Analysis and Modelling of Locomotion

1 Teaching team contact

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Please, in case you need information concerning the exercise sessions, the written report, or the final exam, contact the TAs first.

2 Exercise overview

The exercise of these 4 classes is a group project on the analysis of locomotion, for which you will have to submit a report. **The deadline for the report submission is Friday May 3rd, 23h55.**

The project and report are handled by groups of 4 people.

The goal of the project is to characterize and compare different gait patterns of healthy and pathological human subjects.

In order to do so, you will have to analyse the data that you will acquire during experimental recordings performed at the University Hospital in Lausanne (CHUV) on a healthy subject, as well as a separate dataset recorded on a subject with spinal cord injury (SCI). After extracting the gait events (i.e. toe off and foot strike), you will have to choose parameters enabling to characterize and objectively quantify the gait patterns of both the healthy (CHUV recordings) and pathological (data provided separately) subjects. Finally, you will use those parameters to perform a Principal Component Analysis (PCA) of locomotion.

The team of teaching assistants is there to guide you through this process and answer your questions.

Your report should summarize the experiments performed at the GAIT laboratory (CHUV) and present your analysis performed on the healthy and pathological subjects.

3 Specific instructions

On the moodle of the course you will find:

- the *.mat* files of a healthy subject (under *Exercise - Material - Healthy subject*) ;

- the *.mat* files of an SCI subject (under *Exercise - Material - SCI subject*) (without FLOAT with crutches (cond. 1), and with FLOAT without crutches (cond. 2)) and their corresponding GAIT files (*.csv* files).

Please, follow the workflow below to perform your analysis:

Preprocessing data of healthy subject

- Load raw data of the healthy subject in Matlab.

- Detect gait events (e.g. toe off or foot strike) by visual inspection of the data (an appropriate plot can help).

- Try to develop an automated algorithm to detect these events and compare the results with the visual ground truth. (Please note that this is not the main task in this project, no need to make this complicated).

- Use the visually detected gait events to split the raw data into the different steps.

Preprocessing data of SCI subject

- Load raw data of the SCI subject in Matlab.

- Use the gait events given in the provided GAIT file to split the raw data into the different steps.

Processing of all data

- Compute gait parameters (e.g. max knee angle, step height, max hip angle, . . .) and a selection of EMG parameters. Extract these values for each gait cycle . A minimum of 20 such parameters for the kinematic recordings and 5 parameters for the EMG recordings are required. You should be able to provide arguments supporting your choice of parameters.

Dimensionality reduction using PCA

- A Principal Component Analysis should be performed using the extracted gait parameters. The results of the PCA should be presented graphically and the different gait conditions should be distinguishable. Some questions that can be addressed with this analysis are for instance: What are the gait parameters explaining the most variance in the data? Can the different gait condition be clearly distinguished by the gait parameters? Do the PCA results drastically change when excluding the EMG parameters from the analysis? How do the different gait conditions relate to each other? ...

4 Written report guidelines

Here are some guidelines to help you elaborate your final report.

The report should not exceed 8 pages.

It should comprise the following elements:

- a brief introduction to the project, including a description of the experiment performed in the GAIT lab;

- a description of the gait event detection algorithm and a comparison with the visually detected gait events;

- a precise definition of the gait and EMG parameters you selected and a justification for the choice of these parameters;

- the results of the PCA which you performed on the healthy and pathological subjects;

- your interpretation of these results and a discussion of the method and of the overall analysis.

Please take the following things into account:

- writing well-structured and easy-to-understand code is very important, so think about good coding practices;

- graphically presenting data and results in a comprehensible, efficient and, of course, scientifically sound way is very important. Creativity will be rewarded;

- a good structuring, a smooth story-line and good language of a report highly contribute to its capability of conveying a message.

If you have a particular interest in some part of this project, please do not hesitate to elaborate further on it.

You should submit the report together with all the matlab code that you wrote during your final submission. The scripts should be executable without errors and be properly commented to facilitate the reviewers' work. The scripts and the report should be compressed in .zip format and named *AML_ Group#i_ Name1_ Name2_ Name3_ Name4.zip*.

Reminder: **deadline is Friday May 3rd, 23h55.**

Finally, we are here to guide you, so do not hesitate to discuss with us.

Have fun!