PhD Project

Machine Learning for Image Analysis of dynamic MRI data

Lab

Research at IMT Atlantique involves nearly 800 people, including 290 teachers and researchers and 300 PhD students, and is on digital technology, energy and environment. It covers all disciplines (from the physical sciences to humanities and social sciences through those of information and knowledge) and covers all fields of science and information and communications technology.

The thesis will take place in the laboratory LaTIM (INSERM U1101), at Brest campus under the supervision of François Rousseau and Douraied Ben Salem.

Starting date: October 2020
Funding: IMT Atlantique - ANR Chaire IA

Project description

Musculoskeletal disorders have a debilitating impact on quality of life as well as on healthcare costs. Accurate clinical diagnosis and patient specific treatment are the key areas that play utmost important role in the management of musculoskeletal disorders. Individuals with musculoskeletal disorders often exhibit joint or pain and/or weakness for simple daily tasks or motions. Although using such pain-inducing tasks could be a good strategy to collect dynamic MRI data, a quick and non-repetitive technique to acquire dynamic data is most important. The causative relationship of many disorders spanning almost all human joints have not yet fully understood, and imaging efforts are mostly focused on static diagnosis and treatment follow-ups. Thus, dynamic MRI based evaluation of musculoskeletal disorders could have huge impact in not only understanding the joint pathomechanics but also guiding surgical or rehabilitation therapy. This PhD thesis in image analysis and statistical learning is fully integrated in the work of LaTIM on the mobility of the human locomotor system through the study of the neuro-musculo-skeletal system. More specifically, the aim here is to answer the vast question of improving functionality through rehabilitation or surgical correction with prediction of motor outcome, by adopting the point of view of data analysis and numerical modelling.

The central question of this work will concern the problem of domain adaptation, and more specifically the transfer of high-resolution information from static "image" data to a low-resolution temporal sequence, in order to extract the complementarity between data sets. This PhD thesis focuses on the development of a framework for the analysis of joint mechanics. It will benefit from the development already achieved on the ankle joint in children and will focus on solving the problems encountered in image acquisition and processing. The following specific objectives are sought in this project:

1) the learning of anatomically realistic numerical models (i.e. introducing physical constraints in neural networks),
2) transferability of models learned from small data sets,
3) reconstruction of high-resolution 3D+t data from high-resolution static data and low-resolution time sequence.
This work is part of this framework in order to develop MRI data analysis methods that facilitate medical diagnosis and quantify the evolution of therapeutic monitoring, allowing an optimal choice of the latter. It will be carried out in close collaboration with the radiology department, in particular through co-direction with Douraied Ben Salem (PUPH) and clinicians from the functional re-education department of Brest University Hospital.

Profile
- Master degree in image processing or applied mathematics
- Required skills: machine learning, image processing, programming (C++ & Python).

Net income/month : ~1500€

Contact
François Rousseau
email : francois.rousseau@imt-atlantique.fr

How to apply
Candidates are invited to email (to François Rousseau) a motivation letter and CV detailing in full your academic background, including all modules taken and grades assigned.

Bibliography

Fig. Bones of interest: calcaneus (red), talus (green) and tibia (cyan). (a): Mid-sagittal image from the high-resolution static scan; (b): Mid-coronal image from the high-resolution static scan; (c): Three dimensional rendering of segmented bones.