05/6402 Non invasive brain-machine interfaces

Type of activity: Short Study (2 months, 15 KEUR)

Background

Controlling and guiding computer-based systems using human brain signals seems now to become reality. The available technology allows implementing, in almost real-time, processes which measure neuron's activity, convert their signals, and elaborate their output to the purpose of controlling mechanical systems.

There are mainly two kinds of brain-machine interfaces: 1) invasive; 2) non-invasive. So far, the first kind is the most effective and several universities have been involved. Outstanding results have already been achieved where primates are able to guide robotic manipulators by means of their neural activity. New sensors and actuators have been designed and patented for invasive Brain Computer Interfaces (BCI). The second kind of brain-machine interface seems to be less efficient even it is often based on classical techniques for brain diagnoses and could have a more direct benefit for our society. Electroencephalogram (EEG) is an example of a non-invasive sensing instrument to detect neuron's spikes. Functional Magnetic Resonance Imaging (fMRI) is another new non-invasive procedure that uses magnetic resonance imaging to measure the metabolic changes of active parts of the brain. Magnetoencephalography (MEG) is an additional revolutionary medical technology that provides human brain images through the measurement of its electromagnetic activity.

Space Applications

Space environment is inherently hostile and dangerous for astronauts. For this reason, Extra-Vehicular Activity (EVA) should be limited as much as possible and robotic systems should be used instead. Astronauts are therefore requested to teleoperate external semi-automatic manipulators relying in their physical capabilities. The advantages of using non-invasive brain-machine interfaces are numerous, e.g., commands could be sent with high accuracy and without any output delays. Moreover, multi-teleoperations could simultaneously be performed using one single brain-machine interface. This would maximise the efficiency of astronaut activity that is of primary interest.

Study objectives

Purpose of this study is to survey literature about brain-machine interfaces. All existing interfaces should be considered with emphasis to non-invasive interfaces. The study should also suggest a future time scale for the development of non-invasive brain-machine interfaces. In summary, the study should include:

1. Short introduction on invasive and non-invasive brain-machine interfaces.
2. Review of non-invasive brain-machine interfaces.
3. Short detailed description of the interfaces presented at point 2.
4. Time scale estimate on the development of non-invasive brain-machine interfaces for future feasible applications.

References

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