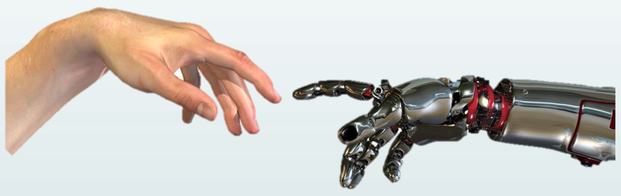
Conception of robotic hands with electormyographic signals

Kirchhofer Simon

Institut Pascal / UCA / SIGMA / CHU de Clermont-Ferrand

Ecole doctorale Sciences Pour l'Ingénieur

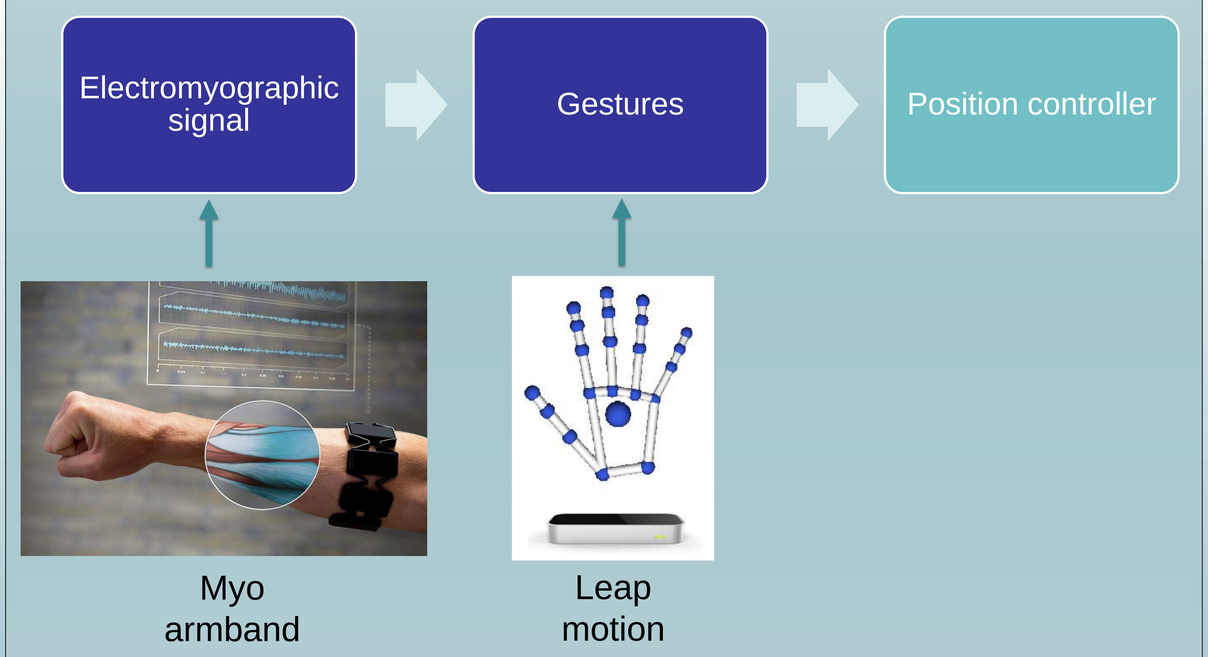
Introduction



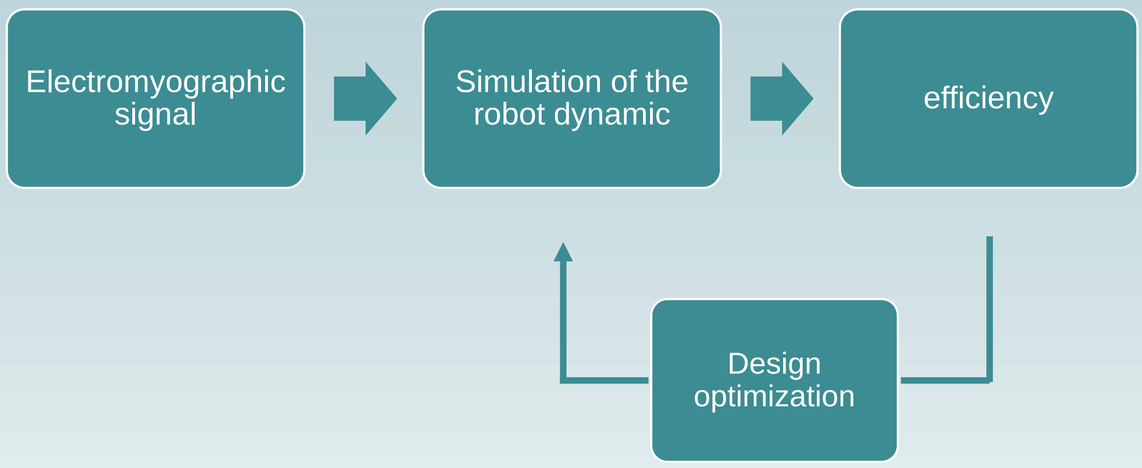
Robotic hands turn on revolutionary perspectives for people with disabilities. However, numerous technical issues are still hard to override in order to design systems as efficient as the human hand. The main difficulties are the human-machine interface and the conception that must be compact, powerful and precise. Nowadays, electromyographic signals seem to be relevant to control such systems but the design is isolated from the signal processing. Robotics hands are developed only with a biomechanical approach [1][2][3][4] and the signals used for the control are ignored. The goal of this PhD is to use the EMG signal in order to get a conception in line with the control capabilities.

Methods

The first step is to understand the link between the electromyographic signal and the motion of a human hand. This is needful to create the control of a prosthetic device from EMG.

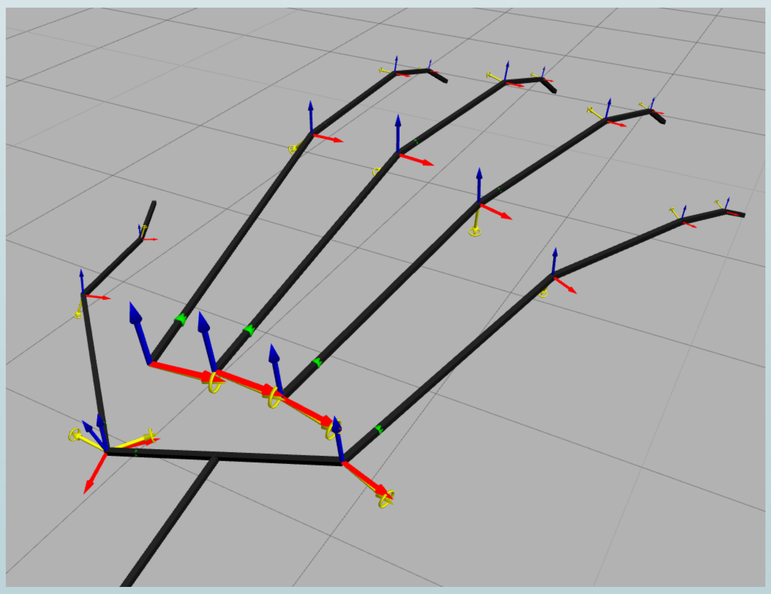


Then, an initial design of the hand will be developed. It will be used as the starting point of an optimization loop. Reinforcement learning algorithms are likely to be used.



Results

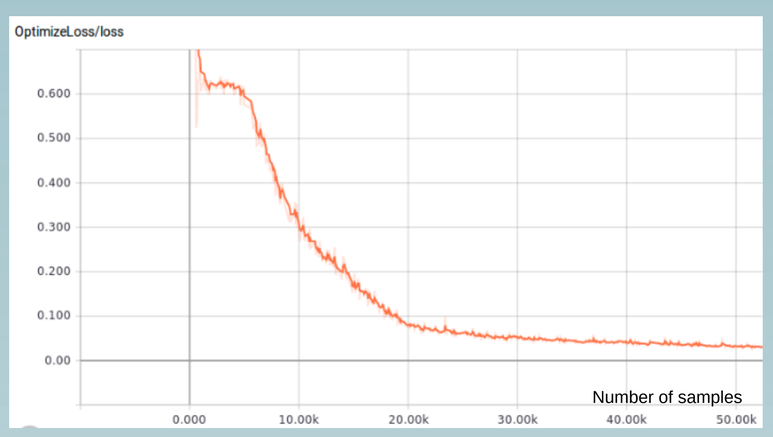
The state of the art in electromyographic processing focuses on the classification of gestures with EMG [5]. As the number of gesture is limited (usually pronation/supination, flexion/extension of the wrist and opening/closing of the hand), we tackle the issue with a regression analysis that estimates the joint coordinates of the hand from the EMG signal. A Kinematic model was developed and the regression was build with a recurrent network.



Kinematic model

Preliminary results

With a small dataset (record of 1 person for several minutes), the training converges. We need to create a database to validate the concept and evaluate the robustness via the study of the differences between people, the impact of muscle fatigue, the importance the sensor positioning, etc.



Conclusions

First results are hopeful, they match the current evolution of the state of the art. Nevertheless, we must keep in mind that a lot of shortcomings still need to be addressed. Mainly, the forces generated by the fingers are not measured or estimated. It seems relevant to include it in the signal processing as the force is significant for the success of grasping tasks.

Bibliography

[1] **LTD S.R.**C., "Shadow hand Website." [Online]. Available: https://www.shadowrobot.com/products/dexterous-hand/ (Accessed 2016-12-24).

[2] **H. Liu, K. Wu, P. Meusel, N. Seitz, G. Hirzinger, M. Jin, Y. Liu, S. Fan, T. Lan, and Z. Chen**, *"Multisensory five-finger dexterous hand: The dlr/hit hand ii,"* in IEEE/RSJ International Conference on Intelligent Robots and Systems, 2008, pp. 3692-3697.

[3] **D. Keymeulen and C. Assad**, *"Investigation of the harada robot hand for space,"* in IEEE RAS Internation Conference on Humanoid Robots University International Conference Center, Tokyo, Japan, 2001, pp. 749-754.

[4] **"Prensilia Srl webpage." [Online]**. Available: http://www.prensilia.com/index.php?q=en/node/40 (Accessed 2016-12-15).

[5] **U. Côté-Allard, C. Latyr Fall, A. Drouin** "Deep Learning for Electromyographic Hand Gesture Signal Classification by Leveraging Transfer Learning" in CoRR, feb 2018, vol abs/1801.07756 http://arxiv.org/abs/1801.07756