HUM-POWER CONTROLLER FOR POWERED WHEELCHAIRS

Master's Thesis Defense
By
Hossein Ghaffari Nik

Thesis Director:
Dr. Nathalia Peixoto

Committee Members:
Dr. Gerald Cook
Dr. Janos Gertler

July 30, 2009 at 1:00 pm
New Engineering Building, Room 3202

The objective of this work is to create a control mechanism for smooth operation of powered wheelchairs through speech recognition and humming detection. Users of wheelchairs are estimated to be about 200 million people worldwide. In the U.S.A., roughly 11000 people are affected by spinal cord injury every year, with 47 percent of those accidents leading to quadriplegia. The technology developed in the last ten years for assistive technology will significantly impact and improve the life of wheelchair users. While current powered wheelchairs, originally designed to facilitate maneuvering through indoor and outdoor areas, have helped millions of people with their handicap, many of these users state that power chairs do not entirely fulfill their needs.

The main shortcoming we detected was the lack of smooth control in speed and direction of movement due to patients' physical limitations. To resolve this deficiency we designed, developed, and tested a new control unit that interfaces with commercially available wheelchairs. Our controller utilizes speech recognition technology and facilitates hands free operation of power chairs by all users through simple voice commands. Digital signal processing is also implemented to tackle smooth control limitations. Our controller allows the user to smoothly change the speed of the chair using the frequency of their humming which is captured via an accelerometer attached to their neck. Our controller enables complete hands free smooth control of the powered wheelchairs for all users and especially for those who cannot use conventional controllers.

We currently use two digital signal processors from Microchip™ (dsPIC30F6014/A) mounted on a custom designed printed circuit board to perform smooth humming control and speech recognition. One DSP is dedicated to speech recognition and implements Hidden Markov Models using dsPIC30F Speech Recognition Library developed by Microchip; the other implements Fast Fourier Transforms on humming signals. The current design has shown that our idea of smooth control not only works, but can be implemented in real time. We have built a prototype, which was implemented and tested on Invacare's Storm TDX5 (mid-wheel drive power chair) donated to us by East Coast Rehab, LLC.