Iconic Interfaces for Assistive Communication[1]

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INTRODUCTION

A significant fraction of our society suffers from different types of physical and cognitive challenges. The seriousness of the problem can be gauged from the fact that approximately 54 million Americans are classified as disabled (Ross, 2001). In addition, approximately 7% of all school-age children experience moderate to severe difficulties in the comprehension and production of language due to cognitive, emotional, neurological, or social impairments (Evans, 2001). The problems faced by this community are diverse and might not be comprehended by their able-bodied counterparts. These people can become productive and independent, if aids and devices that facilitate mobility, communication, and activities of daily living can be designed.

Researchers in the human-computer interaction and rehabilitation engineering communities have made significant contributions in alleviating the problems of the physically challenged. The technology, that assists the physically challenged to lead a normal life is termed *assistive technology*. This article dwells on different aspects of assistive technology that have found application in real life.

One of the important approaches to assistive technology is the use of iconic environments that have proved their efficacy in dealing with some of the communication problems of the physically challenged. The second part of the article discusses the issues and methods of applying iconic interfaces to assist the communication needs of the physically challenged.

BACKGROUND

The problems faced by the disabled section of our society are huge and of a diverse nature. Disabilities can be classified into physical or cognitive disabilities. Physical disabilities like restricted mobility and loss of hearing, speaking, or visual acuity severely affect the normal life of some people. People suffering from such handicaps need the help of an assistant to help them to perform their routine activities and to use standard appliances.

The case of cognitively challenged people is even more serious. Their difficulties can range from deficits in vocabulary and word-finding to impairments in morphology, phonology, syntax, pragmatics, and memory (Evans, 2001). Persons suffering from autism show delay in language development; complete absence of spoken language; stereotyped, idiosyncratic, or repetitive use of language; or an inability to sustain a conversation with others. The problems faced by a dyslexic person can range from disabilities affecting spelling, number and letter recognition, punctuation problems, letter reversals, word recognition, and fixation problems (Gregor et al., 2000). Brain impairments can lead to learning, attention span, problem-solving, and language disorders (Rizzo et al., 2004).

Difficulties in using a standard computer stem from problems like finding command button prompts, operating a mouse, operating word processing, and finding prompts and information in complex displays. The complexity of a GUI display and the desktop metaphor creates severe problems (Poll et al., 1995). In the case of motor-impaired subjects, the rate of input is often noisy and extremely slow.

To solve these problems, which are inherently multi-disciplinary and non-trivial, researchers from different branches have come together and integrated their efforts. Assistive technology, therefore, is a multidisciplinary field and has integrated researchers from seemingly disparate interests like neuroscience, physiology, psychology, engineering, computer science, rehabilitation, and other technical and health-care disciplines. It aims at reaching an optimum mental, physical, and/or functional level (United Nations 1983). In the following, we look at the methodology adopted in this field in order to solve the aforementioned problems.

AN OVERVIEW OF ASSISTIVE DEVICES

Solving the whole gamut of problems faced by this community requires the construction of what are called *smart houses*. Smart houses are used by old people and people with disabilities. An extensive review of the issues concerning smart houses appears in Stefanov, et al. (2004). Broadly speaking, these houses contain a group of equipment that caters to the different needs of the inhabitants. The technology installed in these homes should be able to adapt to each person's needs and habits.

However, the construction of this technology is not a simple task. Assistive and Augmentative Communication (AAC) aims to use computers to simplify and quicken the means of interaction between the disabled community and their able-bodied counterparts. The tasks of AAC, therefore, can be seen as facilitating the interaction with the world and the use of computers. Interaction with the world is facilitated by one of the following methods:

- Design of robotic systems for assistance.
- Design of systems that help in indoor navigation, such as smart wheelchairs.
- Devices that convert normal speech to alphabetic or sign language (Waldron et al., 1995).
- Devices that convert sign language gestures into voice-synthesized speech, computer text, or electronic signals.
- Design of special software-like screen readers and text-to-speech systems for the blind population (Burger, 1994).

For physically disabled people, researchers have designed motorized wheelchairs that are capable of traversing uneven terrains and circumventing obstacles (Wellman et al., 1995). Robots have been used to assist users with their mundane tasks. Studies have shown that task priorities of users demand a mobile device capable of working in diverse and unfamiliar environments (Stanger et al., 1994). Smart wheelchairs solve some of these requirements. They are capable of avoiding obstacles and can operate in multiple modes, which can be identified as following a particular strategy of navigation (Levine et al., 1999).

The problem is quite different in the case of the visually disabled population. Visual data are rich and easily interpreted. Therefore, to encode visual data to any other form is not trivial. Haptic interface technology seeks to fill this gap by making digital information tangible. However, haptic interfaces are not as rich as visual interfaces in dissemination of information. To make these haptic environments richer and, hence, more useful, methods like speech output, friction, and texture have been added to highlight different variations in data, such as color (Fritz et al., 1999). Braille was devised in order for blind people to read and write words. Letters can be represented through tactile menus, auditory patterns, and speech in order to identify them.

As far as assistance for navigation in physical terrains is considered, visually impaired people can use dogs and canes to prevent obstacles. However, it is clear that these options are limited in many senses. For example, these might not help these people in avoiding higher obstacles like tree branches. In Voth (2004), the author explains the working of a low-cost, wearable vision aid that alerts its user of stationary objects. The technology is based on the observation that objects in the foreground reflect more light than those that are not. The luminance of different objects is tracked over several frames, and the relative luminance is compared in order to identify objects that are coming closer. The software informs the user when the object comes too close (i.e., at an arm's length), and a warning icon is displayed onto a mirror in front of the eyes of the user.

To help these people to use computers more effectively, three of the following types of problems must be handled:

- It should be noted that this population might be unable to provide input in the required form. This inability becomes critical when physical or cognitive challenges seriously inhibit the movement of limbs. This entails the design of special-purpose access mechanisms for such

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