

Holistic Approach for Sustainable Adaptable user interfaces for people with Autism Spectrum Disorder

Claudia De Los Rios Perez
Department of Spatial Sciences
Curtin University, Perth, Australia
claudia.delosriosperez@curtin.edu.au

David A. McMeekin
Department of Spatial Sciences
Curtin University, Perth, Australia
d.mcmeekin@curtin.edu.au

Marita Falkmer
Curtin University, Perth, Australia
marita.falkmer@curtin.edu.au

Tele Tan
Department of Mechanical Engineering
Curtin University, Perth, Australia
t.tan@curtin.edu.au

ABSTRACT

Understanding the needs of individuals with Autism Spectrum Disorder (ASD) enables the design of adaptable user interfaces addressing multiple sources of heterogeneity such as personal skills, work environments and context of use given their interaction with system and technology. Applying the human-centered design approach places the needs and limitations at a higher priority, creating a multi-disciplinary analysis to build sustainable adaptable technology solutions, contributing towards a viable world using fewer materials and energy consumption.

Keywords

Sustainable design; Autism Spectrum Disorder; ASD; Web Accessibility Initiative; WAI; User interfaces; UI.

1. INTRODUCTION

Designing technological solutions is getting more challenging; the world resources and energy are limited and at the same time, Information Technology (IT) needs are growing. The focus of the IT industry is to provide solutions for real-world problems. However up until recently little consideration has been given to the obsolete materials, electronic waste and resources using electricity. That is why sustainable design takes into consideration the human's needs and limitations from different perspectives which helps to create a human-centered technology solution [6], not only centered in current user requirements but also those of the next generation [7].

Individuals with Autism Spectrum Disorder (ASD) present a developmental profile that cause impairments of personal, social, academic, and/or occupational functioning [1]. Nevertheless, computer technology has shown significant

benefits supporting these individuals if it is used and developed with appropriate standards and practices [13].

Using a holistic approach, during the modeling of the user with ASD, helps to develop sustainable technology solutions in which several models and standards are used. The standard for Model-Based User Interfaces [25] shows the relevance to addressing multiple sources of heterogeneity when developers design user interfaces addressing challenges such as: users, computing platforms, programming languages, work environments and context of use. The purpose of this model is to identify high-level models to analyze and focus efforts to generate a response according to the specific needs of the user. In the same approach, following good practices and looking to make the Web accessible to people with disabilities, the World Wide Web Consortium created the Web Accessibility Initiative (WAI) [26]; which aims to make the web accessible, independent of hardware, software, language, culture, location, or physical or mental ability.

The use of ontologies and semantic web technologies for user modeling enables the creation of smart interfaces [8; 11; 12] and previous studies have been conducted for people with ASD and related conditions [9; 10; 20]. This research aims to create an ontology-based framework integrating sustainable design principles, user interface semantic technologies for people with ASD and related conditions, the WAI and the Autism ontology [16] to help generate sustainable, adaptable, reliable and efficient user interfaces.

This framework has the ability to address social inclusion, improves the quality of computing interaction for people with different needs in the digital world and helps developers to design user interfaces based on the premise of helping to conserve the planet's limited resources.

2. RELATED WORKS AND FINDINGS

2.1 Initial works

The uses of Computer Assisted Instructions (CAI) and Augmentative Alternative Communication (AAC) help individuals with ASD who may suffer severe speech impairments to communicate their needs [19]. Works related to Computer-Assisted Technologies (CAT) have previously been studied and have been focused on four areas: Remediation of deficits in language skills, enhancement of face processing and

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emotion recognition and comprehension, teaching Theory of Mind (ToM), and teaching of social skills [21]. These are the initial works created to provide user interfaces for individuals with ASD. Recently, the Model-based User Interfaces and the Web Accessibility Initiative have been introduced to emphasize the importance of user-centered design principles.

2.2 Model-based user interfaces and the Web Accessibility Initiative (WAI)

Using the model-based approach to develop user interfaces has proven benefits such as reducing the design time at the same time ensuring system's run-time efficiency [25]. Model-Based User Interface Development (MBUID) is one approach that aims to decrease the effort needed to develop user interfaces while still ensuring quality [25]. The reference widely accepted in the human Computer Interface Engineering community, for structuring and classifying model-based development processes of user interfaces that support multiple contexts of use, is the Cameleon Reference Framework (CRF) which has been used since 2003 [25].

The Web Accessibility Initiative, develops strategies, guidelines, and resources to help make the Web accessible to people with disabilities. It includes all essential components for an adaptable user interface depending on the final users' characteristics.

2.3 Current findings

The research draws attention to the fact that:

- People with ASD and related conditions have special needs when interacting with computers and devices [5; 9; 10; 20-22]. Human communication interfaces have been created to facilitate this interaction but they are not easily adapted for complex and multiple requirements [13; 18].
- The insatiable appetite of digital consumers to want to upgrade their digital devices on a more frequent rate has led to an increase e-waste quantity estimated to be 50 million metric tonnes (Mt) by 2018 [3].
- One of the solutions to reduce e-waste is to increase the durability and retention of devices [4]. This can be achieved by developing user interfaces that are adaptive to the user needs, providing solutions and support to everyday activities with technology designed under principles of sustainability.
- There is a knowledge gap in attempting to integrate ontology and semantic technologies with adaptable user interfaces for people with ASD.

3. APPROACH

The ASD condition has been modeled as an ontology [16], which is the raw material to create the user model for these individuals. By integrating this information, with the WAI, it is possible to create an ontology-based framework that can be used in designing web applications and interfaces adapted to end users with ASD or related conditions.

This technology solution is sustainable because takes into consideration the environmental, societal and economic factors during the design stage. The proposed framework allows the creation of web applications focused on the final user needs and limitations, its context and the target device. Users will not need

multiple devices, providing different services, if only one dispositive is used, it will help user interaction in an efficient manner. It considers the factors for the sustainable development: design, manufacture and energy, recycle, safety, efficiency and social factors, to fulfill the user needs for a living earth with limited resources [7].

The proposed framework reduces the current gap with the integration of the autism ontology with semantic user interfaces, the WAI standards and the sustainable design methodologies. It is an all-inclusive approach shown in Figure 1.

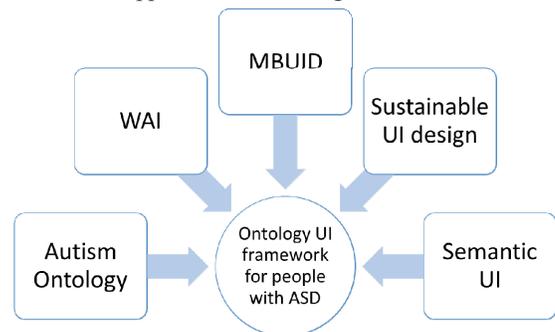


Figure 1. Ontology-based UI framework for people with ASD and related conditions.

4. DISCUSSION

Individuals with ASD have special needs during communication and web interaction. Researches and the IT industry have been working on different approaches to the problem, releasing models, interfaces, and technology to assist these people with special needs, but the efforts have been focused on different kinds of hardware appliances and specific software developments [2; 9; 13-15; 17; 19; 21-24]. The holistic methodology, taking into account sustainable design and applying the human-centered design approach, places the needs and limitations at a higher priority.

The proposed framework benefits the user interaction through an interface adapted and based on their needs, limitations, skills and context because there is no necessity to be surrounded by multiple devices providing different solutions if one device adapted to the user can communicate and interact as needed. As such, an adaptable interface solution is also aligned with the IT industry's obligation to contribute to the sustainable developments and awareness of the efficient use of resources provided to ensure human communication and interaction.

5. CONCLUSIONS

In summary, technology must be created to assist people with any condition and skill level. The holistic approach to designing sustainable adaptable user interfaces, using the Model-Based User Interface Development (MBUID), the WAI and the Autism ontology, can benefit the lives of individuals with ASD and other conditions given that current technologies insufficiently support the day to day activities to gain independence, use public transport, participate in leisure activities, be educated, and to find and keep employment.

Currently, users are increasingly demanding mobile phones, tablets, computers, wearables, storage devices, home appliances and many other smart technologies. It is necessary to create more efficient solutions providing more services through a single device. The quantity of e-waste is rapidly increasing and remediation actions are not taking place at the same velocity

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