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STAGE
TRAINING COURSE

MASTER 2

Date of offer : 30/09/2013

TITLE :

Application of Riemannian Geometry for the Control of a Prosthetic Arm by Electromyography (EMG).

SUPERVISORS :

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PLACE :
Departement “Images and Signal” of GIPSA-lab, CNRS, Grenoble University, Grenoble Institute of Technology (INP), ENSE^3, Campus of Grenoble.

DURATION:
The training will last 5 months, starting on February 1st 2014.

CONTEXT :
This project is part of an ongoing research on ***brain-computer interfaces*** carried out at ***team ViBS*** (Vision and Brain Signal Processing) of ***GIPSA-lab*** since 2009 and on EMG carried out at team *SAIGA* (Signal and Automatic for surveIllance, diaGnostics and BiomechAnics).

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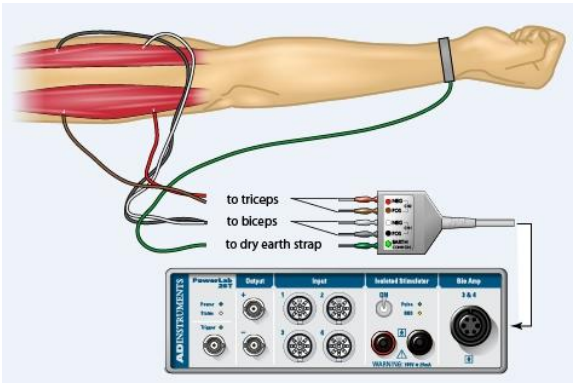
SUBJECT :

There is a large number if impaired people who are in the need of prosthetic arms. This can be caused by an accident or a disease such as diabetics. For example in the UK around 100 diabetics lose a limb because poorly managed diabetes leads to nerve damage and restriction of blood supply. A successful robotic (or “bionic”) arm can also be used for healthy subjects for interacting naturally in a virtual reality world.



Producing such a robotic arm can use signal from the brain (e.g., electroencephalography (**EEG**)) or signal from the healthy part of the hand **EMG** (electromyography). EMG is a technique for evaluating and recording the electrical activity produced by skeletal muscles. Using non-invasive EMG a robotic hand can be controlled (Maier, Sebastian and Smagt van der, Patrick 2008).

We have developed a new algorithm that utilizes symmetric positive-definite matrices. Driven by practical problems in radar data processing, image processing, medical imaging (especially diffusion Magnetic Resonance Imaging), elasticity, mechanics and machine learning, the study of operators for these matrices such as distance and geometric mean has recently grown very fast (Bathia, 2013; Moakher, 2005; Pennec et al., 2004). Interestingly, in this endeavor disparate perspectives from matrix analysis, operator theory, differential geometry, probability and numerical analysis have converged. We have applied the method for the task of EEG classification in brain-computer interfaces, obtaining very promising results, often surpassing the state of the art methods in accuracy and robustness.

The aim of this stage is to analyze offline data and apply the newly developed algorithm for the motor control of a robotic arm. The experimental data will be EMG signals produced by different hand movements. Further work will include applying the algorithm in real-time and connecting it with to a virtual (on screen) hand or a real robotic arm.

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OBJECTIVS OF THE TRAINING :

The candidate will apply different digital signal processing and classification algorithms for the control of prosthetic arm. The student will explore the characteristics of the EMG signal and adapt the new algorithm so to fit EMG signal. The primary used software will be

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Matlab. The student will be assisted by an engineer from the ViBS team for the successful realization of a demo.

KEYWORDS :
Electromyography (EMG), Body-Computer Interface (BCI), Robotic arm

CONDITIONS :
The training is remunerated 1/3 of French SMIC during 5 months.

COMMENTS :
The candidate should have good predisposition for experimental research and data analysis. Good theoretical skills in digital signal processing or machine learning would be an advantage.

REFERENCES :

Bhatia R (2013) "The Riemannian Mean of Positive Matrices" Ch 2 in Nielsen F. and Bhatia R. (Eds.) Matrix Information Geometry, Springer, London.

Moakher M (2005) "A differential geometric approach to the arithmetic and geometric means of operators in some symmetric spaces." SIAM. J. Matrix Anal. Appl, 26 (3), 735-747.

Pennec X, Fillard P, Ayache N (2004) "A Riemannian Framework for Tensor Computing." Research Report #5255, INRIA, Sophie-Antipolis, France.

Maier S, van der Smagt P (2008) "Surface EMG suffices to classify the motion of each finger independently". In: Proceedings of MOVIC 2008. 9th International Conference on Motion and Vibration Control, 2008-15-09 – 2008-18-09, Technische Universität München.

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