Design Proposal for e-Accessibility and Interoperability in e-Health Solutions based on ISO9241-151 and ISO/IEEE11073

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Abstract

The new concepts of e-accessibility and *design for all*, along with familiar concepts like usability and interoperability, must serve to bring the Information Communication Technology (ICT) closer to the people with disability, constituting Ambient Intelligence (AmI) environments. In this context, the ISO9241-151 standard for e-accessibility and the ISO/IEEE11073 standard for personal medical device interoperability have been considered as design guidelines. This article proposes the technical requirements needed in the design and evaluation of a Graphical User Interface (GUI) for its further implementation of e-Health applications over personal devices such as handled devices, *SmartPhones* or Tablet PCs.

1. Introduction

In recent years the concept of *design for all* [1] has been popularized, which means considering the requirements of all potential patients, including elderly and people with disability. Within the broad field of disability hosting, e-accessibility is one key aspect that is becoming more relevant today. The problem of bringing technology to elderly and people with disability makes necessary the implementation of customized Graphical User Interface (GUI) for their specific needs. It could avoid that the hardware requirements for interacting with the medical device poses an additional difficulty.

In Figure 1 an outline of ideas for the design of GUI as the paradigm *design for all* is shown, taking the people with disability with special needs as the centre of the design, which will determine the developed software applications. In this broad context, the first sector in Figure 1 covers the types of disabilities that exist, the barriers that they face and the foundations that represent them. In the area of legislation, all the laws that protect the rights of the people with disability are reviewed. In the section on e-accessibility, the concept *design for all* allows developing new designs according to the recommendations of how to bring new technologies closer to the specific requirements of people with disability. The area of usability that defines the ease which people can use a particular tool or other human-made object to achieve a particular goal. Thus, the design of new e-Health GUI has to comply with the specific characteristics of usability for people with disability. The hardware section allows to design a graphical interface applies to any platform and have the necessary adaptive hardware for people with disability. Finally, the methodology area covers technical guidelines to follow with different systems, programming tools and communication standards.

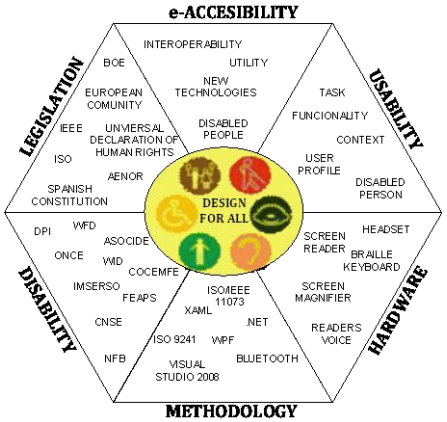

Figure 1. Outline of ideas for the design of a Graphical User Interface based on the paradigm of *design for all*.

From this outline of ideas, this article deals with the design an evaluation of a GUI that meets the main requirements associated with the paradigm of *design for all*, according to the ISO9241-151, and applied to an e-Health solution, according to the ISO/IEEE11073 standard. In Section II the concepts of e-accessibility and related legislation are introduced, remarking the ISO9241-151 standard. In Section III the proposed design methodology is applied to an e-Health solution according to the ISO/IEEE11073 standard and its evaluation process is described. The conclusions are discussed in Section IV.

2. e-Accessibility and legislation

The equation of equality means equal quality access (Equality = e-Quality) [2]; it was the beginning to integrate the Information Communication Technology (ICT) for people with disability and, therefore, to provide equal opportunities to the people that depend on e-accessibility and quality of systems and services.

Previous standard-based designs for e-Health solutions did not follow a GUI based on the e-accessibility paradigm, since the different implementations only tried to meet the standard and ensure interoperability of medical devices. There are projects related to e-Health and disability, such as *SIStema de COmunicación para usuarios con DIScapacidad* (SISCODIS) [3] of *Fundación Telefónica* where a global communicator is developed, based on new technologies and facilitating communication to people with all types of disabilities according to their specific needs. There are also projects of the association for the promotion of people with disability (PROMI) [4] intending to implement in rural areas to care for critically illness, elderly or people with disability.

In this context, the legislation is one of the cross-cutting themes for the design of an e-accessible GUI. After an extensive legal research in Spain, [5]-[8] the standard of design that regulates the implementation of all legal requirements is ISO 9241-151 [9]. ISO 9241-151 provides guidelines for human-centred design to user interface web-based software with the aim of increasing the usability. The strengths and development key points that are extracted from the standard for the proposed design are following detailed:

- GUI must be concise, coherent and consistent to reduce user effort.
- The use of sound is commonly considered as an indicator of end task or alert of some kind of error, so it must be accompanied by visual signal associated with the event.
- The icons should have an associated label, facilitating the identification and understanding of the role of the icon.
- The redundancy of the communication channel solves many of the problems of accessibility. It must not only be redundant the output channel but also in the input: it should be possible to do only with a mouse, only with a keyboard, just pushing a button and only with voice recognition systems.
- Data entry is similar in interfaces text mode and graphics mode. The written text must be possible to be readed with the pointer so that it can synthesize a voice or be converted into Braille language.
- The keyboard is an essential element, so that all aspects of e-accessibility must be carefully set so the user can access to any interface item.
- In order to speed up the typing over the entire keyboard, menus should be circular, i.e. skip the last option on the first and vice versa.

Finally, ISO 9241-151 also notes that, for an environment be fully e-accessible, it is not enough that it includes all the services and the general requirements above described: it is also necessary that the applications using these services are coordinated with them and meet other design considerations are not allocated directly to the operating environment. Thus, depending on the type of disability, it will require other technologies in addition of assistive products, and equipment has to be consistent to the user [10]. Furthermore, the application must be designed so that the number of steps required to access any option will be the minimum possible and will do not require simultaneous use of more than one user device, with particular emphasis on the most frequently used options. Thus, any user will get larger efficiency. Figure 2 shows a relationship diagram "technology - type of disability" for different types of visual, hearing, physical and speech impairment.

Figure 2. Relationship Diagram "technology - type of disability".

3. e-Accessible design for a ISO/IEEE 11073-compliant e-Health solution

ISO/IEEE11073 provides interoperability for medical devices communication and enables efficient exchange of vital signs, transparent update of medical devices and harmonization between different proprietary protocols [11]. In previous ISO/IEEE11073-compliant e-Health solutions [12], the results for interoperability together with the implementation of prototypes remarked the challenge to create an e-accessible GUI, as proposed in this paper. The proposed design methodology will permit the e-Health solution to comply with the recommendations of e-accessibility, usability and *design for all* so needed in a personal health application focused on patients, their illnesses and their possible disabilities. This new GUI could be allow the e-Health solution be accessed uniformly by any type of patient and enhance the benefits of the standard-based design. This is because the ISO/IEEE11073 framework solves the process of interoperable communication in a transparent way for being integrated with transport technologies (such as Bluetooth) and with other standards for application design (such as ISO9241-151).

Thus, the proposed design could be added to previous contributions in order to maintain the framework but extending it to new personal devices (e.g. handheld computers, SmartPhones, Tablet PCs, etc.), and several user profiles [13]-[15]. The user profiles considered in this study have been:

- *Technical profile:* staff assigned to manage the connectivity, and researchers that make application improvements and contributions.
- *Health profile*: nurses, doctors or caregivers who will use the graphical environment with the appropriate applications.
- *Patient profile*. It includes several kinds of people with disability that it will imply different profile parameters: type of disability, location of the patient, used technology (wired, wireless), type of device (fixed, wearable), etc. From this study and previous collaborations within the Personal Health Devices Working Group (PHDWG) [16], Figure 3 shows the three specific cases for the patient profile: elderly patients that could have an independent life with a little help (aging independently), patients with diseases that need to manage their disease (disease management) and the users who require medical monitoring to improve their health (health and wellness).

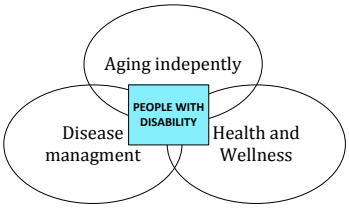

Figure 3. Patient profiles.

From the considerations of Section II and satisfying the ISO9241-151 requirements, the proposed design based on e-accessibility is shown in Figure 4. The showed GUI corresponds to a Compute Engine (defined in ISO/IEEE11073 as *manager*) that gathered the medical information of every medical device of the patient (defined in ISO/IEEE11073 as *agent*) in a homogeneous and interoperable way. This design is based on a *cover flow* format, see middle area of Figure 4, allowing the efficient exchange of information through applications and complying with the circular menu recommended by ISO9241-151 as one of the basic requirements. It contains different specific applications depending on every user profile (see Table I). The upper left area of Figure 4 shows a menu to choose among different users and distinguish, for example, between different members of the same family or different patients in a nursing home or in a dependency. Common applications for the three user profiles are displayed in the lower left area of Figure 4 and some examples of e-accessible design options, customized by visual, hearing, physical and speech impairment, are shown in Figure 5. This lower left area corresponds to the tools menu to make changes to the environment by adapting it, as it was appropriated, to every disability and specific need of each user profile. In addition, the lower right area of Figure 4 shows the messaging application for every profile.

Following the ISO9241-151 recommendations, the *cover flow* can be managed with the help of the arrows that are under it, with the arrows of keyboard, or using audio interfaces. It can scroll through the options while the user can see at all times the total of such applications and the effect of distance and proximity, and the number of times has to press the arrow to reach the desired application. The help button is located at the bottom right, and it will solve any doubts or problems.

Figure 4. GUI design for *Tablet PC**.

Figure 5. Examples of e- accessible design options.

Table I. Major user-specific applications *.

Icon	Application Description
	Allows you to modify the characteristics of the application depending on the needs of the patient and his disability. It also serves to install the personal medical devices.
	This application is used to send / receive messages with the medical staff responsible for monitoring the user/patient, who may know the frequency of the measures to be followed.
	This application is used to set alarms for taking action according to medical recommendations. Depending on the disability be established visual alarms, sound or vibration mode.
	After installing the medical device, this application will allow the patient to begin with the connection according to ISO/IEEE 11073.
	Collect as much calendars their appointments with the doctor, as revisions to the medical center or the frequency with which must get the tension or weighed.
	Here you can see graphically the evolution of blood-pressure or weight, according to its latest measures.
	To consult the latest measures taken and the medical follow-up graphics and the basic parameters such as sex, height, weight, ...
	This application will be able to enter / view / cancel an appointment with your doctor or medical personnel responsible for the patient.
	To store the values taken in an instant and for some reason do not need to send and just want to save. In addition it allows you to see the previous measurements stored.

Figure 6. GUI Design for *iPhone* *.

Finally, as proof-of-concept of development in new personal devices, Figure 6 shows the proposed design for *iPhone* or similar devices where all the aforementioned requirements have been considered but adapting to the specifications of this device.

From this design methodology, the next step is its evaluation in official institutions of disabled and elderly people. The evaluation methodology of e-Health services requires doing a systematic review on safety, efficacy, effectiveness and suitability of the software. This evaluation includes the visit to visual disability centres, such as the ONCE Foundation, centres for the hearing disability, such as La Purisima school for deaf children, the Association of Physically Handicapped of Aragon (DFA), and the Aragon Institute of Social Services (IASS). To carry out this evaluation, the design of software has been presented to test the impact on disable and elderly people in order to determine whether the design is safe, efficient and effective. From this, the review with users will be incorporated to the design to improve it, check if the applications made are correct and if they need anything else to cover the specific needs of people with disability, like sign language videos for deaf people that don't know or cannot read subtitles.

From this design and evaluation proposals, the future lines would involve the deployment, implementation and clinical evaluation of the entire graphical environment. The implementation will be based on *Windows Presentation Foundation* (WPF) technologies over .Net development platforms for different patient profiles. Furthermore, the next evolution will consist on an analysis, for its potential further migration to new interactive devices present in the daily life of the patient, such as television with remote control and/or tactile interaction.

4. Conclusion

This work has presented a design proposal of GUI for people with disability based on the new paradigms of e-accessibility and interoperability according to the main standards in this context: ISO9241-151 and ISO/IEEE11073, respectively. The aim is that these concepts, integrated with the new technologies, will be fully extended in a near future to new e-Health solutions.

Acknowledgements

This work was partially supported by projects TIN2008-00933/TSI of the Interministerial Commission of Science and Technology (CICYT) and European Funds for Regional Development (FEDER), and TSI-020302-2009-7/Plan Avanza I+D of Ministry of Industry, Tourism and Trade.

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