Supervisor Project Idea

Supervisor

Insert a brief CV and/or external link, the total number of publications, the ORCID link, 5 of the most significant/recent publications, and a list of funded projects and awards. max 300 words

Alessandra Giuliani, Associate Professor
ORCID Id: 0000-0003-4177-7441
Brief CV: Professor of Applied Physics at the Polytechnic University of Marche. Within the Physics Group, she leads and coordinates research lines in Applied Physics to tissue physiopathology, biomaterials, tissue engineering and regenerative medicine. The aim of the research is to study, using advanced physical techniques (such as X-ray microdiffraction, absorption and phase contrast high resolution tomography) based on synchrotron radiation, the structural changes of different types of biological tissue (bone, tendon, connective tissue, myocardium , skeletal muscle, vessels, etc.) when affected by specific pathologies (advanced diagnostics), in conditioned environmental conditions (such as micro- or macro-gravity), or to verify the outcome of a treatment, often performed by cell therapy or, more generally, with innovative tissue engineering techniques.

She is the author of about 80 articles in peer-reviewed journals, 1 book, chapters on 10 books distributed internationally and numerous papers and abstracts related to presentations at National and International Congresses. Her research in Applied Physics to Tissue Engineering and Regenerative Medicine has been the subject of over 50 presentations at Congresses, many of which as an invited speaker.

Prizes and awards:
- (2015) - Best Poster on Medical Imaging at the Medical Applications of Synchrotron Radiation conference, ESRF Grenoble & Villard de Lans, France;
- (2011) - Mention for the Oral Presentation, Section of Biophysics and Medical Physics, Congress of the Italian Physical Society;
- (2018) Top 1% reviewer in Publons' global Peer Review Awards (position #23 in Multidisciplinary).

Funded projects:
- Grant Holder - MPNS Action COST MP1005. €762,570.00
- UNIVPM Unit Scientific Coordinator - PRIN2010-2011 "Stem cells and 3D scaffolds: an innovative biocomplex in bone regeneration" (prot.0102ZLNJ5). €90,566
- Scientific Coordinator - 2016-UNIVPM Strategic Project "MicroCT for SEM: a 3D exploration into the intermediate hierarchical level of laser-sintered biomaterials". € 182,000

Research Group Description

Provide the name the reference department and a brief description of the research group, including external links, and available instrumentations and infrastructures. max 300 words

Applied Physics Group (SSD FIS/07) in the Medical Area- Dept. of Odontostomatologic and Specialized Clinical Sciences (DiSCO); the research lines of the group focus on tissue physiopathology, biomaterials, tissue engineering and regenerative medicine. The aim of the research is to study, using advanced physical techniques based on synchrotron radiation, the structural changes of different types of biological tissue when affected by specific pathologies (advanced diagnostics), in conditioned environmental conditions (such as micro- or macro-gravity), or to verify the outcome of a treatment, often performed with innovative tissue engineering techniques. We are approaching this study also with the support of digital platforms suitable for the application of artificial intelligence to image processing.

Below, the used experimental techniques are indicated:
- Access to imaging beamlines at European Large Scale Facilities (synchrotron radiation and neutron sources);
- SkyScan Bruker 1174 benchtop microtomograph-System;
- Atomic force microscope;
- X-ray high resolution microtomography detector (Photonic Science 1-Tap Imagestar; 4096 x 4096 pixels). Currently the detector is granted to ELETTRA Synchrotron on loan;
- Commercial software VG Studio MAX 1.2 (Volume Graphics, Heidelberg, Germany): application for image processing;
- ORS-Dragonfly" non-commercial license (Version 2022.1 for Windows, Object Research Systems (ORS) Inc, Montreal, Canada, 2020): digital platform suitable for the application of artificial intelligence to image processing;
- Dedicated hardware and data storage for high-resolution image processing.

Title and goals

Provide the title of the topic and a short summary of the project idea. max 200 words

Title: Artificial Intelligence applied to collagen imaging data in physiologic, pathologic and tissue-engineered conditions

Goals: Mechanical stimuli are regulators not only in cell but also of the extracellular matrix (ECM) activity, with special reference to collagen bundles: sustained mechanical stimulation may lead to modifications of the collagen composition, amount and distribution. These interactions can determine pathophysiological processes, including developmental defects, fibrosis, inflammatory diseases, tumor growth and metastasis. Mechanical stimuli of the ECM can also support the body's reaction to a therapy and the long-term therapeutic outcome.

Thus, the maintaining or re-establishment of tissue tension, modulating external forces, is key to successful and regulated tissues remodeling/repairing and wound healing.

In this context, this Project has two main objectives: (1) the identification of three-dimensional morphometric parameters deriving from the tomographic images analysis of pathological (fibrotic or cancerous) and regenerated collagen-based tissues (with comparison with healthy twin contexts); (2) to reconstruct volume forces and contact forces acting locally in these contexts.

The morphometric parameters are those that will be extracted by the big amount of high-resolution phase-contrast synchrotron imaging data, contained in the archive of the Supervisor research group.

Segmentations guided by artificial intelligence will be also implemented and followed by data mining.