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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).

Titles published within the Human-Computer Interaction Series are included in Thomson Reuters' Book Citation Index, The DBLP Computer Science Bibliography and The HCI Bibliography.

More information about this series at <http://www.springer.com/series/6033>

Pradipta Biswas

Inclusive Human Machine Interaction for India

A Case Study of Developing Inclusive
Applications for the Indian Population

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Foreword



Having made a mark in providing ICT based-services to significant parts of the developed world, India has begun focusing over the last decade to proliferate usage of ICT in every aspect of life of its citizens. While most of the youngsters readily adapt to the host of electronic devices available today, irrespective of the region and educational background that they come from, this is not true for the elderly population. The aged, in particular, and especially if their educational background is limited, find difficult to master and use different devices readily. Poor-eyesight, stiffness of limbs, inability to move their fingers as rapidly and similar such limits that emerge with age, makes the user-interfaces, available with these

new devices, difficult to use.

This book comes in as timely reminder to limits of technologies and human-machine interface, which have been developed without taking into account needs of this section of population. As discussed in the book, “the diversity of language, culture, and geography” in India, makes it particularly important to address this aspect. The study further points out that the solutions do exist; just that sufficient attention has not been paid to them in India. Further, with their technological abilities, India’s young IT professionals are in advantageous position to address this problem and make design of inclusive human-machine interface as an integral part of all its development work. If they are able to do that, they would not only address this problem for India but “technologies developed for common people of India will find useful applications in other developed countries.”

The book, for the first time, does a systematic study of human-computer interface for the aged population in India in different parts of the country. It has sufficient data for one to begin understanding the problem. In that sense, it will be a useful study for young students and scholars who wish to train themselves in this field or in developing IT solutions for common people of India.

Prof. Ashok Jhunjhunwala

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- Member of Prime Minister's Setup Scientific Advisory Committee

Introduction



Surveys and trials reported in this book were conducted at Mandi, Delhi, Kolkata and Bangalore in India and Cambridge in UK

Mr. and Mrs. Gonsalvez¹ live in Bangalore. Their son works in a multinational company in US. Mr. Gonsalves has retired from a Telecommunication firm and is still very interested and proud about his son’s work and achievement. He is 84, already lost part of vision and hearing, but still reads a lot of magazines and if finds something interesting, he reports it to his son. However, talking to US for long time is pretty costly. So the Gonsalves couple went to a local cyber training school to learn email technology, video conferencing, and Internet browsing. It was a new world for them. Mrs. Gonsalvez also rekindled her old hobby of embroidering by downloading new designs from Internet. But all did not go well. They failed to remember how to use the mouse, how to operate the email client, how to attach photographs, surf Internet, and so on. Presently Mr. Gonsalves does not use computer himself, rather he pastes interesting news clips, their photographs or any other message on a sheet of paper and then takes it to a cyber café. The local computer guy scans it and sends it to his son.

Shrimati (Mrs.) Nilima Devi¹ is 87-year-old and lives in an old-age home at Mandi in Himachal Pradesh. She is well educated in Hindi, still regularly reads

¹ The names are not real but the use cases are true.

holy religious books but cannot read English. She has high-powered glasses and also has slight tremor in hand. However, she has no problem in operating her mobile phone, which does not support local language. She cannot SMS, but apart from that, not only can make and receive calls but also plays her favorite songs by browsing through the menu hierarchy and song list.

Rapid advancement of interactive technologies during the past two decades has made access to information easier for us however at the expense of a clear digital divide. There is a generation who grew up with these technologies while there are a lot of people who still find a lot of modern electronic systems counter intuitive and do not find any use of these in their daily life. This digital divide becomes more prominent in developing countries as state-of-the-art interactive systems were not or even are still not affordable to a lot of users. Differences in lifestyle, culture, and prior experience between people of developed and developing countries also often contribute to this digital divide.

This book presents an end-to-end case study of developing interactive technology for common people of India. India is considered to be a subcontinent offering unity among diversity. The diversity of language, culture, and geography offers a fantastic location for research on human factors. However, leveraging this research to develop practical and useful applications remains a challenge. Countering this challenge may prove to be productive, however, technologies developed for common people of India will find useful applications in other developed countries. The book addresses this challenge in following chapters.

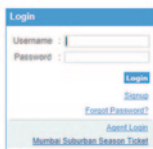
- **User Survey:** This chapter presents results from a user survey conducted in India. It focuses on elderly users and compares it with a similar survey conducted in Europe. The chapter concludes by summarizing a few design guidelines.
- **User Model:** This chapter summarizes the Inclusive User Model that can simulate users' interaction patterns and can adapt interfaces for a wide variety of users and applications. The chapter provides detail on the integration of the model to personalize interfaces for a wide range of applications and user trials to evaluate these adapted applications in Indian context.
- **User Interaction:** This chapter presents detail on novel modalities of interaction like eye-gaze and head tracking interfaces. It discusses detail of a target prediction technology that facilitates human machine interaction using these new modalities of interaction. In particular, it proposes a Neural Network based model that can be used to predict pointing target for both physical and situational impairment. The model takes different trajectory profiles like velocity, acceleration, and bearing of movement as input parameters, and based on that, predicts next pointing target. The chapter reports three user studies—one involving users with physical and age-related impairment using a mouse and the other two involve able-bodied users using head and eye-gaze tracking based systems.
- **New Interfaces:** This chapter proposes a set of new user interfaces to facilitate interaction for applications that are used almost every day by computer-literate people. It presents new graphical user interfaces for electronic shopping, banking, traveling applications, and so on. The user interfaces are especially targeted to people who do not know computers well or have age-related physical or cog-

nitive impairment. The chapter also presents a few user trials those involved an eye-gaze tracker to operate these new interfaces.

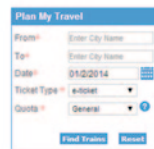
- **Conclusion:** The last chapter summarizes the overall content of the book and discusses about future research scopes for developing world.
- The **Appendix** contains a sample consent form used in the user trial, a sample of NASA TLX score sheet, and description of a user profile format proposed in the book and published by ITU-T.

Aim of the Book

This book primarily focused on researchers, students, and practitioners of India involved in designing electronic user interfaces and web sites. However, discussions on the user modeling web services, eye-gaze tracking system, and user trials should be useful for all interaction designers. For any interface or interaction designer, covering the huge population of India and its inherent diversity is a tremendous challenge. However, a few minor tweaks in interface can often significantly increase the usability of a whole system. For example, let us consider the use case of booking a train using the website of Indian Railway Catering and Tourism Corporation Limited (IRCTC). Indian railway network was the third biggest in world at the time of writing this book (after USA, China, and Russia) and the IRCTC website has undoubtedly made railway reservation easier. Figure 1 below shows three screenshots in the process of booking a train.



Screen 1



Screen 2

| Train No. | Train Name | From | Departure | To | Arrival | Dist.(Km) | Travel Time | M | T | W | T | F | S | S | Class |
|-----------|-------------------|------|-----------|-----|---------|-----------|-------------|---|---|---|---|---|---|-------------|----------|
| 12019 | SATABDI EXPRESS | HSRN | 00:05 | DGR | 07:45 | 158 | 01:43 | Y | Y | Y | Y | Y | Y | Y | EC CC |
| 22387 | BLACHANDRMOHD EXP | HSRN | 00:15 | DGR | 08:54 | 171 | 02:39 | Y | Y | Y | Y | Y | Y | Y | CC 2S |
| 13051 | NDL EXPRESS | HSRN | 00:45 | DGR | 09:45 | 171 | 03:01 | Y | Y | Y | Y | Y | Y | Y | CC |
| 12381 | POORVA EXPRESS | HSRN | 00:15 | DGR | 10:17 | 158 | 02:02 | N | N | Y | N | N | Y | 1A 2A 3A SL | |
| 12365 | HWK DHN D D EXP | HSRN | 00:25 | DGR | 10:45 | 158 | 02:14 | Y | Y | Y | Y | Y | Y | N | CC |
| 13007 | U ABHATOOFAN EXP | HSRN | 00:25 | DGR | 12:33 | 171 | 02:08 | Y | Y | Y | Y | Y | Y | Y | 3A SL |
| 13151 | JAMMU TAWI EXP | KOAA | 11:45 | DGR | 14:25 | 161 | 02:40 | Y | Y | Y | Y | Y | Y | Y | 2A 3A SL |
| 12319 | KOAA AGC EXPRESS | KOAA | 13:10 | DGR | 16:29 | 161 | 02:19 | N | N | Y | N | N | N | N | 2A 3A SL |
| 13105 | SDAH BUI EXPRESS | SDAH | 13:20 | DGR | 16:33 | 178 | 03:13 | Y | Y | Y | Y | Y | Y | Y | 2A 3A SL |
| 13049 | AMRITSAR EXP | HSRN | 13:50 | DGR | 17:17 | 171 | 03:27 | Y | Y | Y | Y | Y | Y | Y | 3A SL |

Screen 3

The first screen is a simple LogIn screen. Interestingly, the second screen has the ‘Reset’ button almost in the same relative position of the ‘LogIn’ button of the first screen, which increases the chance of accidentally clearing the form. The spacing of the ‘FindTrains’ and ‘Reset’ button also contributes to missed selection if the user has tremor in hand or using a small-screen device like a Smartphone or tablet. Finally, the third screen uses small font size, does not offer any explanation of the abbreviations of coach names, (1A, CC etc.) and only the small red script at the top right corner tells how to book a train from the list, which will not only be missed by users with visual impairment but also by non-expert users.

This book starts with a survey highlighting subjective requirements of users. Then it proposes a technology to personalize interfaces which can enhance usability of interfaces like the one discussed above. The book looks forward to new modalities of interaction like eye-gaze and head tracking systems and discusses about their prospect of being incorporated in everyday computing applications. The book also presents details of a lot of user trials and can solely be used as a guideline to design controlled experiments on software applications. The user trials also highlight the gap between designers and users viewpoints and the results can be extrapolated for any application.

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Unique Features of this Book

- **HCI book for India:** A first attempt to address challenges in developing state-of-the-art interactive technology for Indian population.
- **Bridging digital divide involving state-of-the-art technology:** Investigation on using latest interactive devices like eye-gaze tracker or Brain computer interfaces for common users including people with age related or physical impairment for everyday computing like online shopping, banking, and so on.
- **An inclusive end-to-end case study:** A report starting from user survey to user validation for developing personalized applications covers the whole life cycle of developing interactive systems.

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At first, I would like to thank all participants of the survey and trials described in this book. Without their active help and support, this book would not have been possible. I am grateful to all colleagues of IUATC project, especially, the PIs Prof. Gerrard Parr, Prof. Nader Azarmi, and Prof. Ashok Jhunjhunwala. The project was funded by UK EPSRC, BT, and Department of Science and Technology (DST) of Government of India. In particular, special mention is deserved by Dr. Patrick Langdon of University of Cambridge, Ms. Jayalakshmi Umadikar of RTBI, Indian Institute of Technology, Madras, Dr. Sanat Sarangi and Prof. Subrat Kar of Indian Institute of Technology, Delhi, and Prof. Arti Kashyap of Indian Institute of Technology, Mandi, for their active support in conducting the user trials.

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