of the field trials is to evaluate the user acceptability and effectiveness of the HELASCoL platform.

Finally the display mode of the product application shall be adaptable to the characteristics of the elderly user, with faster navigation with a more

enjoyable, intuitive and fluid experience for the user.

4 RESULTS

A set of external services is used to achieve some features such as user authentication and calendar sharing. Issues with authentication such as account hacking are delegated for an API. Guest invitations and calendar sharing invitations are handled by google.

Figure 2: WebApp main user interface.

4.1 Social Services

The social section of the web application provides the user access to the configuration of personal contacts, calendar and oriented games for the stimulation of cognitive abilities. It is complementary to the previous section, a facilitator of recreational activities and social life and important for a healthy and stimulating maintenance of life.

Contacts: This module ensures the display of user contacts, allows the user to add and delete contacts and also associates a user account invited to contact.

Calendar: This module ensures the display of shared calendars with the user, allows the subscription of a new calendar, enables the detail view as each calendar events and even add a new calendar.

Games: This module provides the user with access to a set of predefined game-oriented maintenance of cognitive functions such as memory and mental calculation function in addition to the fun and interactivity with others.

4.2 Communication Services

The communication section of the web application provides mechanisms for inter user communications such as chat and video calls.

Non Real Time – Chat: This feature allows the user to view the status of other users in the chat, send and receive text messages with another application user and even invite a user from the list of contacts but has not yet accessed the chat. Through this service, it's possible for two users to exchange messages with each other instantly and also, messages are stored to be read later.

Real Time - Video Chat: For real time conversation a video chat room is enabled via WebRTC. Only two users are allowed per video chatroom. This line of conversation enables real time video and audio communication as long as both users are logged in. At any time the call can be terminated, closing the video and audio channels.

4.3 HELASCoL Webapp

The application base is a service that manages the communication with the sensors and the synchronization with the remote server. The service implements an interface in order to allow the main application, communicate with this service, allowing the user to change the state of connection with the sensors through the UI as other relevant parameters for monitoring. When the Gateway connects to the service it retrieves data and the application makes calls to the Service.

This service also uses TimerTasks that allow a portion of code to be executed promptly. Thus it was possible to implement reconnection mechanisms to sensors in the case of sensors are disconnected for any reason, as they leave the reach or come into hibernation.

Health Monitoring: The application provides a self-monitoring service. This service enables data collection and threshold configuration for blood pressure, glucose, O2, heart rate, weight, body temperature and a bed sensor which indicates if the user is lying in bed.

Home Monitoring: The application provides a house monitoring service. This service enables data collection and threshold configuration for humidity, temperature, CO levels, CO2 levels and water usage in kitchen and bathroom.

4.4 Mobile Gateway

Through continuous monitoring of health status of an individual, the gateway facilitates assistance quickly in emergencies, since when anomalies are verified alerts for the caregiver and / or centralized emergency system are automatically issued.

The gateway communicates with wireless sensors

to continuously monitor the vital signs, or any other parameter that is desired to monitor, and processes this information to provide a set of services such as:

- Monitoring management
- Manual values insertion

This module consists of a smartphone with the mobile application which is responsible for the acquisition and processing monitored data collected by Bluetooth® wireless sensors, and send to the central server.

4.5 Sensor Network

Sensors are devices that produce output for evaluation and or processing by the node while actuators are devices that require input driven by the same node

Wireless Sensors Network: The SUPSI wireless sensor network (WSN) concept consists of a sensor network based on smart nodes (node and connected sensor/actuator) able to read and possibly write general purpose input/output lines either analog or digital. These lines are connected to sensors or actuators.

Bed Sensor: The bed sensor is based on a component that changes the electrical resistance when a force is applied vertically. By putting this component under the mattress and measuring its resistance it is possible to detect when a person is or not in bed and then monitor the sleep cycle.

Water in Bathroom and Kitchen Sensor: This water sensor is based on a piezoelectric microphone that generates a continuous electric signal proportional to the acoustic noise level. By positioning this sensor on the water pipe it is possible to detect when the water is flowing inside by performing a fast Fourier transform (FFT) analysis running on the node.

Bio Sensors: The vital signs can be gathered by a chest strap or wearable t-shirt sensor that uses Bluetooth® to provide vital signs readings such as heart rate, speed and distance which provide access to the users' parameters and potential alerts that may arise based on pre-configured thresholds.

Other vital signs and health data such as weight, blood glucose, blood pressure and oxygen levels can also be monitored with wireless devices, fully integrated with the system. These devices communicate via Bluetooth® to increase the ease of use and learnability by the targeted users.

5 FIELD TRIALS

The first field trial was organized in cooperation with the elderly home of Giubiasco (FCPA), in Switzerland and intends to verify:

- Usability, the quality of user experience and the acceptance of the HELASCoL solution by the primary users i.e. the elderly people;
- Assess the usability of the secondary users (the caregivers and the family members);
- The effectiveness of the HELASCoL solution in terms of promoting the integration of the older adults in the social community through the use of ICT and Internet services, to avoid their loneliness and helping them to live an active and socially connected life;
- The actual usage of HELASCoL platform by the elderly in terms of frequency of use, duration of sessions, interlocutors of communication, etc;
- Finally, to test the overall HELASCoL system, fully integrated and operating in a real life scenario from a technical point of view.

The application was set up in a shared PC in a common place inside the sheltered flat building, where elderly could freely use the platform to gain confidence with the services. At all times a user manual was made available to avoid panicking by the users.

A single training session for the elderly was executed for two groups. Before this training the purpose of this project was explained to elderly, relatives and home staff.

During the participant recruiting phase we aimed to introduce the technology to elders and relatives to build the network of social contacts. For this trial, the high priority was the shared agenda and the video chat.

The evaluation of the results was made by directly follow-up of the users while using the system and through satisfaction questionnaires after the experience.

The results obtained with this set of trials were shared with the institution that seemed interested in keeping the solution with additional features and several sets of devices.

6 CONCLUSIONS

The definition of design standards and metrics for the development of health systems interfaces for the elderly and the integration of new features for a web

application capable of remotely and in real time connect healthcare professionals and patients seeks to be implemented by promoting the increased adherence and facilitate the incorporation of the use of information systems in elders day-to-day activities.

The HELASCoL WebApp was introduced in the elderly home by means of a shared PC installed in a common area. The elderly can freely use the platform to gain confidence with the services.

In general, the users were all very happy and curious with the interface and its capabilities.

Some contents need further development as it was not so easy to comprehend.

Users were extremely pleased with games such as Sudoku and Crosswords.

Some items are described with clinical or technical terms, such as “send email” or “my account”. These must be adjusted to the user’s perception in order to relate to their daily routines without the help of someone every time you want to use the platform.

At this stage, as further trials are to be planned, we are planning to perform a demo installation of the full sensors network in a sheltered flat and increase the number of participants as well as points of service.

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