Accessibility for Older Users through Adaptive Interfaces: Opportunities, Challenges and Achievements*

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Abstract. It has been widely suggested that accessibility to technology for older people could be improved by the provision of adaptive user interfaces. However there has been little practical work in the area. The MyUI[1] project sets out to explore this area and to build infrastructure and three demonstrator applications based on interactive TV technology. This paper, looking at the project from a Human Factors perspective, explores whether accessibility for older people through dynamically adapting interfaces is a realistic goal, identifies some challenges and research questions, and provides an insight into some achievements and ongoing work in the project.

Keywords: "older people" "adaptive interfaces" "accessibility".

1 Introduction

Systems which adapt their user interface or content dynamically are increasingly deployed for various purposes including personalised learning [1], increasing sales on ecommerce sites [2] and user productivity [3].

For over a decade, researchers have been suggesting that adaptive interfaces could be a promising vehicle to deliver universal accessibility, to open up access to an increasingly digital society to users with physical, sensory or cognitive impairments [4,5,6,7,8].

The need for more accessible technology for work, leisure and health grows ever more urgent. Societies are aging; people are living for longer with age-related impairments; retirement from economic work is being postponed, and more and more services are available only or mainly through technology.

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[1] http://www.myui.eu

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However there appears to be little research into exactly how automatic interface adaptation can support accessibility. The area demands scrutiny as adaptive interfaces and devices are becoming available and technology is increasingly able to detect user characteristics. Recent projects such as MyUI, GUIDE[2] and SUS-IT[3] are now beginning to explore this area.

This paper discusses the work being conducted within the MyUI project, specifically from the Human Factors perspective. The many technical achievements of the project are described elsewhere [23, 24, 25].

2 Aging Societies and Technology

Across the world, societies are aging, and therefore the prevalence of age-related impairments is increasing dramatically. Access to technology for older people can be limited by a range of impairments in the physio-motor, sensory and cognitive domains, and the prevalence and impact of these are well documented [e.g.9, 10, 16].

Some impairments can be mitigated with assistive devices or by other means; e.g. spectacles, brighter lighting, reminders (for prospective memory), but the benefits are limited and the need for more accessible technology remains.

3 An Opportunity for Adaptive Systems

Technology is increasingly necessary to access basic services in an increasingly digital society [17] and also has the potential to deliver services of specific value to older people in their domestic environments.

Technological standards and guidelines concerning general application design for older people and those with disabilities are particularly developed in web accessibility discourse [e.g. 11, 12, 13, 14]. Advances are being made in other areas too, e.g. television [15] .The ISO document "*Ergonomics Data and Guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities*" [16] represents an excellent resource in this important and growing field.

Standards and guidelines of this sort, as well as inclusive design methodologies, have marked important steps towards accessibility. However progress towards universal accessibility has been limited in several respects.

There have been long standing aspirations for "Universal Design", or "Design for All"; products which anyone can use [17]. However for a variety of reasons the notion of a single universal interface seems not to be practical. Several researchers [4, 5, 6, 7, 8] have suggested adaptive interfaces are a plausible solution to the desire for universal accessibility, providing an affordable and effective design-once, adapt-to-all strategy.

Kelly et al conceive three waves of critique which shift the focus of accessibility away from a standards-based universal model, to critical, holistic and ultimately adaptable positions [18]. This review notes that early universal methods of design frequently overlook the importance of context in which technologies are used. Further to this, the authors observe a requirement to recognise the 'idiosyncratic needs and

[2] http://www.guide-project.eu/index.php
[3] http://sus-it.lboro.ac.uk/

preferences of individual users' and to cater for them accordingly. This moves away from a homogenised archetype to an accessibility model more accommodating to diversity. This is important given the contrary requirements for different impairments.

Kelly et al's conception of Adaptability recognises the active role that the user can play in achieving accessibility and designing their own experience [18]. However in some cases, customisation processes pose accessibility problems, so automatic adaptation has an attraction.

Automatic adaptation involves three stages [19]:

- "Afference" - Sensing user behaviours,
- "Inference" - Inferring information about user,
- "Efference" - Presenting the interface in a way customised for that user.

An adaptive system designed specifically to improve accessibility would therefore set out to sense user behaviours which might indicate an ability or impairment or accessibility need, and, from patterns of such observations, make inferences about the user to be stored in a user profile. When interacting with the user, the interaction design would be constructed or modified in real time to optimise accessibility for that specific user. It would need some method of identifying the user, so that the correct user profile is accessed.

The MyUI project sets out to build an infrastructure to support affordable development of accessible adaptive applications, and three demonstrator applications based on interactive TV technology.

4 Technical Challenges

An ideal adaptive system to enhance accessibility would need to instantly and accurately determines a user's accessibility needs and preferences without any overt intervention or obtrusive devices, and adapt immediately to provide an interaction style perfectly suited to that user. This seems an over-optimistic and unrealistic aspiration.

The proposed approach poses several significant questions currently underrepresented in literature:

- What, if any, observable behaviours do older users exhibit when they encounter accessibility problems? Do all relevant impairments result in some observable behaviour? How consistently do they do this?
- What devices can detect and measure such behaviours, and how accurately?
- To what extent will older users tolerate extra devices and/or extra interactions which are intended to measure accessibility needs? Must a system rely purely on invisible ambient detection?
- How accurately is it possible to infer accessibility needs from observed behaviours? And to what extent does this require a number of observations over a timescale? An additional complexity arises from the fact that older people sometimes use assistive devices (such as hearing aids) erratically and inconsistently, creating erratic changes in accessibility needs.
- What features of an interface can be adapted in a way which older users will find acceptable and beneficial? Design standards for older people [e.g. 16] recommend stable, consistent interfaces, rather than changeable ones. Adaptations must be so

designed that the benefits of increased accessibility outweigh the disadvantages of changeability.
- When adapting an interface, to what extent should the user be advised or consulted on the proposed change?
- When a system gathers data about a user's abilities and limitations, what responsibilities does the system have if it discovers information which may indicate a significant medical condition? Do privacy rights prevail?

5 Methodological Challenges

Initiatives to improve accessibility should take an ethical stance on defining, understanding and measuring accessibility [20]. For many older people the affordability of the technology and availability of support may be key issues. An evaluation methodology which ignored such factors would not be ultimately in the user's interests. Users should be fully engaged throughout.

There are also some significant more general challenges, arising from working with older people with such varied abilities and limitations:

- It can be difficult to obtain and retain informed consent from users with possibly poor hearing, poor memories or comprehension difficulties.
- It can be hard for older people to envisage or imagine usability issues and the benefits and shortcomings of unfamiliar technologies. Eliciting requirements and discussing proposed solutions can be difficult unless there is some kind of prototype to provide more concrete experience.
- Older people sometimes have less focus on a task, and are more prone to distractions and digressions. Working with older people, especially in their own homes, can sometimes involve quite a lot of time spent on digressions and "social niceties" [11]. This increases research timescales.
- Bringing older people into a lab situation can be problematical, because of heightened artificiality of the environment, and because of matters relating to the "duty of care". This means results from lab studies may be subject to distortion and have little correspondence to their real lives.

6 Some Achievements within the MyUI Project

A series of Focus Groups with older people were conducted in field locations in the UK and Spain. The groups were stimulated by handing round a number of devices and visual aids, asking questions, mingling and conversing, demonstrating and facilitating group conversations. Researchers used a plenary session at the end to check whether anecdotal observations were common experience or specific to individuals. This process provided a wealth of rich qualitative feedback, rooted in practical experience. The researchers gained an in-depth and ecologically valid understanding of the users, their environments, their objectives, their existing use of relevant technologies and hopes, difficulties, preferences and achievements in their use of technology.

This information was supplemented by a series of interviews with therapists, carers, professionals in care of older people, wardens, Day Centre staff etc. All research was informed by prior literature study.

From this research base, the project produced:

- Personas – archetypal representations of some possible users;
- Scenarios – descriptions of possible situations in which a proposed technology could be used;
- A Requirements document

The Requirements document [21] arose from study of existing literature as well as the research. It catalogued User Characteristics, User Requirements (including Accessibility Requirements), Functional Requirements, Technical Requirements, Developer Requirements and Non-functional Requirements.

There were remarkable contrasts in the lifestyles, abilities, patterns of aging and therefore requirements between users in the UK and Spain [22].

It proved difficult to elicit and verify requirements specifically for adaptation as the older people had little experience of adaptive systems, the devices handed round in Focus Groups had few adaptive features, and it proved difficult to get participants to imagine such systems from verbal descriptions.

A later task involving formative evaluations is in progress. This consists of studies at three levels, as illustrated in Figure 1.

In this pattern, more formal (Level 1) studies of specific human characteristics or components of possible technical solutions precede and inform the design of more complex components. These studies will thus make novel contributions to scientific knowledge. They are more abstract, involve more rigorous controls, tighter participant selection criteria, more specific participant instructions and more objective measurements, and tend to use simpler interfaces to minimise any potentially distracting features.

Higher level studies will use more complex and realistic prototypes, increasing realism and ecological validity but also at the risk of reduced controls and higher potential for participant distraction.

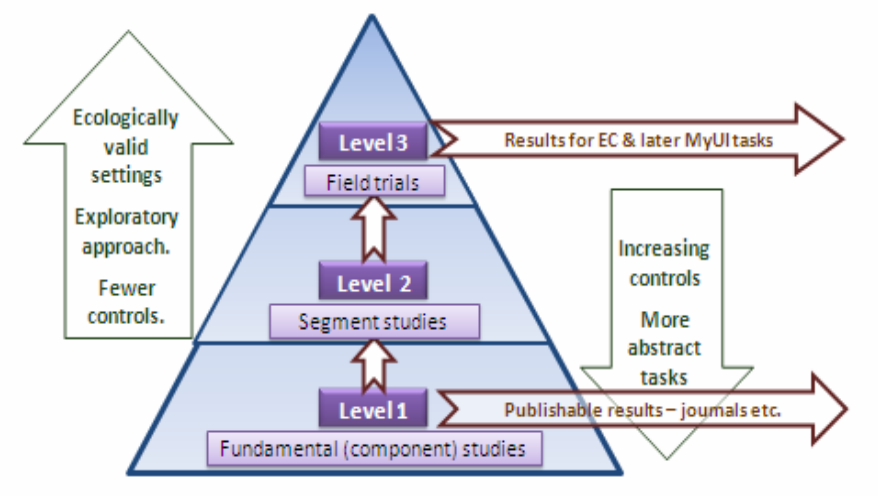

Fig. 1. Study Structure

At Level 3, potential demonstrator products will be tested, and for these purposes, longer term, ecologically valid field-based studies are appropriate.

7 Conclusion

Adaptive user interfaces are widely prescribed as a method to make technology more accessible to older people with age-related impairments. There are, however, a huge number of research questions which need to be addressed in order to make progress in this area. The MyUI project is providing promising insights and progress towards this. We are currently conducting level 1 studies; e.g. to identify what if any observable user behaviours are exhibited when a font size on a display is too small. Further work will conduct higher level studies including eventual evaluations of the MyUI demonstrator applications.

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