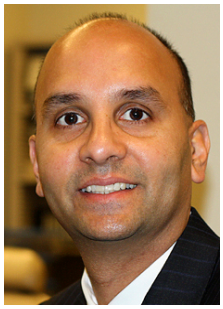
THE HARTWELL FOUNDATION

2009 Individual Biomedical Research Award

Review of Proposed Research

Investigator: **Sanjay D. Joshi, Ph.D.**
Associate Professor
Department of Mechanical and Aerospace Engineering

Institution: **University of California, Davis**



Proposal: **New Human-Computer Interface for Severely Paralyzed Children**

Dr. Joshi proposes to enhance the quality of life for children who are severely paralyzed by providing them with a new method to control computers, digital phones, wheelchairs, and other available electronic devices, using only a miniature portable machine interface and small sensor placed on a single muscle behind their ear. When human-beings move any muscle, they produce a natural electrical signal at the site of the muscle. A graphical record of electrical activity associated with muscle contractions is called an electromyogram (EMG), which can be analyzed quantitatively in the time or frequency domain. However, with the development of signal acquisition and analysis techniques, attention has now been focused on the frequency domain. In this regard, Dr. Joshi recently discovered that humans, simply by contracting a muscle, can actively command simultaneous power levels in two separate frequency-bands of an EMG. In effect, he was able to demonstrate that each frequency band can be treated as a separate control channel, simultaneously available to control different aspects of an electronic device. Based on this underlying discovery, he developed a machine interface for a human that relies on the surface EMG signal from a single, seldom used muscle of the head. The muscle is easy to locate near a small non-descript area behind the ear. Since ear muscles are rarely used (most people can't even wiggle their ears), his system will not interfere with other natural head functions. Moreover, the interface will not need to be replaced as the child grows physically. Dr. Joshi intends to develop miniature digital machine interface hardware that can easily be used in any location and for which normal bodily functions do not have to be sacrificed while they are used to perform a desired control function. Currently, tongue and breath controlled systems require complete dedication of the mouth during use, which would be impossible if connected to a respirator; and eye-gaze systems require the full dedication of sight. He seeks to develop intelligent software that can automatically adapt to changes in the muscle as it strengthens or fatigues with repeated use, or as the child grows. In this context, he intends to asses the ability of children to use the machine interface, including learning time and the ability of the device to adapt to muscle changes. If Dr. Joshi is successful, those afflicted with life long paralysis will be able to achieve an extra measure of independence using his machine interface, which will provide them an opportunity to enjoy a fulfilling and productive life as they grow.