Human–Computer Interaction Series

Editors-in-chief
Desney Tan, Microsoft Research, USA
Jean Vanderdonckt, Université Catholique de Louvain, Belgium
HCI is a multidisciplinary field focused on human aspects of the development of computer technology. As computer-based technology becomes increasingly pervasive – not just in developed countries, but worldwide – the need to take a human-centered approach in the design and development of this technology becomes ever more important. For roughly 30 years now, researchers and practitioners in computational and behavioral sciences have worked to identify theory and practice that influences the direction of these technologies, and this diverse work makes up the field of human-computer interaction. Broadly speaking it includes the study of what technology might be able to do for people and how people might interact with the technology. The HCI series publishes books that advance the science and technology of developing systems which are both effective and satisfying for people in a wide variety of contexts. Titles focus on theoretical perspectives (such as formal approaches drawn from a variety of behavioral sciences), practical approaches (such as the techniques for effectively integrating user needs in system development), and social issues (such as the determinants of utility, usability and acceptability).

More information about this series at [http://www.springer.com/series/6033](http://www.springer.com/series/6033)
A Multimodal End-2-End Approach to Accessible Computing

Second Edition
An explosion in the widespread public use of computers and the rapid deployment of digital delivery of entertain- ment means that very few citizens can now avoid having to use a variety of user interfaces in their everyday lives. We might need to access official government information which is only conveniently available via the web or we may wish to select our TV viewing from a myriad choice of programmes and channels and then to choose those programmes which have subtitling or audio description.

Historically, user interfaces (UIs) have typically been designed for an individual product or range of products in apparent isolation. Rarely, it seems, has much consideration been given to the complete system from service design, application and delivery to user interaction and essential real-time help functions including post-installation support. Designers have seldom taken a broad view of “digital literacy” when considering the full range of capabilities of their potential users. Thorough involvement of the entire user community at each stage of product or service development has been the exception rather than the rule. Where UI designers have paid any attention to the particular needs of elderly or users with disabilities, all too often the result has been a bespoke solution specific to one disability alone – an exclusive “ghetto” approach which has inevitably resulted in small markets, high unit costs and very short lifecycles. Alternative simplistic “one-size-fits-all” approaches have generally failed to offer a wholly satisfactory solution for any one user.

One direct consequence is that service users are often faced with an uncoordinated multiplicity of disparate UI styles and thus with a bewildering and dispiriting inconsistency in user experience between different products (even where these offer similar notional functionality). This would be a challenge for anyone but is especially so for older people or those with some functional disability.
In addition to the moral imperative of inclusion and equal opportunity for all, consistent ease of use clearly brings strong commercial benefits for any manufacturer or service provider in terms of wider markets, improved brand reputation and brand loyalty plus a significantly reduced need for post-sales support. The importance of a coherent end-to-end strategy for “accessibility” is now becoming recognised by some individual manufacturers and service providers.

This book brings together research from a number of groups active in this field. It outlines a coherent framework for the design, development and maintenance of accessible interactive intelligent systems and in doing so makes a valuable contribution to our understanding of the wider context of accessibility.

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Nick Tanton
Head of Technology BBC Switchover Help Scheme 2007–2012
The second edition of the book *Multimodal End-to-End Approach to Accessible Computing* further broadens the scope of accessible computing with new chapters from researchers at Nippon Hōsō Kyōkai (Japan Broadcasting Corporation), Auckland University of Technology, New Zealand; Leuphana University, Germany; and Indian Institute of Technology, Madras. The book does not confine accessible computing only to computers and computer peripherals; rather, it presents a wide array of chapters ranging from designing accessible interactive television in China, Japan and Europe to mobile phone-based agriculture advisory system developed for Indian farmers. Authors of this book belong from 13 different countries spread over four different continents.

The new edition has the following 16 chapters divided into three sections:

1. **Design**: This section focuses on user-centred design process and discusses the challenges of meeting requirements of users with a wide range of abilities and a prospective solution through user modelling.

   (a) **Chapter 1 [What Technology Can and Cannot Offer an Ageing Population: Current Situation and Future Approach]** sets the scene up with a case study of an elderly family, points out requirements of inclusive design and advocates for adopting the ‘design for all’ approach.

   (b) **Chapter 2 [Survey on Inclusive Human Machine Interaction Issues in India]** takes forward the discussion of Chap. 1 in Indian context. It compares and contrasts HCI issues for elderly users between developing and developed countries.

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P. Biswas • P. Langdon
Department of Engineering, University of Cambridge, Cambridge, UK

C. Duarte
Department of Informatics, University of Lisbon, Lisboa, Portugal

L. Almeida
Centre of Computer Graphics, University of Minho, Guimarães, Portugal
Chapter 3 [Developing an Interactive TV for the Elderly and Impaired: An Inclusive Design Strategy] examines a user-centred design approach for inclusive populations, where capability ranges are wider and more variable than found in conventional design.

Chapter 4 [Designing TV Interaction for the Elderly – A Case Study of the Design for All Approach] presents a case study of ‘design for all’ approach in the context of developing a multimodal inclusive digital TV framework and lists a set of technical requirements.

Chapter 5 [Inclusive User Modeling and Simulation] presents the concept of user modelling, which formulates the user requirements into a statistical model that can be used to improve interface design and adapt interaction in run time.

2. Development: The development section looks at both research on multimodal systems and accessibility solutions for different platforms like computers, ubiquitous devices and digital televisions.

Chapter 6 [Intelligent Interaction in Accessible Applications] presents assistive devices and interaction systems developed at North Carolina State University. It presents a tactile wearable system that aids people with vision impairment in locating, identifying and acquiring objects and helps them to explore maps and other forms of graphical information.

Chapter 7 [Interaction Techniques for Users with Severe Motor Impairment] extends the discussion at Chap. 5 to more novel interactive sys-
tems involving eye gaze tracker, single-switch scanning system and brain-computer interfaces.

(c) Chapter 8 [Embodied Virtual Agents as a Means to Foster E-Inclusion of Older People] introduces virtual character (commonly known as Avatar) as a means of showing empathy to elderly users and discusses the state of the art of the Avatar technology.

(d) Chapter 9 [Building an Adaptive Multimodal Framework for Resource Constrained Systems] binds the previously discussed interaction technologies together through presenting a system that fuses multiple modalities of interaction and thus provides adaptation capability to nonadaptive systems.

(e) Chapter 10 [A New Agricultural Advisory System-Personalized Interfaces and Interactions] extends the principle of inclusive interfaces to Indian farmers presenting a system for early detection and remedy of diseases in crop.

(f) Chapter 11 [Audio Games: Investigation of the Potential Through Prototype Development] discusses a few prototype games developed in New Zealand for visually impaired users and analysed their acceptance for both visually impaired users and their able-bodied counterpart.

3. Maintenance: Development should always be followed by evaluation and deployment. The last section discusses case studies of evaluating accessible systems and developing international standards to maintain accessible solutions.

(a) Chapter 12 [R&D for Accessible Broadcasting in Japan] discusses various technologies to improve accessibility of broadcasting in Japan and the vision of accessible broadcasting in the future.

(b) Chapter 13 [Evaluating the Accessibility of Adaptive TV Based Web Applications] presents a system to evaluate dynamic web content.

(c) Chapter 14 [Television Accessibility in China] addresses the present status and the strategic options for making television accessible in China.

(d) Chapter 15 [An Interoperable and Inclusive User Modeling Concept for Simulation and Adaptation] extends the concept of user modelling presented in Chap. 4 to develop an international standard on user modelling.

(e) Finally Chap. 16 [Standardization of Audiovisual Media Accessibility] concludes by discussing existing issues in accessibility with respect to different stakeholders and sets up a vision for the near future.

Editorial for the First Edition

Modern research in intelligent interactive systems can offer valuable assistance to elderly and disabled population by helping them to engage more fully with the world. However, many users find it difficult to use existing interaction devices either for physical or ageing-related impairments, though researches on intelligent voice recognition; adaptable pointing, browsing and navigation; and affect and gesture
recognition can hugely benefit them. Additionally, systems and services developed for elderly or disabled people often find useful applications for their able-bodied counterparts. A few examples are mobile amplification control, which was originally developed for people with hearing problems but helpful in noisy environments, audio cassette version of books originally developed for blind people, the standard of subtitling in television for deaf users, and so on. Further, many important technical achievements could not yet be implemented at the industrial level, mostly due to the lack of awareness among industrial developers and missing software and guideline support during design and development. Existing research and development on interactive systems often works for ‘average’ users and excludes a certain portion of the population who finds it difficult to use existing systems and may benefit from intelligent adaptation of the interface. There exists a gap between accessibility practitioners and other computing professionals; they often fail to understand each other and come up with wrong solutions. The lack of knowledge about the problems of disabled and elderly users has often led designers to develop non-inclusive systems. On the other hand, accessibility research often focuses on developing tailor-made products for a certain type of disability and lacks portability across different platforms and users. Existing literature on accessibility consists mainly of guidelines like Web Content Accessibility Guidelines (WCAG) and conference proceedings like ACM ASSETS proceedings, which are useful for a particular audience, but lacks a coherent picture of the challenges and vision for accessibility.

This book takes an end-to-end approach to illustrate the state of the art of technology and sketch a vision for accessibility in the near future by considering challenges faced by accessibility practitioners at research institutes, industries and legislative institutes like international standardization organizations in different parts of the world. The book looks at different phases of delivering accessible products or service starting from design, development, deployment, and maintenance. It leverages the range of abilities of users through intelligent multimodal interfaces and aims to be a handbook for practitioners. It does not go into the details of individual research or work; rather, it provides a context for thoughts and vision for the future.

What This Book Is About

A Handbook for Researchers and Practitioners This book is different than existing conference proceedings and LNCS books on accessibility in terms of a coherent structure. It consists of only 11 chapters written by selected authors from 10 different countries spread over three continents who are working in the field of accessibility for many years. Each section is on a particular theme like design, development, or maintenance. The chapters do not explore too much technical detail and statistical results; instead, they provide an assimilation of individual authors’ work that can be accessible to people with a wide range of backgrounds.
End-to-End Approach  The book contains chapters from researchers, industrial developers and representatives from international standardization institutes. It aims to provide an end-to-end picture in terms of requirement analysis, accessible content development, evaluation and maintenance through regulation and legislation.

Unique Multimodal Approach to Accessibility  Existing research or development on accessibility is often stigmatized as ‘special’ additional features for people with disabilities. Instead, this book leverages the range of abilities of users in different contexts through user modelling and multimodal interaction techniques like gesture-based system, virtual character, brain-computer interfaces or eye gaze tracker-based interaction techniques.
Acknowledgement

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