Volume 5, Issue 5, May 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Accessible Display Design to Control Home Area Networks

Rohini B. Thube, Archana A. Hatkar
E&TC Department& Pune University
Maharashtra, India

Abstract*—Recently, the social inclusion and technical aid to assure autonomy to people with disabilities are getting attention all over the world. This paper presents a display design for accessible interaction in home area networks. Based on a research on the accessible interfaces state of the art, an interface design is proposed. This interface is implemented over a Tablet that controls domestic devices through a home network controller prototype. This research consolidated a feasible accessible interface to control home area networks pointing out the main requirements considering a diversified group of impairments.

Keywords— accessibility, home automation, user interface, universal design.

I. INTRODUCTION

Focusing on the use of home area networks to improve disabled people's autonomy at home, this paper presents a display design for accessible home control. In the past years, computational devices have turned faster, smaller, connected and cheaper. It brings the "intelligent house" vision, promised for decades, closer to reality. This pervasive, intelligent home, a luxury item for many people, could have a key role in assuring the autonomy of people with disabilities[1]. Thinking about users with disabilities, it is necessary to invest efforts in the research and development of accessible interfaces, through the perspective of a universal design that is easy to use and to learn how to use. The design for all, also called universal design. In this perspective, accessibility is defined as "a condition for autonomous and safe use of space, furniture and urban facilities, buildings, transport services and devices, systems and media and information by people with disabilities or reduced mobility." [2]. It is worth stressing that accessibility is not the creation of exclusive spaces for people with disabilities, which could be a form of discrimination, but rather of thinking of systems and environments, which can be used by everyone. The work was developed starting with an interface design proposal, based on the research on accessible interfaces state of the art. The interface was deployed targeting Tablets and Smart Phones interoperability. It was integrated to control a home gateway prototype. This research could consolidate a feasible interface to control home area networks pointing out the main requirements for home area networks considering a diversified group of impairments. This paper is an extended contribution to the work [3].

II. LITERATURE REVIEW

The works on user interface for home automation for people with disabilities are very specific. There are works focusing on elder lies, visually impaired people, hearing impaired, people with motor impairment and cognitive disabilities. The project Assistive Housing [4] was developed focusing on the elderly comfort, allowing home automation by using the television set and its regular remote control as an interface. There are two other relevant projects to monitor elderly using sensor networks and integrating home automation, but they do not explore user interface design [5] [6].In Mainardi's work [7], the project is designed for people with manual dexterity and mobility impairments, but it could be widely used. The idea is to have a portable touch screen device with the proposed interface. Another work presented the use of touch screen devices combined with voice control, allowing the interaction of people with limitations in their upper and/or lower limbs, replacing the standard devices (mouse and keyboard) [8]. The voice control systems in the state of the art are suitable for interactions with menu screens. Some works present systems based on a hardware-software co-design that allows speaker-independent speech recognition at an accuracy rate of 95%, without voice training [9].Other works present solutions of image processing for interacting without traditional interaction. A gesture-based control system was developed to simplify the home automation interaction to people with mobility impairments in the Intelligent Sweet Home project [10].Another solution was developed to replace hand interaction using head movements and mouth position [11]. Through serial communication and infrared, the system controls appliances.

III. INTERFACE DESIGN

This work target users are people with visual, hearing, motor and cognitive disabilities. In order to develop a widespread and easy-to-use interface, a design approach based on icons was adopted quadrants and touch screen combined with voice control. The touch screen choice was made based on three factors: the widespread use of this technology on mobile devices, the touch screen intuitiveness and the possibility to include people with upper limbs impairments [7]. Considering that people with disabilities have more locomotion difficulty, the possibility to have the home control interface on a portable device such as a smart phone or a tablet is an extra advantage. The interaction

mechanism was based on "touch" and "hold pressed" events. The "touch" event selects the key and a "hold pressed" event triggers the action related to the key. The action could be to send a command or to go to a next screen in the interface. The interface proposed also has another interaction mechanism that uses speech control. The user can say the name of any screen or key in order to trigger an action. The central button on the main menu screen activates the speech control mode.

IV. IMPLEMENTATION

The interface was implemented over a Tablet. The interface implementation consists of thirteen screens with five devices and lighting being controlled. Figure 1 presents the screen of our proof of concept implementation.

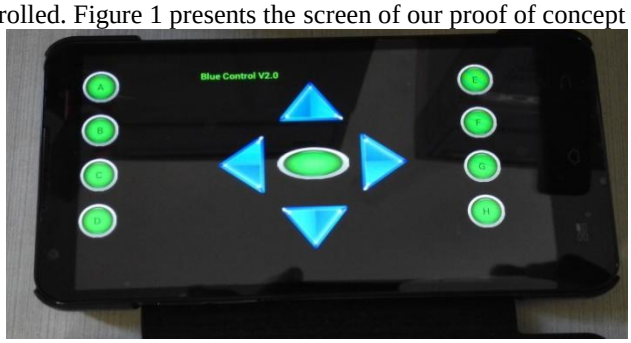

Fig. 1. Main menu screen.

In order to integrate this interface with a home automation system, a development board with an embedded microcontroller was used. The interconnection between the tablet and the automation system was made using a Bluetooth connection that is currently available in most tablet models. A commercial Bluetooth module was used connected to the development board in order to execute the experiment. In our tests, the development board was used to control lighting, air conditioner and a TV set.

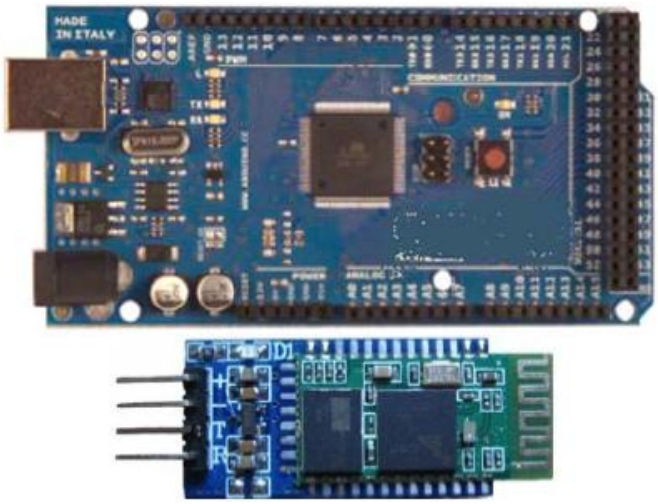

Fig. 2. This Figure presents a picture of the development board and its Bluetooth daughter board.

V. DESIGN EVALUATION

The development cycle of our prototype included usability evaluations by users. Usability of a product is analyzed by considering user satisfaction in an approach that values your expectation and experience of use [12] [13]. Products developed without usability requirements can cause poor performance and a reduction in quality of product for users [14] [15]. Design methodology chosen to usability evaluation was Empirical Usability Method with participation of users [16]. In this method, real users perform tasks with the product while being observed by evaluators. Therefore, it is important to review the test conditions, making sure they are the same for all participants. Among the objectives of this method, are: predict usability problems such as learning difficulties and run-time task in the operation with the product; diagnose what may be inconsistent with the standards implicit and explicit usability; see, observe and record usability problems during interaction with the product; calculate objective metrics for effectiveness, efficiency and user productivity through interaction with the product; no opinion of user about product; suggest priorities for solving usability problems based on the test results [15], [16].

VI. CONCLUSIONS

Despite working with a considerably varied group of users, with different needs, an interface suitable to them was achieved. Our interface integrates accessible interface ideas in a single portable interface that can contribute to people with disabilities' autonomy at home. Despite being a potential solution to improve the autonomy of people with impairments, the interviews have shown that home automation is not even considered as a possible solution to these people's reality. They consider home automation a high technology solution out of their reach. It points out to the

demand for researching and developing lower cost and simpler solutions. As the next steps to this research are the improvements of the interface with the interviewees' feedback, to integrate the new explore-by-touch features available in the new tablets' operating systems libraries and the repetition of the described experiments with larger groups of users.

ACKNOWLEDGEMENTS

The authors would like to thank for helping us with the interviews. The authors would also like to thank to the volunteers that helped us to provide feedbacks.

REFERENCES

[1] L. C. P. Costa, N. S. Almeida, M. K. Zuffo, "Accessible display design to control home area networks." IEEE Transaction on Consumer Electronics,vol.59.No.2, Proceed.,May 2013.

[2] Brazil. "Federal Decree no 5296". December 2004.

[3] L. C. P. Costa, N. S. Almeida, M. K. Zuffo, "Accessible display design to control home area networks." IEEE International Conf. in Consumer Electron. Proceed., pp.426-427, Jan. 2013.

[4] M. Ghorbel, F. Arab, M. Monhtari, "Assistive housing: case study in a residence for elderly people." IEEE Second International Conf. on Pervasive Computing Technologies for Healthcare, pp.140-143, Jan.-Feb. 2008.

[5] X. H. B. Le, M. D. Mascolo, A. Gouin, N. Noury, "Health smart home - towards an assistant tool for automatic assessment of the dependence of elders." Proc. of the Annual International Conf. of the IEEE Eng. In Medicine and Bio. Soc., pp. 3806-3809, Aug. 2007.

[6] A. Sleman, M. Alafandi, R. Moeller, "Integration of wireless fieldbus and wired fieldbus for health monitoring." IEEE International Conf. on Consumer Electron., pp. 1-2, Jan. 2009.

[7] E. Mainardi, "Design of a portable touchscreen interface for powerline domotic systems." IEEE Autom. Science and Eng., pp. 680-684, Aug. 2008.

[8] M. Valles, F. Manso, M. T. Arredondo, F. Del Pozo, "Multimodal environmental control system for elderly and disabled people." 18th Annual International Conf. of the IEEE in Eng. in Medicine and Biology Society, pp. 516-517, Oct.-Nov., 1996.

[9] J. Zhu, X. Gao, Y. Yang, H. Li, Z. Ai. X. Cui, "Developing a voice control system for zigbee-based home automation networks." IEEE 2nd International Conf. on Network Infrastructure and Digital Content, pp. 737-741, Sep. 2010.

[10] J. Do, H. Jang, S. H. Jung, J. Jung, Z. Bien, "Soft remote control system in the intelligent sweet home." IEEE International Conf. on Intelligent Robots and Systems, pp. 3984-3989, Aug. 2005.

[11] W. Xianmei, L. Lingyan, D. Ti, W. Zhiliang, "Smart home control system for the disabled using the head and the mouth movement." IEEE 29th Chinese Control Conf., pp. 3527-3530, July 2010.

[12] ISO 9126. "Software precuts evaluation: quality characteristics and guidelines for their use." 1991.

[13] ISO 9241. "Ergonomic requirements for office work with visual display terminals (VDTs): dialogue principles." 1998.

[14] P. W. Jordan, An introduction to usability. Taylor & Francis: New York, 1998.

[15] J. Nielsen, Usability engineering. Academic Press: San Diego, 1993.

[16] J. Nielsen, R. Mack. Usability inspection methods. John Wiley & Sons: New York, 1994.

