Chapter 14
Sensors in Assistive Technology

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ABSTRACT

This chapter reports on the development of an eyeglass-type infrared-controlled computer interface for the disabled. This system may serve to assist those who suffer from spinal cord injuries or other handicaps to operate a computer. This system is comprised of three major components: (A) an infrared transmitting module; (B) an infrared receiving / signal-processing module; and (C) a main controller, the Intel-8951 microprocessor. The infrared transmitting module utilizes tongue-touch circuitry which is converted to an infrared beam and a low power laser (<0.1mW) beam. The infrared receiving / signal-processing module, receives the infrared beam and fine tunes the unstable infrared beam into standard pulses which are used as control signals. The main controller is responsible for detecting the input signals from the infrared receiving / signal-processing module and verifying these signals with the mapping table in its memory. After the signal is verified, it is released to control the keys of the computer keyboard and mouse interface. This design concept was mainly based on the idea that the use of an infrared remote module fastened to the eyeglasses could allow the convenient control of the input motion on the keys of a computer keyboard and mouse which are all modified with infrared receiving / signal-processing modules. The system is designed for individuals with spinal cord injuries and disabled in which the subjects' movement are severely restricted. The infrared transmitting module can be easily mounted on eyeglasses or artificial limbs.

DOI: 10.4018/978-1-60566-206-0.ch014

INTRODUCTION

The infrared-controlled human-computer interface utilizes a small infrared- transmitting module mounted on the user`s eyeglasses, and a tongue-touch panel on the input headset was developed and designed for this system. The user utilizes the tip of the tongue to gently touch the panel which is attached to one side of the mouth in order to turn the power switch of the infrared transmitting module on or off. The infrared transmitting module generates an infrared beam and a low power laser beam. The infrared beam is used for selecting the keys from a keyboard, while the laser beam allows the user to see which keys are selected. All the keys of the computer keyboard have been replaced with infrared receiving / signal-processing modules. By aiming the laser beam at the desired number, letter, or function key, the user can select the key. After verification for error, a main controller, the Intel-8951 microprocessor, carries out the signal reception processing and input functions. The microprocessor is also responsible for controlling the computer keyboard interface and providing feedback to the user that the input motion has been completed.

BACKGROUND

Patients with spinal cord injuries (SCI) and persons with disabilities involving paralysis increasingly utilize electronic assistance devices to improve their ability to perform certain essential functions. The functional areas in which the disabled most commonly utilize electronic equipment are: communications, environmental control and powered wheelchairs. A wide range of interfaces between the user and the device are available. The interface may be an enlarged keyboard or a complex system that allows the user to operate or control a function with the aid of a mouthstick, eye movements, an eye imaged input system and electroencephalogram (EEG) signals (Peizer et al. 1982; Vasa, 1982; Perkins et al. 1986; Ranu, 1986; Andrews et al. 1980; Kilgallon et al. 1987; Lacourse et al. 1990; Keirn et al. 1990) etc.. In many disabilities such as quadriplegia, the mouthstick method has poor accuracy and is uncomfortable. The eye movement and EEG methods provide few available controlled movements, can have slow response time for signal processing and requires substantial motor coordination. However, these instruments all tend to be highly specialized and are generally cost prohibitive. Thus, alternative systems which utilize commercially available electronics to assist in the performance of special tasks such as computer operation and environmental control are sorely needed.

The ability to operate a computer is becoming increasingly more important to the disabled persons and to those with SCI as advances in technology allow more and more functions to be computer controlled. There are many reasons for operating a computer. These include acquiring new knowledge and communicating with the outside world. However, they also include doing work at home, leisure activities, and many other things. This paper reports on the design of an infrared-controlled (Chen et al. 1999; Chen et al. 1999) human-computer interface for patients who are paralyzed from a cervical cord injury with quadriplegia but retain the ability to rotate the neck and perform shrugging movements.

INFRARED IN COMPUTER ACCESS

The configuration of the infrared-controlled computer interface is shown in Figure 1. This system replaces the keys of the original computer keyboard with infrared receivers and mounts an infrared transmitting module onto the eyeglasses of the disabled user. The user employs neck rotation movement to aim the infrared beam at the key of the computer keyboard in order to input data and perform all computer functions. The computer keyboard was divided into three parts: two