IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

# PhD Project

# Image Analysis of dynamic MRI data to study musculoskeletal disorders

## 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 2019
Funding : IMT Atlantique - Philips

## 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 [1].

To this extent, we have developed dynamic MRI sequences on the current 3.0T Philips MRI scanner. Both these sequences are real-time sequences with one based on Fast Field Echo (FFE) and another on balanced-FFE. We have also developed a post-processing technique to convert the low-resolution dynamic MRI images to high resolution images using a log-euclidean polyrigid framework.

This PhD thesis is focused on developing a framework to analyze the joint mechanics. It will benefit from the development already done on the ankle joint in children and will focus on resolving challenges faced in image acquisition, and processing. Following specific aims are sought within the scope of this Project:
1) Development of image processing algorithms for specific joint and acquisition (3D+t image reconstruction [2] and segmentation),
2) Application of the developed algorithms on targeted musculoskeletal disorders [3] (ankle joint development in cerebral palsy (see figure below)),
3) Study the complementary between MRI sequences and the potential of diffusion MRI for musculoskeletal system study.

## Profile

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

Net income/month : ~1500€

## Contact

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## 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

1. B. Borotikar, M. Lempereur, M. Lelievre, V. Burdin, D. Ben Salem, S. Brochard. Dynamic MRI to quantify musculoskeletal motion: A systematic review of concurrent validity and reliability, and perspectives for evaluation of musculoskeletal disorders. Plos One 12(12), 2017.

2. K. Makki, B. Borotikar, M. Garetier, S. Brochard, D. Ben Salem, F. Rousseau. In vivo ankle joint kinematics from dynamic magnetic resonance imaging using a registration-based framework. Journal of Biomechanics, 86, 193-203, 2019.

3. K. Makki, B. Borotikar, M. Garetier, O. Acosta, S. Brochard, D. Ben Salem, F. Rousseau. 4D in vivo quantification of ankle joint space width using dynamic MRI. IEEE EMBC, 2019.

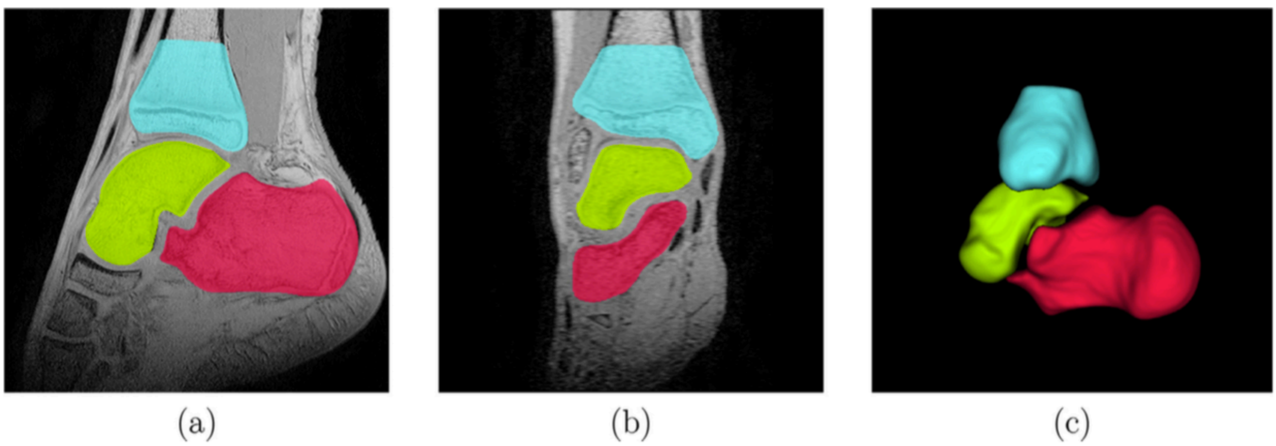


Fig. Bones of interest: calcaneus (red), talus (green) and tibia (cyan). (a): Mid-sagittal image from the high-resolution static scan; (b): Mid-coronal image from the high- resolution static scan; (c): Three dimensional rendering of segmented bones.