# Postprint: Overview of Information Accessibility Technologies for People with Disabilities

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## Abstract

The objective of information accessibility technology for people with disabilities is to leverage advanced information technologies and means to eliminate various barriers encountered by individuals with disabilities in information acquisition, utilization, and communication. This paper provides an overview of domestic and international research in the field of information accessibility technology, introduces a selection of representative information accessibility products, and presents an analysis and forecast of current research status, industry conditions, and future development trends.

## Full Text

## Overview of Information Accessibility Technologies for People with Disabilities

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### Abstract

The goal of information accessibility technologies for people with disabilities is to leverage advanced information technologies and methods to eliminate barriers encountered by individuals with disabilities in information acquisition, usage, and communication. This paper provides an overview of research developments in the field of information accessibility both domestically and internationally, introduces a selection of representative information accessibility products, and offers analysis and predictions regarding current research, industry status, and future development trends.

**Keywords:** Information accessibility for people with disabilities; technology-assisted disability support; computer systems for the blind

## 1 Introduction

There is currently no unified definition of what constitutes information accessibility technology for people with disabilities. Generally, it refers to the use of advanced information technologies and methods to eliminate various barriers that people with disabilities encounter in information acquisition, usage, and communication, enabling them to live without obstacles in the information society just like anyone else.

Compared with the general population, people with disabilities face two major challenges. On one hand, physical impairments create various difficulties in daily life, learning, and work. On the other hand, they encounter problems adapting to the contemporary information society: as information technology develops and informatization levels continue to rise, IT has become widely applied in people's work, learning, and daily lives. However, nearly all information products and services, particularly human-computer interaction methods, are designed for the general population without considering the application needs of people with disabilities. This prevents them from enjoying the conveniences brought by information technology like ordinary people and places them at risk of marginalization in social life. According to statistics from the China Disabled Persons' Federation, China has approximately 80 million people with disabilities, including over 20 million with hearing and speech impairments, about 12.33 million with visual impairments, more than 5 million with intellectual disabilities, over 25 million with physical disabilities, more than 6 million with mental disabilities, and approximately 13.52 million with multiple disabilities. Without effective measures, the ability of this vast population of people with disabilities to survive and develop in the information society will be further constrained, preventing them from truly integrating into modern information society. Clearly, the effective solution to this problem lies in adopting technological means that accommodate the usage habits of people with disabilities and fundamentally eliminating information access barriers caused by their disabilities.

Information accessibility for people with disabilities has received high-level attention from international organizations, governments, relevant institutions, and manufacturers worldwide. In 2002, the United Nations adopted the "Biwako Millennium Framework for Action," which explicitly called for prioritizing the development of information accessibility and using modern information technology to address the difficulties faced by people with disabilities, enabling them to keep pace with global information development. The Chinese government has attached great importance to this issue. The China Disabled Persons' Federation and the former Ministry of Information Industry jointly established the China Information Accessibility Forum, which has been successfully held four times since 2004. Also starting in 2004, the China Disabled Persons' Welfare Foundation launched the "100,000 Blind People Learning Computers" campaign, with over 20,000 individuals receiving computer training. At the end of 2006, the China Disabled Persons' Federation launched a Braille version of its website, greatly facilitating blind people' s access to information via the Internet.

By the end of 2007, the China Disabled Persons' Foundation funded pilot programs in select cities to establish telephone relay service platforms for people with disabilities, equipped with dedicated personnel and equipment to provide communication between deaf and deaf, deaf and hearing, and deaf and blind individuals.

To provide the technical foundation for information accessibility for people with disabilities, the Chinese Academy of Sciences and the China Disabled Persons' Federation jointly organized the "Technology Assistance for People with Disabilities Program" to support relevant research and applications at CAS institutes. The Ministry of Science and Technology established the key project "Key Technology Support System and Demonstration Application for Information Accessibility for People with Disabilities in China" under the "Eleventh Five-Year" Science and Technology Support Program. China' s first information accessibility standard, "Technical Requirements for Accessible Web Design" (YD/T 1761-2008), was also promulgated in 2008.

## 2.1 International Research and Application Overview

International research and application in information accessibility for people with disabilities began relatively early. In addition to specialized research institutions and manufacturers, renowned IT companies such as IBM and Microsoft have conducted extensive research and development in this area.

IBM [1] established the world' s first Global Accessibility Center and developed a large number of assistive products. Early products included voice typewriters and Braille printers, while current products focus primarily on Internet applications. Notable offerings include Home Page Reader [3], Easy Web Browsing [4, 5], and aDesigner. These products include systems that enable users to access the Internet using a numeric keypad through IBM' s home page browser, systems that convert text and images from the Internet and other network resources into speech, voice display systems to help deaf and mute individuals practice vocalization, and learning systems for various types of disabilities. For example, Easy Web Browsing targets users with visual impairments: when a user hovers the mouse over a location on the screen, Easy Web Browsing magnifies that portion of the webpage locally while simultaneously describing the magnified information to the user through speech, as shown in Figure 1

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Microsoft' s research in information accessibility focuses on Assistive Technology/Information Technology (AT/IT), including hardware devices (accessible mice, keyboards) and software (accessible operating systems and assistive tools). Early Windows 3.0 provided specialized accessibility features for people with disabilities, while the current Windows Vista system includes capabilities for individuals with visual, auditory, and arm disabilities to use computers. The core technologies include speech recognition, web access, and screen magnification. The speech recognition function enables system commands and text input, while

Figure 1: Figure 1

the Web Access Center can achieve local text magnification from 2x to 16x. Additionally, Microsoft initiated the creation of the Accessibility Interoperability Alliance.

The University of Manchester Institute of Science and Technology (UMIST) developed the WebbIE [6] system, whose main function is to transform complex webpages into simple pages containing only sequentially arranged text, enabling users to browse with screen reading software.

The well-known HearSay project [7-9], funded by the U.S. National Science Foundation and undertaken by Stony Brook University (SUNY) in collaboration with the Helen Keller School for the Blind, developed an open-source, cross-platform non-visual web browser client. A beta version was released in December 2007. The system uses VoiceXML language to handle user-system interaction, allowing users to control the browsing process through voice commands and shortcut keys, greatly facilitating use by blind and visually impaired individuals.

Freedom Scientific, a U.S. technology company renowned for developing software specifically designed for blind people, has developed the world' s first handheld computer for the blind, PACMate [10]. PACMate runs Microsoft' s Pocket PC operating system and features either an 8-button Braille keyboard or a standard traditional keyboard, allowing users to run all Windows programs. PACMate also includes Freedom Scientific' s popular screen reading software JAWS [2], which can fluently read aloud all text appearing on the screen in English.

Hitachi' s Zoom Sight [11] is another assistive tool for people with visual impairments. It can change page size, color, background, and angle according to user needs, and can also read webpage and document content through speech synthesis. Additionally, Hitachi has implemented a bidirectional conversion system from Japanese to Japanese Sign Language. This system can convert Japanese gestures into Japanese speech and vice versa, and has been applied to an automatic ticket vending and inquiry system.

## 2.2 Domestic Research and Application Overview

Several institutions and individuals in China have conducted research on information accessibility for people with disabilities. Early research achievements were primarily PC-based with a focus on software implementation, though some hardware products have also emerged.

Tsinghua University is one of the earliest institutions in China to conduct research and product development in information accessibility for people with disabilities. Its representative achievement is a comprehensive application system for blind users that integrates keyboard Chinese input, text editing, speech output, and printing operations [12]. Since the 1990s, the system has evolved from a DOS version to a Windows version and now includes a browser for blind users, enabling them to access and search for various information online. Additionally, Tsinghua University has developed a Braille display device.

The China Braille Press and Huajian Group jointly developed the "Sunshine" Braille system, which is Windows-based and consists of ten modules: Chinese and English speech server software, screen reading software, a universal Braille-Chinese input method, a speech browser, voice email management software, a pronunciation dictionary, computer system detection and boot guidance configuration tools, voice network file download software, reading software for blind people, and professional Braille editing and publishing software. Additionally, the China Braille Press has developed the "Reading Companion" handheld e-book for blind users.

Wang Yongde, a blind individual, has made dedicated efforts in developing software for blind users and achieved notable results. His representative product is the Yongde Screen Reader, which enables blind people to independently perform various routine operations on the Windows platform, as well as participate in online chats, browse webpages, and enjoy music.

The Institute of Computing Technology of the Chinese Academy of Sciences began relevant technical research in the early 1990s and has made significant progress in sign language synthesis and gesture/sign language recognition. Its "Chinese Sign Language Synthesis System"has been successfully applied to teaching in schools for the deaf through donation, while also developing a TV sign language production system for broadcast programs and an Olympic sign language online teaching system for learning sign language vocabulary. In recent years, the institute has also conducted research on Braille input, non-visual browsers, and computers for blind people.

In addition, domestic institutions such as Tongji University, Zhejiang University, Beijing Shensuofeng, and Harbin Yishidai have also conducted relevant research. Telecommunication operators such as China Telecom and China Netcom have launched specialized information services for people with disabilities.

## 3 Other Representative Products

In addition to the research developments described above, domestic and international manufacturers and research institutions have developed a series of information accessibility products tailored to the characteristics of people with disabilities. The following introduces some of the more representative products (including concept products).

### 3.1 Products for Physical Disabilities

**"Head-Controlled" Mouse Smart-Nav [13]** Smart-Nav is designed for individuals with upper limb disabilities and consists of a camera with supporting software and hardware. Its usage is shown in Figure 2

. During use, the camera is positioned facing the user, and a sensor point is attached to the user' s glabella. The camera continuously tracks the position of this sensor point and maps it to the computer screen, thereby achieving "head-controlled"mouse pointer movement. For left and right button clicks, a matching foot pedal can be used. Additionally, Smart-Nav features a dwell-click function, which simulates a mouse click when the cursor remains in one position for a certain period.

### 3.2 Products for Hearing Disabilities

**Radio with Subtitles** The new type of radio with a screen shown in Figure 3

was jointly developed by the U.S. National Public Radio, Harris Corporation, and Towson University. Listeners can see the textual information from the broadcast in real-time on the screen. Due to the use of speech recognition technology for real-time processing, the technical difficulty is significant, and currently this radio remains only a concept prototype.

### 3.3 Products for Visual Disabilities

**Braille Display (Tactile Screen)** Devices for blind people to read by touch are called Braille displays (abbreviated as Braille screens) or tactile screens. When such a tactile screen is connected to a computer, users can freely read text from the computer. Figure 4 [FIGURE:4] shows one such Braille display. In addition to 40 Braille cells, the display panel includes four directional keys for navigating the text being read up, down, left, and right, enabling the device to display moving up one line, down one line, left one screen, or right one screen of the document. The operation is simple and efficient. The Braille display is used with a complete set of software, including not only the Braille display driver but also necessary speech software and Chinese input software, such as speech servers, Chinese input systems, Braille editors, and browsers for blind users.

**VirTouch Mouse for the Blind** Figure 5 [FIGURE:5] shows a Braille mouse developed by an Israeli high-tech company called the VirTouch System (VTS)

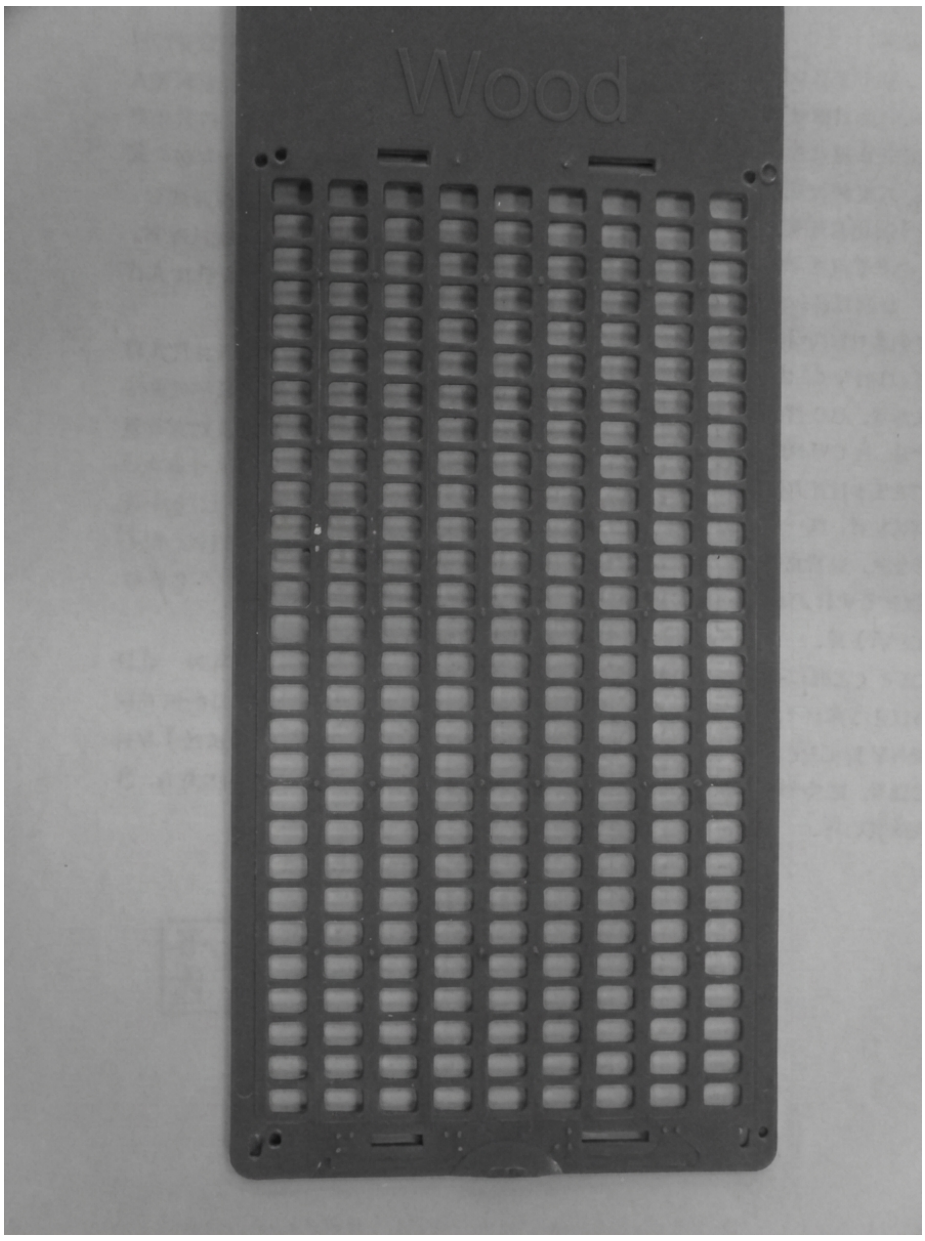


Figure 2: Figure 2

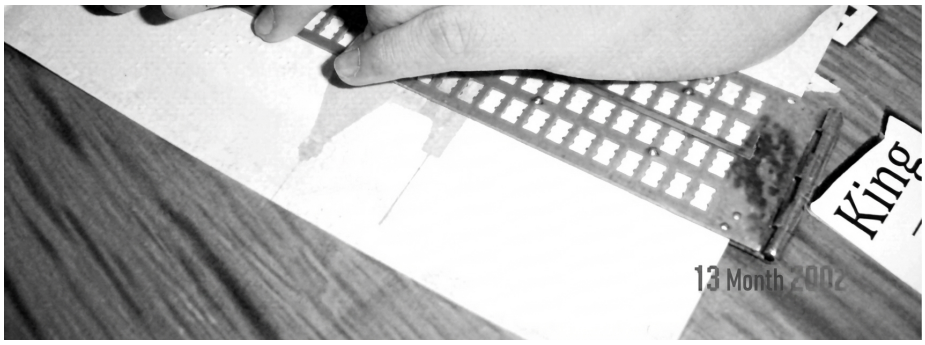


Figure 3: Figure 3

[14]. With this mouse, blind people can "see" computer screen content through touch and perform various operations.

**Portable Computer for the Blind** Figure 6 [FIGURE:6] shows two portable computer systems designed specifically for blind individuals. The left system is based on the Windows CE operating system, supports Bluetooth, WiFi, Ethernet, and USB interfaces, has no LCD display, but includes a built-in 18-cell pin display for blind recognition and eight specially designed buttons for input. The right system is a portable computer with telephone functions, using the Windows CE .NET operating system. This product features tri-band GSM mobile phone functionality and wireless Internet access.

**Samsung Braille Mobile Phone** Figure 7 [FIGURE:7] shows a concept product developed by Samsung. Through a special Braille keyboard and a display that can show Braille, blind people can send and receive text messages on mobile phones. This design won the gold award for the Industrial Design Excellence Award (IDEA), co-founded by the Industrial Designers Society of America and *Business Week* magazine.

### 3.4 Products and Services for Multiple Disabilities

**VisiSpeechClass Software [15]** This software is primarily used for speech training for deaf people. Its main purpose is to provide visual aids for speech training and learning while conducting speech analysis. The software' s key feature is providing reference and training windows that simultaneously display graphical and numerical results of various analyses for both reference speech and training speech. The former serves as standard speech for reference, while the latter is the learner' s own pronunciation. Comparing the two can precisely identify problems in the learner' s pronunciation, effectively helping to learn and correct erroneous pronunciation and achieving "learning speech through visual feedback."

**Vodafone Accessibility Devices and Services** The mobile communications

giant Vodafone offers special services for special groups including the elderly, children, deaf people, and blind people. For blind and visually impaired individuals, there is the "Vodafone Speaking" service, which provides voice prompts to help blind people use their mobile phones for calls by installing specialized screen reading software on ordinary mobile phones. Additionally, Vodafone has launched specialized services for deaf people in some countries: at Vodafone' s 24-hour customer service center, a dedicated team provides services for deaf people. These users can send text messages to this team to receive careful answers and assistance, making it convenient for them to check bills and learn about new services and products.

## 4 Conclusion

Although information accessibility has received some attention in China and certain achievements have been made, there remains a significant gap from the actual needs of people with disabilities, and much work remains to be done. These efforts can be summarized in two main aspects: equipment and services.

In terms of equipment, the first priority is achieving accessibility based on universal platforms. The advantage of information accessibility systems based on universal platforms is their rich resource environment, short development cycle, and ability to accommodate both people with disabilities and ordinary users. The disadvantage is that they are based on graphical user interfaces, which do not conform to the characteristics and usage habits of people with disabilities. Therefore, fully utilizing the advantages of universal platforms while further improving and enhancing the usability of accessibility systems remains one of the future development directions. The second priority is developing dedicated systems for people with disabilities that fully consider their characteristics and create convenient, applicable, and reasonably priced specialized systems—this is also a key development focus. Additionally, developing specialized peripheral devices and products for people with disabilities is another noteworthy direction.

In terms of services, comprehensive utilization of Internet, mobile phone, location positioning, and other technologies and platforms will provide information accessibility services for various types of people with disabilities.

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