Accessibility Guidelines for Tactile Displays in Human-Robot Interaction. A Comparative Study and Proposal

Malak Qbilat(✉) and Ana Iglesias

Computer Science Department, Universidad Carlos III de Madrid, 28911 Madrid, Spain
100344402@alumnos.uc3m.es, aiglesia@inf.uc3m.es

Abstract. Many people face accessibility barriers when interacting with robots, mainly people who do not usually interact with new technologies, elderly people and users with disabilities. Current laws, standards and guidelines protect the right of the users interacting with computers, however, they are not specific for human-robot interaction and they have not considered the special characteristics of robots. This paper is focused on the accessibility requirements of tactile displays integrated into service robots. An extensive study and comparison of the main accessibility guidelines, standards and recommendations is conducted. Moreover, a first draft of guideline for tactile displays in HRI is proposed.

Keywords: Human Robot Interaction · Accessibility · Guidelines

1 Introduction

Human Computer Interaction (HCI) is a field of a study focusing on the design of computer technology and interaction between users and computer [1], while Human Robot Interaction (HRI) is a field of study focused on analyzing, designing, modeling, implementing and evaluating robots that are dedicated to serve humans in several aspects such as domestic tasks, entertainment, elderly and handicap assistance, etc. [2]. Nowadays, there are different accessibility guidelines, standards and recommendations in HCI which help designers and developers to implement accessible products for all users, nevertheless of their capabilities or abilities. However, there are not specific standards, guidelines or recommendations for HRI, considering the special interaction characteristics of the robots. This paper presents an in-depth study of three of the main accessibility guidelines and standards of HCI. Then, based on this study, a specific accessibility recommendation for tactile displays in HRI is proposed. Section 2 summarizes related works, Sect. 3 clarify the methodology, Sect. 4 presents a comparative study of main accessibility guidelines and proposal, while Sect. 5 presents conclusions and further research.

K. Miesenberger and G. Kouroupetroglou (Eds.): ICCHP 2018, LNCS 10897, pp. 217–220, 2018.
https://doi.org/10.1007/978-3-319-94274-2_29

2 Related Works

2.1 Accessibility Laws, Standards and Guidelines for HCI

The necessity to ensure accessibility to all users with different abilities and needs has motivated countries to make laws and decisions. Web Accessibility Initiative (WAI) is continuously updating different guidelines for several web components to improve web accessibility, as the WCAG v2.0 guideline [3], BBC Accessibility Standards and Guidelines, as the BBC guideline [4] and Funka Nu Mobile guidelines [5]. All these laws, standards and guidelines are necessary for designing and developing accessible software products (websites, web applications, mobile applications, etc.). However, none of the available guidelines and standards covers all HRI accessibility aspects.

2.2 Accessibility Barriers in Using Robots

Many researchers study the robots' usability, social acceptance, societal impact or even if the user experience is positive or not. For instance, Yanco et al. research work [6] and USUS evaluation framework [7] provide a basis for research in HRI, addressing multiple research areas like HCI, CSCW (Computer Supported Cooperative Work), and SS (Social Sciences) to offer a holistic picture of research aspects of HRI. However, none of these frameworks considers the interaction accessibility as a central and a necessary feature to be treated in this kind for systems.

3 Methodology

To integrate users' needs and expectations from early robot-system design phases, a User-Centered approach [8] is followed. The process and methods followed in the research study are explained next:

1. *A **study of the main accessibility standards, guidelines and recommendations*** for web sites, web applications and software applications was conducted. None of them can be completely applied to HRI, due to the differences in physical components and application areas between HRI and HCI. But the similarity in displays components of robots and web sites, web applications and software applications allows to integrate them to form a proposal for accessibility guideline in HRI.
2. *A **study of the main interaction characteristics of tactile displays in HRI*** was conducted, based on the literature review and the authors' experience.
3. ***Selection of the accessibility standards and guidelines to compare***. The authors have chosen three of the main accessibility guidelines in HCI: WCAG v2.0, Funka Nu and BBC, to be studied as the basis for the new proposal.
4. ***Analysis of the documentation according to the characteristics of tactile displays in HRI.*** The guidelines requirements were carefully studied to check if they apply or not to tactile displays for HRI.
5. ***Analysis of guidelines' overlapping.*** The intersected requirements were combined.
6. ***Requirements Classification***, based on WCAG v2.0 classification: perception, understanding and interaction.

4 Comparative Study of Main Accessibility Guidelines and Proposal

Implementing accessibility guidelines is a complex task and it may require a set of precise processes. In W3C they standardize the web technology accessibility based on the consensus of the membership, team, and public, and the technical report development process [9]. In this study, a first draft of 51 applicable requirements is proposed, as a first step to get a complete guideline. More details and the whole draft is published in *Malakqbilat.com* web page. It is classified into three categories:

- Perception: related to interface component and appearance, interface structure and assistive technology.
- Understanding: related to errors & help, readability, predictability and design.
- Interaction: Interaction: related to keyboard, time, navigation, interface and conformance.

The three guidelines were compared to each other. The main conclusions are:

- Understanding: BBC guideline does not take into account requirements to meet errors & help and predictability issues, where WCAG v2.0 and Funka Nu have no requirements to meet design issue. WCAG v2.0 and Funka overlap in errors & help, readability and predictability issues, while WCAG v2.0 and BBC overlap in readability issue only.
- Perception: Funka Nu guideline does not take into account requirements to meet assistive technology issue. WCAG v2.0 and BBC do not take into account requirements to meet interface structure issue. WCAG v2.0, Funka and BBC guidelines overlap in interface component and appearance issue.
- Interaction: BBC guideline does not take into account requirements to meet time and conformance issues, WCAG v2.0 has no requirements to meet interface issue, while Funka Nu does not have requirements for conformance issue. WCAG v2.0, Funka and BBC guidelines overlap in navigation issue. WCAG v2.0 and Funka overlap in time issue.

5 Conclusions and Further Research

There are many accessibility guidelines, standards and recommendations which are related to HCI. However, there is no specific one for HRI. This paper proposes a first draft proposal of guideline for tactile displays in HRI. A scientific methodology was followed to conduct a comparative study on WCAG v2.0, Funka Nu and BBC guidelines. Currently, the authors are working on evaluating the proposal by involving real users with functional diversity. CLARC robot [10] is a social robot where it's going to be evaluated.

Acknowledgment. This work has been partially funded by the European Union ECHORD++ project (FP7-ICT-601116) and the CSO2017-86747-R Spanish project.

References

1. What is Human-Computer Interaction (HCI)? https://www.interaction-design.org/literature/topics/human-computer-interaction. Accessed 16 Mar 2018
2. Fong, T., Thorpe, C., Baur, C.: Collaboration, dialogue and human-robot interaction. In: Proceedings of the 10th International Symposium of Robotics Research, Lorne, Victoria, Australia (2010)
3. Checklist for Web Content Accessibility Guidelines 2.0. https://www.w3.org/TR/2006/WD-WCAG20-20060427/appendixB.html. Accessed 24 Mar 2018
4. Future Media Standards & Guidelines - Accessibility Guidelines v2.0. http://www.bbc.co.uk/guidelines/futuremedia/accessibility/html/. Accessed 24 Mar 2018
5. Mobile guidelines. https://www.funka.com/en/our-assignments/research-and-innovation/archive—research-projects/mobile-guidelines/. Accessed 16 Mar 2018
6. Yanco, H.A., Drury, J.: Classifying human-robot interaction: an updated taxonomy. In: 2004 IEEE International Conference on Systems, Man and Cybernetics, vol. 3, pp. 2841–2846. IEEE (2004)
7. Weiss, A., Bernhaupt, R., Lankes, M., Tscheligi, M.: The USUS evaluation framework for human-robot interaction. In: AISB2009: Proceedings of the Symposium on New Frontiers in Human-Robot Interaction, vol. 4, pp. 11–26 (2009)
8. Kim, M., Oh, K., Choi, J., Jung, J., Kim, Y.: User-centered HRI: HRI research methodology for designers. In: Wang, X. (ed.) Mixed Reality and Human-Robot Interaction. ISCA, vol. 1010, pp. 13–33. Springer, Dordrecht (2011). https://doi.org/10.1007/978-94-007-0582-1_2
9. How WAI Develops Accessibility Guidelines through the W3C Process: Milestones and Opportunities to Contribute. Web Accessibility Initiative. W3C. https://www.w3.org/WAI/intro/w3c-process.php. Accessed 23 Mar 2018
10. Ting, K.L.H., Voilmy, D., Iglesias, A., Pulido, J.C., García, J., Romero-Garcés, A., Bandera, J.P., Marfil, R., Dueñas, Á.: Integrating the users in the design of a robot for making Comprehensive Geriatric Assessments (CGA) to elderly people in care centers. In: 2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN), pp. 483–488. IEEE (2017)