Self-study on dimensionality reduction – Topic 7

Following our first lecture on synergistic control of human movements, this second lecture (Topic 7 on Moodle) contains a video lecture where a practical example on how to extract muscle synergies is shown (see folder "video lecture"). Follow the instructions in the video for performing similar data processing and:

1 - *reflect on the use of this tool for potential implementation of dimensionality reduction and motor control representation in Robotics*. In the "**Literature**" folder, there is a paper called "Oliveira (2014) EMG, synergies, methodological", which has extensive explanations on the use of NMF to investigate motor control using EMG, and relevant methodological considerations on the use of EMG to investigate motor control.

2 – *Run the NMF code on the data provided from subject 2* (stored on the file **EMG_data**, in the folder "**EMG/kinematics data and scripts**"). Subsequently, compare the number of synergies required to reconstruct the original EMG (>90% reconstruction quality across all muscles) to the results from subject 1. Do this using the first 16 EMG channels, as well as all 32 channels (see file **EMG_info** for details on EMG channels).

IMPORTANT: copy the EMG data, the matlab scripts, and the folder "nmf_toolbox_ver1.4" to the same folder in our PC.

Regarding walking kinematics:

In the "**Literature**" folder, there are two papers that describe the use of kinematic synergies, consisting of using kinematic data as input features to understand movement control. The kinematic data are joint angular velocities, and the degree of agreement between the different joints of a segment can be used for describing movement control just like it has been shown through the use of surface EMG.

As a self-study task, students should *read these two papers and also perform dimensionality reduction* on data included in the folder "**EMG/Kinematics data and scripts**". The data is already processed and filtered (6 Hz low-pass, buttweworth), and ready to use. The folder contains a text file called "**KIN_info**" and "**KIN_data**", which contain information regarding the data, and the data from four subjects.

Dimensionality reduction for kinematic data can be performed by deriving the angular velocity from the joint angle data provided. It is recommended to use Principal Component Analysis (PCA), as there are positive and negative angular velocities for the different joints. Keep in mind that the provided kinematic data contains joint angles, therefore it is necessary to use the first derivative of the joint angles to compute velocities. Please follow some instructions provided on the two videos on PCA processing to set the pca function on Matlab.

The principles of reconstruction quality of the original data from the decomposed matrices, demonstrated in the video lecture, can also be used in this self-study. Ultimately, *define how many principal components are necessary to explain >90% of the variability across all joint angles provided*. An additional task is to *compare the results across the four subjects provided*.

Good luck in your studies,

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