# Evaluation of an accessible home control and telecare system

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**Abstract.** The article presents part of the research carried out within a project aimed at procuring interaction of people with disabilities and elderly with their environment through the use of information and communication technologies. We present methodological aspects related to participation models, user experience, technology acceptance and peer training. Technology was designed to test the effectiveness of systems and interfaces developed. Evaluation was conducted in an automation environment with older people as users.

**Keywords:** usability, accessibility, interactive system evaluation, evaluation methodology, device interaction, domotics

## 1 Introduction

INREDIS [1] is a basic research project in the field of accessible and interoperable technologies aimed at developing basic technologies for communication and interaction between people with some kind of special needs and the environment. An architecture capable of adapting different types of interfaces to users' needs and preferences, was designed and developed. This paper explains how within the home environment, two use cases were assessed: a prototype home automation control and a telecare service. The home prototype allows the control of different home devices, while the telecare prototype offers to make an appointment request to different specialists.

### 1.1 Smart home

A smart home is defined as a residence equipped with computer and information technology that meets occupants' needs, working to promote comfort, harmony, security and entertainment through the management of technology at home and its connections. Smart homes are also characterized by research focused on users [2]. Among essential factors considered to achieve a good experience are trust and perception of control. For trust to be relevant it should be two preconditions [3]: first there must be a dependency between the "truster" and "trustee", and this dependence

must involve some risk, and further the risk must contain both uncertainty and vulnerability. According to [4] a comprehensive definition of trust comes from the union of three elements: the function or element that has to inspire confidence, the belief that anticipated results will occur and the will to act on this trust.

Conversely automation can be defined as the performance of functions by a machine agent (usually a computer), which have previously been carried out by an individual. Considering automation different ways of control were proposed [5] and applied in various technological areas: supervisory control, negotiated and shared.

## 2 Methodological background and Evaluation method

In order to design a methodology adapted to the needs of the defined environmental assessment a study of two methodological approaches aimed assessing different products and services were conducted: Extended Technology Acceptance Model, and People Lead Innovation benchmark. The Technology Acceptance Model (TAM) [6] argues that attitudes towards the use of an information system is based on the perceived usefulness and perceived ease of use, it also suggests the link between perceived usefulness and intention to use in determining the use of the system. The Extended Model of Technology Acceptance [7] based on the original TAM and Innovation Diffusion Theory (IDT) [8], incorporates the dimensions of cost, and perceived risk. People Lead Innovation methodology [9] integrates users citizens in the innovation processes. The dimensions used in this methodology are: emotional approach, ergonomics, public innovation, sustainability and security management.

The validation of the automation environment involved evaluating the smart home control and monitoring system as well as the devices used to control the system. For each of the proposed elements a methodological adjustment was needed in order to determine what dimensions to assess during the experience. All platform elements - home control and telecare systems and devices- were evaluated and validated focusing on all those dimensions and material features that conform the usability and accessibility from a system. Also measures were taken related to information transmission, navigation, configuration, training, fitness requirements, ethics and privacy.

Information to assess the system was collected through post-test questionnaires (see Fig.1) measuring technology acceptance (comprise by perceived risk PR, cost COS, compatibility COM, perceived usefulness PU, perceived ease of use PEU and use intention UI), confidence CON (degree to which targeted users perceive the system as a reliable element for tasks' achievement) and automation level AUT(degree to which targeted users perceive that they control the system relative to automation level).

**Participants.** 12 elders aged between 70 and 88 years (mean = 79.33). Two had displacement problems and one had handling problems. 25% had previous experience with computers, and 18.18% with the Internet.

**Devices.** Four tactile devices: 1) iPhone, 2) iPad, 3) Tobii (used only as a touch screen computer), 4) touch screen PC. Each user was using a portable device and a non-portable device, always starting with the non-portable device.

**Test Protocol**. Firstly participants went into a devices familiarization and training period, followed by the test when they had to use the devices to perform the proposed tasks. Familiarization and training was carried out involving previous participants to observe knowledge transfer and identify this group representative vocabulary. The following tasks were performed: 1) INREDIS interface registration, it determines INREDIS profile type, 2) digital home use case (control of household items through the interface. e.g. up blinds, turn off lights, open door), 3) telecare use case (request, view and cancel a doctor's appointment).

**Qualitative results.** For iPad and touchscreen the most frequently encountered difficulties were "identification" and "navigation": identification of screen elements and functionality, menu navigation system, and how to move through the different screens. By activities Telecare services interacting with the iPad concentrated the largest number of use problems. For the iPhone and Tobii the difficulties encountered were concentrated in three activities: "Select items", "Identification" and "Accuracy needed". Regarding the difficulty of use identified by task, which can relate to the devices used, it could be seen that most problems were detected in the iPhone.

**Quantitative results.** Performance results indicated that all users were able to perform the tasks, although sometimes only partially: the telecare use case tasks were successfully overcome by all participants using the iPad.

Performance results with the iPhone and Tobii indicate that all users have exceeded the registering task without difficulty. However only one user managed using the iPhone to partially complete the telecare task (request, view and cancel a doctor's appointment). A significant amount of difficulties caused by the device's functions were detected, rather than system problems. The task of controlling the home elements was completed successfully by 2 users and partially by 5.

**Questionnaires results.** Likert scales1 to 5 were used to evaluate the devices and the system. In general the touch screen computer, with a mean of 2.09 obtained better scores than the iPad, with an average of 2.17. The dimensions most valued are the emotional aspects, with a mean of 1.77, followed by accessibility, with 1.97. The familiarity dimension was highlighted in relation to interaction, while cognitive ergonomics, which questioned navigation and information distribution obtained the worst rating, with an average of 2.34 and 2.33 respectively.

In relation to the system's perception in general it caused a good sensation and participants seemed to approve of it (see Table 1) considering that the system cover their daily needs at present time and would benefit from it in the future. They considered the system easy to use and with time they would use it proficiently.

**Table 1.** Results from the system questionnaire.

| CON | AUT | PU | PEU | UI | PR | COS | COM | Average |
|---|---|---|---|---|---|---|---|---|
| 2.17 | 2.25 | 1.93 | 2.19 | 2.5 | 3.21 | 2.27 | 2.99 | 2.44 |

**Peer training.** Participants generally felt inhibited by having to explain how they used the devices, and according to their own utterances by the presence of the facilitators: "You explain it better" "I do not know, you better tell them". There was a tendency to explain the devices that they had been used more easily, mainly the Tobii as touch screen and the touch screen computer. The vocabulary used was not very

specific e.g.: "You touch what you seek" "Tapping here?" referring press a button on the IPAD) and, in most cases, participants used gestures to indicate those elements of the system they needed to describe. Explanations lacked information regarding key aspects such as navigation and exploration of the interfaces.

## 3 Conclusions

There was a trend in participants not to assess negatively the devices, the applications neither the services on the usability questionnaires. Participants' comments showed they acted as if use was easy even though they needed to learn to use the system and devices: self-perceived as people with little technological knowledge. They tend to avoid criticism: very few users suggested changes to the system interface even when having major problems during its use. It would be interesting to think about a format that facilitates spontaneous expression of negative opinions and criticism.

Major problems were detected during the interaction with mobile devices iPhone and iPad, especially for features implemented in browsers' traditional interface, such as URL space, although the interface did not require using it, it puzzled users.

Cost of acquisition, installation, maintenance and support of the functionality offered by the system with users' real needs and perceived risk, specially the use of cameras in the home environment were detected as the main issues that could influence the acceptance and use of the system. In principle, factors that are not directly related to the interface or the system and unrelated to the interaction.

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