A New SEP Classifier for Intraoperative Spinal Cord Surgery Monitoring

This invention allows spinal cord surgery patients to go through a shorter anesthetic and therefore reduces their secondary risk.

Background
Evoked potentials are the electrical responses generated by the nervous system to sensory stimuli. Somatosensory evoked potentials (SEPs) consist of a series of waves that reflect sequential activation of neural structures along the somatosensory pathways. The dorsal column-lemniscal system is the major anatomical substrate of the SEPs within the Central Nervous System. Intraoperative SEP monitoring is the most popular technique used for preventing significant risks of iatrogenic injury to the spinal cord during spinal surgery and neurosurgery. However, SEP recordings are usually accompanied by a lot of noises which decreases the quality of the signal, making peak identification difficult, often preventing accurate latency/amplitude measurements, and defeating the many available averaging systems or other processing methods. These noises, or so-called artifacts, are often transient phenomena caused by either physiologic or non-physiologic sources. It is important to detect recordings containing artifacts, especially when the amplitude and the number of artifacts is so high that they cannot be canceled out by the averaging process. Once detected, it may be possible to reduce the influence from artifacts on the resulting average. Typically, signal averaging is used to extract the SEPs from the other electrical signals picked up by the recording electrodes. Artifact rejection is used to prevent sweeps with unusually high noise levels from contaminating the averages, making it an effective tool for selecting SEP sweeps with good quality in a high-noise environment, such as in an operating room. The current approach of automatic artifact rejection involves the use of a voltage threshold criterion, whereby data are accepted for analysis only if the peak values during a sweep are less than the pre-set maximum.

The HKU Invention
The application of a new SEP classifier for automatic artifact rejection can be a solution in increasing the reliability of SEP recordings and spinal cord monitoring. Using both the frequency and the temporal property of SEP and noise components as classification criteria to reject sweeps that are too noisy, this method will not only boost the signal quality for averaging, it will also use fewer sweeps. The use of this invention will increase the signal quality, reproducibility, and reliability of SEP recordings. Because much fewer stimuli are needed to measure the nerve conductivity per site, the time needed can be shorten. Moreover, the measurements will then become more accurate as they have a high reproducibility between successive measurements when compared to traditional method. Because of the shorter time, patients will go through a shorter anesthetic and therefore less secondary risk. It also helps to free up the professional physiologists and improve their availability to other patients.
This innovative signal processing method can be implemented by either software or hardware. Should this be applied, in addition to improving the application of automatic high-noise rejection for spinal cord monitoring, it will also help the development of the monitor equipment market.

**Market Opportunity**
Considering the use of electrophysiology monitoring during surgery, an estimated 336,816 spinal fusion procedures were performed in the United States alone in 2001. The number of fusion surgeries performed is expected to increase approximately to 548,354 in 2008 (CARG is about 7.21%). Along with an increase in the number of surgeries performed every year, revenues in the spinal market are forecasted to grow significantly in the coming years. Degenerative spinal disorders have increased considerably in recent years with the aging trend in the population in China, especially in Hong Kong and the Great Pearl River Delta. There are more than 130 spinal surgeries per year (an estimated 5-10% in Hong Kong) that undergo intraoperative spinal cord monitoring in the Department of Orthopaedics and Traumatology of the University of Hong Kong. The Orthopaedics Department in one of the Hospitals of Sun Yat-Sen University reported that more than 500 spinal surgeries require intraoperative spinal cord monitoring, and about 3,000 spinal surgeries in Guangdong require intraoperative monitoring every year.

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