Laboratory for domotic usability evaluations

E Conde-Alvarez, A Rodríguez-Ascaso, JB Montalvá, MT Arredondo
Life Supporting Technologies (LST)/ Integral Domotics Centre (CEDINT)
Telecommunications Faculty – Technical University of Madrid (UPM)
econde@lst.tfo.upm.es, arodrigu@lst.tfo.upm.es, jmontalva@lst.tfo.upm.es, mta@lst.tfo.upm.es

Abstract

In a context of deep revision of the existing models for the provision of social and health services through Europe, digital homes may provide a wide social usefulness.

One of the key factors for success in their effective adoption as support elements for the independent living of people with functional limitations will be the consideration of human factors in the involved engineering processes.

A laboratory specifically oriented to the evaluation of accessibility and usability of digital home products and services has been created. Human, methodological and physical resources are available both to analyze the quality of the man-system interactions, and to produce redesign recommendations to improve user experience in those environments.

1. Introduction

According to the World Health Organization, approximately 600 million of people have functional limitations, and this figure will increase during next decades due to several reasons, mainly because of the generalized aging of the population [1].

The current model for the provision of social and health care services is under revision because of this demographic trend, together with the increase of service related costs, and the changes that European traditional structures of provision of informal care services are experiencing, especially for the countries in Southern Europe [2].

Moreover, the so-called "independent living movements" have been fighting for decades for the rights that people with functional limitations have to decide about their lives, and to claim for Public Administration to provide resources to put such rights into practice [3].

A shift of paradigm in social and health care models is required to ensure the provision of quality services, considering the above mentioned circumstances. The current trend is to achieve a gradual transfer of hospital and institution based services to the primary care and home environments. This constitutes a key strategy for policy makers in several countries [4], and also within the European Commission [5].

Technological progress, mainly related to Information and Communication Technologies (ICT), eases this shift of paradigm. Digital home technological platforms are a good example of this trend. These platforms are considered as accessibility tools, contributing to improve personal autonomy and quality of life as it eases the access to domestic devices and to external social resources [6]. From the point of view of providing support to the independent living, these platforms integrate generically four types of services: control of the environment, personal monitoring, alarms management and communication [7].

The adequate addressing of human factors in the future creation and provision of these services and products, will constitute a key factor in the success of their effective adoption as support elements for the independent living of people with functional limitations. The adoption, within the engineering process, of specific phases of methodological evaluation of human factors aspects, such as accessibility, usability, personalization, respect for ethical principles, security of operation, privacy, etc. will allow to detect and solve deficiencies in time, increasing the quality perceived by the potential clients of the these services.

2. Objective

The general objective of the work presented in this paper was to create a laboratory where accessibility and usability of domotic services could be assessed. It is expected that some other human factors will be included in further stages of this work, planned to serve as a laboratory for evaluating the user experience in digital homes.

Figure 1 Evaluation space

The evaluation structure will be applied both to the scientific work that is being carried out by our research group in this field, and to products coming from external entities willing to hire consultancy services. The structure that has been created consists of three basic resources: physical resources, composed of hardware and software domotic elements; methodological resources, consisting of a group of assessment tools and procedures; and human resources, in charge of designing and accomplishing the evaluation processes, analyzing the obtained results and producing the correspondent reports with conclusions and recommendations.

3. Materials and methods

The evaluation laboratory involves three types of resources: methodological, physical and human resources.

Methodological resources: The general methodological framework is inspired on the Design for All philosophy, which is the process of creating products, services and systems which are usable by people with the widest possible range of abilities, operating within the widest possible range of situations, without the need of adaptation or specialized design. The main references used to build up the laboratory methodology are the following:

- USERFIT methodology [8]. User centred design methodology that provides designers and developers with tools to ensure the consideration of users' attributes, and to create products which are consistent with users and the operation context.
- Results of the NJORD-TIDE project, where several purposes of assessment methodologies for domotic systems are included [9].
- Evaluation methodology of the HEPHAISTOS-TIDE project, in which several usability demonstrations of a multimodal system of control of the environment were done with users of different functional profiles [10].
- Usability evaluation work based both on the Jacob Nielsen's heuristic techniques [11], and other works related with the design of the users group [12].
- Standardization work about human factors in telecare systems, accomplished by the European Telecommunications Standardization Institute [13].

Physical resources: The domotic infrastructure is composed of the following elements:
- Home devices interconnected by the Siemens Instabus-EIB, controlling lights, air-conditioning, window blinds, doors and taps. Besides, there are light, fire, flood, movement and open door sensors.
- Uninterrupted Power System.
- OSGI opened architecture platform and Internet communications gateway.
- Software for secure communications management based on firewall and antivirus.
- Software to manage home and users databases with remote management interfaces.
- Middleware based on Web Services.
- Voice recognition/synthesis engines, microphones, head-speakers and high precision tactile screens; different mobile communication terminals are also available.

Human support: The laboratory staff is composed of one post doctoral fellow and two doctoral students, with experience in the human factors of ICT products and home systems.

4. Results

A laboratory for the evaluation of accessibility and usability of digital home products and services has been established. Different parameters are analyzed:

- Accesibility: Analysis of identification/localization, reach, access, perceptibility and comprehensibility levels of system messages, information input and navigation components of the user interface.
- Usability: Analysis of effectiveness, efficiency and satisfaction parameters of user-system interaction.

A Digital Home Platform is available, composed of hardware and software products. Domotic products and/or services under the evaluation process will be integrated within this platform. Core services offered by OSGI and Web Services will ease this integration process.

Besides, a set of Evaluation Tools to assess the Accesibility and Usability levels of the domotic products and services is also available.

Context analysis: Formal description of services/products under evaluation, according to the target user group, and to those tasks users can perform.

Expert evaluation: Based on Context analysis, a heuristic analysis of user interfaces is accomplished by a group of experts who have not participated in the design of the assessed product. Every component of the system is methodologically analysed, following functional and interaction heuristics. A report is produced with the detected problems and the proposed solutions. Figures 2 and 3 show the redesign process applied to interfaces developed by the research group after a previous expert evaluation. The original interface (Fig. 2) did not allow using tactile screens to log in the system so an on-screen keyboard was designed (Fig. 3) to solve that problem.

Figure 2 Original interface

Figure 3 User interface after the redesign process

Evaluation with users: User groups and evaluation processes are designed, according to the Context Analysis. The evaluation process is composed of several sessions to be held with every user. During one session, a set of tasks are proposed to the user, who will carry out them while the evaluator annotates quantitative or qualitative data related with the following topics: Completed tasks, errors made, times the user asks for help, blocking situations, time to accomplish tasks, error recovery time, etc. The evaluator will also take notes about the observed problems of use, the satisfaction or displeasure expressions, etc. If necessary, sessions can be recorded to allow a posterior detailed analysis, but only if users give their consent after being informed about the envisaged use of that information.

Users complete questionnaires both at the end of every session and at the end of the whole series. There they show their opinion both about the quality of the interaction elements (acoustic, tactile or visual), their satisfaction when using the system, and aspects related with the adequateness of the services for their personal circumstances.

The analysis of the data related with objective and subjective variables generates both a report with conclusions about the accessibility and usability levels of the evaluated domotic services, followed by a set of redesign recommendations to improve them.

Figures 4 and 5 show graphics where objective and subjective measures are displayed. These data belong to a process where domotic interfaces developed by the research group where evaluated by 16 users with different functional and age profiles. Figure 4 shows users' opinions about controlling home devices by means of three different interaction agents: voice interaction, tactile screen and mobile telephone. The results indicate users felt more comfortable with the speech interaction whereas they have more difficulties with the interfaces for mobile phones due to the small size of the keypads.
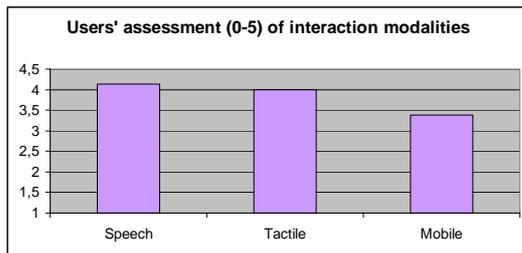
Figure 4 Users' assessment of different interaction modalities

Figure 5 shows the evolution of the time consumed by users to interact with a lamp through three interaction agents, in two different sessions. In the three cases, the necessary time to finish the proposed tasks was shorter during the second session which demonstrates their usability and easiness of learning.
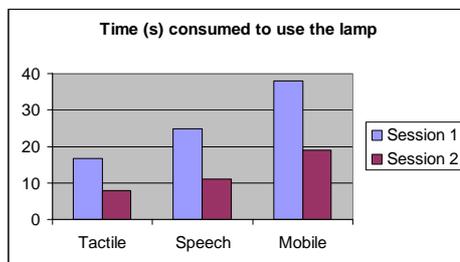

Figure 5 Time to control a lamp

5. Conclusions

A laboratory specifically oriented to the evaluation of Accesibility and Usability of digital home products and services has been established. The laboratory is composed of human, methodological and physical resources both to analyze the quality of the human-computer interaction, and to generate recommendations to improve the user experience in digital home systems.

An Evaluation Space, based on an open architecture of domotic hardware and software, is available to integrate and assess products or services. A set of evaluation tools is available (Context Analysis, Experts Evaluation, Evaluation with Users). They allow the analysis of services to detect deficiencies in the human-computer communication, and to propose specific actions to improve them.

The future work plans include the development of methodological tools to evaluate additional human factors, relevant within the digital home field.

6. Acknowledgments

7. References

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