Winter School on Computational Methods for Neurorehabilitation

Introduction to the mini-projects

N. Jarrassé
ISIR, CNRS-UMR7222, Univ. Pierre et Marie Curie, France
Human Robotics Group, Imperial College London, UK

January, 28-31th 2014, Obertauern, Austria

Introduction

- **Goal**

  - Apply theoretical knowledge presented during the morning lectures sessions

  - Explore practical applications and possibilities of computational methods.

- **Organization**

  - 8 different mini-projects

  - groups of 4 / 5 students, supervised by 1 to 2 tutors

  - Mini-project session every evening (7-9pm)

  - Mini-projects will take place in the dinner area

- **Deliverable**

  - A short presentation of obtained results on Friday morning (10 min+5 min questions per project)

List of mini-projects

- **Project A:** *Isometric Assessment of Multiple Sclerosis vs. Healthy Subjects*
- **Project B:** *Decomposition Techniques for Analysing Motor Tasks*
- **Project C:** *Analysis of Grasping Strategies and Function using an Instrumented Object*
- **Project D:** *Motor Adaptation and De-adaptation*
- **Project E:** *Optimal Control (LQG, LQR) as a Model of Human Motor Control*
- **Project F:** *Models of Neuromotor Recovery*
- **Project G:** *Analysis of Movement Smoothness*
- **Project H:** *Analysis of Coordination Learning in a Figure Drawing*

Project assignment

Project A *A. Hussain*
Nicolas Gerig
Rick Bosveld
Tamara Lorenz
Anneleen Maris

Project B *A. Pennycott*
Gaurav Mukherjee
Kerstin Sobus
Virginia Ruiz Garate
Susanna Summa
Alice De Luca

Project C *N. Jarrassé, W. Dailey*
Jaime Duarte
Sumner Norman
Albert Sans
Andrea Crema
Belen Rubio

Project D *A. Takagi*
Firas Mawase
Thomas Seel
Guoping Zhao
Oscar Giles
Karin Eibenberger

Project E *E. Guigon*
Patricia Leconte
Joel Perry
Laura De Rijcke
Luca Ricci

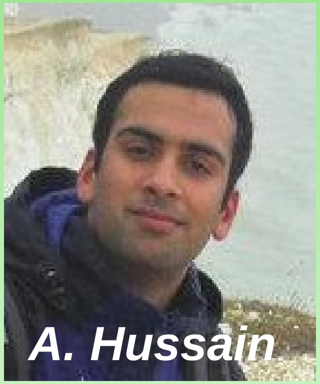
Project F *V. Sanguinetti*
Andrei Ninu
Georg Rauter
Vincent Crocher
Jessica Allen
Kazimierz Wojewoda

Project G *A. Melendez*
Frieder Wittman
Christophe Everarts
Carlos Rodriguez
Sharah Mutalib

Project H *S. Balasubramanian*
Eleonora Tamilia
Fabio Oscari
Cristina Fonte
Meret Branscheidt
Irene Tamagnone

Learn to recognize your project's instructor

Project A: *Isometric Assessment*



Project B: *Decomposition techniques*

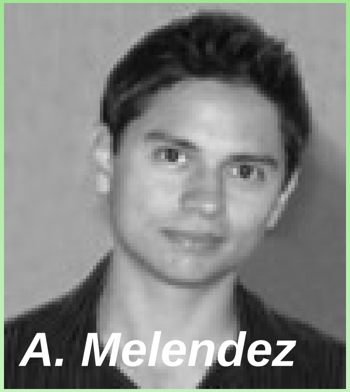
Project C: Instrumented object

Project D: Motor adaptation

Project E: Optimal control

Project F: Models of recovery

Project C: Movement smoothness



Project H: Coordination learning

Thank you for your attention

Project A: *Isometric Assessment of Multiple Sclerosis vs. Healthy Subjects*

- **Context**

  - Muscle strength is essential for producing motor output (accelerate limb, compensate for gravity, interact with env.).

  - Quantification of sensorimotor function could be based on isometric force/torque measurement

- **Objectives**

  - Analysis of the richness of isometric force signal (strenght and control) using sample entropy

  - Comparison of recorded data between multiple-sclerosis patients and healthy subjects

Project B: *Decomposition Techniques for Analysing Motor Tasks*

- **Context**

  - Muscle synergies: simplified control of a large number of DOF through a smaller number of motor output patterns

  - Interpretation of large set of physiological signals through dimension reduction

- **Objectives**

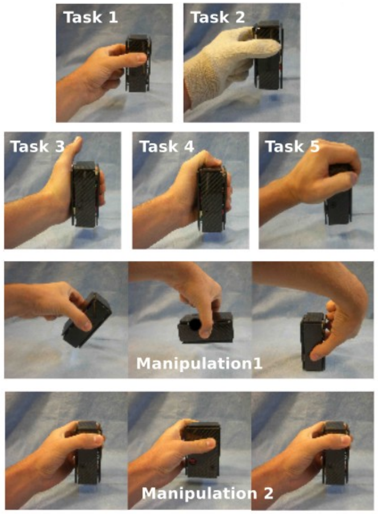
  - Analyze of data sets (16 EMG signals) recorded during walking

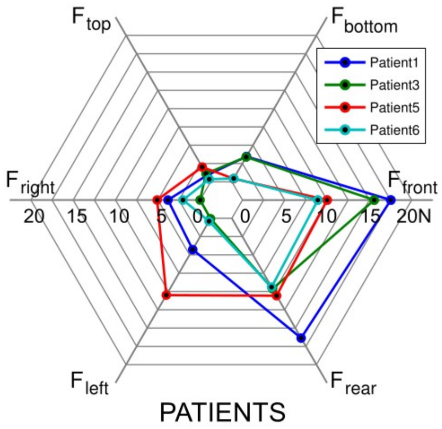
  - Comparison of 2 different pattern recognition techniques (PCA and NMF)

Project C: Analysis of Grasping Strategies and Function using an Instrumented Object

Context

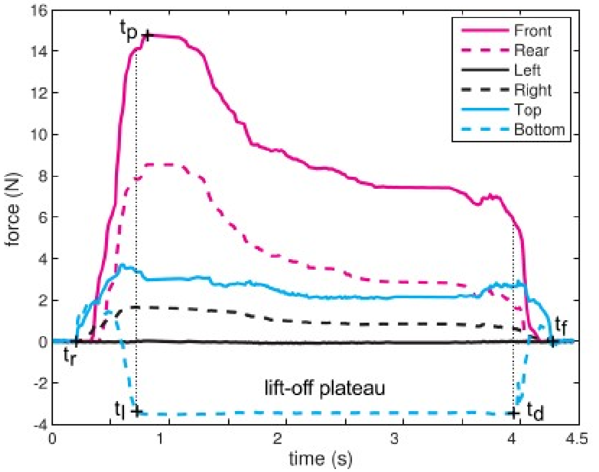
- Bridging the gap between elementary measures and functional scores for better therapy and follow-up for stroke patients
- Quantitative assessment of grasping function
- Use of an simple, robust and low-cost Instrumented Object (iBox)





Objectives

- Data acquisition during simple grasp and manipulation experiments
- Comparison of healthy recorded datasets with hemiparetic datasets via a set of pertinent variables (existing or to define)



Project D: Motor Adaptation and De-adaptation

- **Context**

  - Constant motor adaptation to environment and body changes

  - Using robots to generate force fields and study how this motor memory is retained through iterative learning

- **Objectives**

  - Analyses data from healthy subjects who learned a linear velocity-dependent force field

  - Examine modelling of this adaptation and de-adaptation using an iterative control model (Matlab)

Project E: Optimal Control (LQG, LQR) as a Model of Human Motor Control

- **Context**

  - providing solutions to ill-posed and stochastic problems such as those encountered in sensorimotor control (e.g. reaching with a redundant limb to a target located at an uncertain position)

  - Optimal control then consists in finding a control policy that minimises (or maximises) the performance value

- **Objectives**

  - Learning to manipulate LQ optimal control models, and design computer simulations

  - Simulation and comparison (redundancy and robustness) of different controllers (feedback, LQR, LQG and H-infinite)

Project F: Models of Neuromotor Recovery

- **Context**

  - Quantification of the effect among time of rehabilitation procedure

  - Modelization and understanding of recovery mechanisms of recovery at the functional level

- **Objectives**

  - Exploration of the basic methodologies to describe the recovery process in a rehabilitation trial as a dynamical process

  - Development of a dynamical model of the recovery process from time series data of a rehabilitation trial

  - Parameters identification and method comparison

Project G: Analysis of Movement Smoothness

- **Context**

  - Development of more objective, detailed and sensitive assessment methods to precisely quantify sensorimotor ability.

  - Robust and representative quantification of movement smoothness

- **Objectives**

  - Investigation of the performance of four selected smoothness measures on healthy and stroke data.

  - Analyze and comparison of the performance of these measures.

Student repartition among mini-projects

- **Context**

  - Muscle strength is essential for producing motor output (accelerate limb, compensate for gravity, interact with env.).

  - Quantification of sensorimotor function could be based on isometric force/torque measurement

- **Objectives**

  - Analysis of the richness of isometric force signal (strenght and control) using sample entropy

  - Comparison of recorded data between multiple-sclerosis patients and healthy subjects

Project G: Analysis of Movement Smoothness

- **Context**

  - Muscle strength is essential for producing motor output (accelerate limb, compensate for gravity, interact with env.).

  - Quantification of sensorimotor function could be based on isometric force/torque measurement

- **Objectives**

  - Analysis of the richness of isometric force signal (strenght and control) using sample entropy

  - Comparison of recorded data between multiple-sclerosis patients and healthy subjects