Computer Aided Rehabilitation for the Handicapped

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ABSTRACT

Miniaturization in electronics and unlimited flexibility of computers has helped in providing a comprehensive support to the disabled for their independent living. Earlier difficulties in drawing hardware specifications encountered due to individual variations, anthropometric dimensions, local diverse conditions and the desirable response have now been overcome. In this paper an integrated approach to develop an rehabilitative technological aid is suggested. A five linkage model proposed takes into account the user: transducer; microelectronics; interface for the computer and the actuator that triggers the user response to the input. Use of alternate modalities provide for the desired sophistication at affordable cost that can be implemented in developing countries. Three representative examples to depict the role of computer and electronics in rehabilitation engineering that are in use have been presented.

Keywords: Computer, Electronics, Spastics, Communication Aid, Blind

INTRODUCTION

Over the past two decades a major advance in the rehabilitation engineering has come about due to miniaturization of electronics and the introduction of computers. Development of an electronics based aids for the handicapped is possible. What is required is to identify the user need, individual residual ability, general and individual specifications and then design the transducer to convert the input to electrical signal. Desired features of the signal are then processed and fed directly to the actuators or through the computer interface to the user. Control of the input parameters and the functions must preferably be with the user. Implementation of the user feedback into the system is essential before inducting the device for mass scale use. The illustrative examples of the developments are microprocessor based communication system for nonverbal spastics, graphic dynamic biofeedback speech trainer and the teaching aid for the blind.

MICROPROCESSOR BASED COMMUNICATION SYSTEM FOR SPASTIC CHILDREN

Cerebral palsy among children is prevalent largely in south Asia. Children suffering from this disease have normal mental abilities but their motor control is severely affected. In most cases it results into serious problem in oral communication leading to frustration amongst them. Earlier attempts were made to use electronic preprogrammed memory devices to aid the fixed format output. These devices have two major lacunae; firstly, the user is expected to remember over three hundred messages or their codes; secondly, the cost is beyond the reach of most users. A small typewriter could be an alternate tool but only a few spastics who have reasonable residual control can operate the full keyboard. The computer keyboard has been replaced by an analog interface and a spastic can address the personal computer through this interface. This interface is controlled by the residual activity of spastic child such as touching a few plates, blowing in/out or even using eye movement. With the help of a software program BLISS SYMBOLS have been incorporated along with the characters and the numerals, such that modes of communication can be rapidly implemented. The Symbols and the characters are first selected for display on the screen and printed. Presently the system incorporates only the Bliss Symbols but messages can be customer built. A portable system is being developed which will be carried by the user for communications at public places. Such a system not only aids the communication but also will give job opportunity for mentally able spastic children on software programming. The new system is of value as a teaching aid as well as in daily living and helps to bring the spastics into the mainstream of life.

GRAPHIC DYNAMIC BIOFEEDBACK SPEECH TRAINER

Now the speed and computational power of the personal computers (PC) has been used in an innovative way to overcome the problems of earlier systems clinically used for correction of speech defects. Audio signal processing have
been incorporated. The trainer has to voice the vocabulary list into the system and the electrical signal is stored in the memory. The handicapped subject is provided with the microphone. Speech trainee is asked to voice any word from the vocabulary through the microphone. The electrical analog of the signal is then displayed on the screen along with that of the trainer. Trainee is given a visual, auditory, tactile, error feedback from the PC based system. Visual display of the lip movement and the relative movement of the teeth and the tongue appears on the screen along with the word being voiced. Auditory signal is displayed in the form of the electrical waveform on the monitor screen along with the speaker output through the headphones form the auditory feedback to the subject being trained. To further enhance the training auditory output is converted to the tactile form and placed under the trainee's hand. For information regarding the cumulative error between trainer and the trainee's response is calculated and displayed on the screen. The algorithms for generating the error signal is kept flexible depending upon the individual student and the experience of the trainee with the system. Software and the hardware for all the possible feedback mechanisms have been worked and implemented. Such a closed loop control for the training can be used for all types of speech handicap.

**COMPUTER TECHNOLOGY INTERFACE FOR PRESENTATION OF MAPS TO THE BUND**

A computer based system had been developed earlier by the investigators to communicate diagrams and text to the blind in the class room (1). The system was based upon a single computer placed on the teaching desk and only monitors on student desks. Access to the information displayed on the monitors was obtained by means of an optoelectronic sensor and vibrotactile output. Two versions of the sensor had been made, one for sensing line diagrams and the other for Braille text. The innovation now adopted brings in the capability of the computer along with the digitizer to present complicated physical, political or mobility maps to the blind students. Maps are placed on a digitizer plate illuminated from the bottom and traced by the 'Mouse'. Coordinates of the digitized boundaries upto an accuracy of 0.001 mm are stored as digital values to be retrieved as a reconstructed map on the computer screen. A modified version of the vibrotactile stimulator used for tracing line drawings is moved over the screen to study the map outlines. Different shades of gray are perceived as changes in frequency of vibration. Through proper training, the blind students can distinguish at least seven different vibration frequency. For improved perception the map boundaries are drawn by adjoining black and white lines. This gives a 100% discrimination of the boundaries. When a small portion of the map is to be presented in detail, that section is enlarged by computer software to a user selectable magnification and displayed on the monitor screen. Thus the maps fed into the computer once can be modified retrieved and updated by simple software techniques. An added advantage of the system is its low cost and convenience to use. Efforts are underway to provide a hard copy of the map on the plastic sheet. The system is being tried at one of the Blind Schools in Delhi.

**CONCLUSION**

Thus it has been demonstrated that in India a beginning has been made in developing aids for the handicapped which have a potential market. The sophistication in the device has been achieved using an optimal approach in a cost effective manner to suit the economy as well. Research is underway to design an alternate to extracochlear prosthesis as well as a toe controlled artificial arm for below elbow amputee.

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**REFERENCES**