

Working Experience

- 2020–today (24 months) **Research Fellow, CNR-IMATI Genova BANDO IMATI 014-2019-GE**
Title: *Image-fusion study and development of innovative approaches to fusion, analysis, and visualization of MRI low field images and ultrasound for the improvement of musculoskeletal pathologies diagnosis.*
Partners:
 - CNR IMATI, Genova
 - Esaote S.p.A., Genova
 - Regione LiguriaResearch Project: 3D model acquisition sensors are available nowadays in different low-cost devices such as depth sensors (e.g., Microsoft Kinect, Intel Realsense, etc.), and are also starting to be integrated into mobile devices of everyday use (e.g., Lidar system in iPhones and iPads), opening to new opportunities of developments in the clinical environment. Application scenarios are guided systems for the execution of the imaging exam, optimization of hospital protocols for imaging exam acquisition, subject posture analysis and correction during exam execution, and visual support to surgical intervention.

This work, funded by Regione Liguria (European Social Fund 21014-2020), focused on the integration of heterogeneous medical data for image acquisition guidance and image coregistration (e.g. US and MRI). The core of the project consisted in coregistering accurately a 3D surface of the patient acquired through a depth camera with a 3D volume image (e.g., CT or MRI). The main difficulty other than the heterogeneity of the input data, resided in the fact that the depth camera is supposed to be free to move during the acquisitions and placed by the physician that keeps it in his/her hand.
Expertise:
 - Programming skills Matlab
 - DICOM data structure, image processing and segmentation
 - 3D surfaces processing
- 2021–today **Technology and knowledge tranfer**
Co-author and developer of the software IMAGE-FUSION-Library, for the segmentation and co-registration of MR images with data acquired through 3D sensors. In the context of the license contract between CNR-IMATI and ESAOTE Spa, subscribed on the 01/03/2021 and lasting 12 months, I am carrying on the following activity:
 - specialization and optimization of the software library IMAGE-FUSION-Library concerning ESAOTE specification to integrate the software library in the ESAOTE's ultrasounds systems;
 - support to the integration of the software library IMAGE-FUSION-Library in the ESAOTE ultrasound systems, to the calibration of the parameters of the algorithm with respect to the MR images and the 3D surfaces provided by ESAOTE;
 - optimization, evaluation, and validation of the algorithms included in the library IMAGE-FUSION-Library and of the relative results;
 - scientific support necessary for the integration and validation of the algorithms developed for the registration in class IIa, compliant with the MDR legislation.
- 2017–10/2020 (36 months) **Research Fellow, CNR-IMATI Genova, BANDO IMATI-006-2017-GE**
Title: *Rappresentazione ed analisi di dati derivati da immagini medicali: modelli canonici, annotazione semantica e rappresentazioni ibride*
Partners:
 - CNR-IMATI, Genova
 - University of GenovaResearch: The focus of the work was the integration of medical 3D MR image information and 3D anatomical models in order to create a useful visualization tool for physicians and surgeons. During this period I attended different courses on machine learning, data analysis, data visualization, and image/video processing. I published different papers both for an international journal and conferences. Expertise:
 - programmin skills: Matlab, Python
 - DICOM data structures
 - 3D surface moldeling
 - scientific papers composition
 - conferences and seminars presentations

09/2012–10/2012 **Internship, Zimmer Biomet, San Giuliano Milanese**
(1 month) Role: the Stage consisted in familiarizing with the different types of prosthetic elements developed by Zimmer Biomet and to properly cataloging them while updating the company website. The principal anatomical district involved were knee, hips, elbow and shoulder.

Education

2017–2021 **PhD in Science and Technologies for Electronic and Telecommunication Engineering. Curriculum: Electromagnetism, Electronics, Telecommunication (EET), XXXIII cycle., University of Genova**

Title of the Thesis: *Novel Approaches to the Representation and Analysis of 3D Segmented Anatomical Districts*

Supervisors: Dr. Michela Spagnuolo, Dr. Giuseppe Patané, Prof. Silvana Dellepiane.

Description: Image processing and 3D shape analysis are an integral part of clinical practice and have the potentiality to support clinicians with advanced analysis and visualization techniques. Both approaches provide visual and quantitative information to medical practitioners, even if from different points of view. Indeed, shape analysis is aimed at studying the morphology of anatomical structures, while image processing is focused more on the tissue or functional information provided by the pixels/voxels intensities levels. When working with 3D models analyzing shape features, the information of the volume surrounding the structure is lost, since a segmentation process is needed to obtain the 3D shape model; however, the 3D nature of the anatomical structure is represented explicitly. With volume images, instead, the tissue information related to the imaged volume is the core of the analysis, while the shape and morphology of the structure are just implicitly represented, thus not clear enough.

The aim of my work was the integration of these two approaches in an augmented hybrid visualization tool, in order to increase the amount of information available for physicians, allowing a more accurate analysis of each patient. To this end, given a segmented anatomical district, we proposed a novel mapping of volumetric data onto the segmented surface. The resulting texture mapping is coherent to the local morphology of the segmented anatomical structure and provides an enhanced visual representation of the anatomical district. The integration of volume-based and surface-based information in a unique 3D representation also supports the identification and characterization of morphological landmarks and pathology evaluations. The main research contributions of the Ph.D. activities and Thesis were:

- the development of a novel integration algorithm that combines surface-based (segmented 3D anatomical structure meshes) and volume-based (MRI volumes) information. The integration supports different criteria for the grey-levels mapping onto the segmented surface;
- the development of methodological approaches for using the grey-levels mapping together with morphological analysis. The final goal is to solve problems in real clinical tasks, such as the identification of (patient-specific) ligament insertion sites on bones from segmented MR images, the characterization of the local morphology of bones/tissues, the early diagnosis, classification, and monitoring of muscle-skeletal pathologies;
- the analysis of segmentation procedures, with a focus on the tissue classification process, in order to reduce operator dependency and to overcome the absence of a real gold standard for the evaluation of automatic segmentations;
- the evaluation and comparison of (unsupervised) segmentation methods, finalized to define a novel segmentation method for low-field MR images, and for the local correction/improvement of a given segmentation.

2014–10/2016 **Master of Science in Biomedical Engineering (Electronic Technologies), Polytechnic of Milan, 106/110**

Title of the Thesis: *Assessment of Pulmonary Rehabilitation by Combination of Inertial Sensors and Pulse-oximetry*

Supervisor: Prof. Andrea Aliverti

Description: the project was focused on the improvement of a pre-existing smart device, sensed with a pulsioximeter, by adding an IMU sensor. The principal aim of this sensor integration was to provide a direct feedback to the patient on the quality and intensity of his physical activity, during the rehabilitation tasks. Moreover, it would help the physician in the follow up of the patient. For the development of the project I spent six months in England working with Heartland Hospital in Birmingham and Warwick University. During the thesis project, I gained experience in interviewing and collaborating with phisioterapists and surgeons.

- 2010–2013 **Bachelor of Science in Biomedical Engineering**, *Polytechnic of Milan*, 95/110
Title of the Thesis: *Pletismografia Resistiva: progettazione, realizzazione e validazione di un nuovo strumento per la misura del volume toracico ed addominale*
Supervisor: Prof. Andrea Aliverti
Description: we developed a resistive plethysmography to measure torachical and abdominal respiratory volumes variation separately. We leveraged two resistive bands made of elastic bands sprayed with graphite. The sistem was developed through a Psoc microcontroller, for signal acquisition and sampling, Labiew for signal visualization, and Matlab for signal processing and analysis. The system was validated using Resptrace inductive pletismograph as a Gold standard.
- 2005–2010 **High School Degree**, *Liceo Scientifico O. Grassi, Savona*, 93/100

Publications

Journal Papers

- M. Paccini, G. Patané, M.Spagnuolo, *3D Anatomical Modelling and Analysis of the Spine* (submitted to *Computerized Medical Imaging and Graphics*) 2022
- M. Paccini, G. Patané, M.Spagnuolo, *Analysis of 3D Segmented Anatomical Districts through Grey-Levels Mapping*, *Computers & Graphics* 2020 volume 91 pp 179-188, <https://doi.org/10.1016/j.cag.2020.07.015>

Conference Proceedings

- M. Paccini, G. Patané, M.Spagnuolo, *Combining Image and Geometry Processing Techniques for the Quantitative Analysis of Muscle-Skeletal Diseases*, *Lecture Notes in Computer Science* volume 13373 pp 450, ICIAP 2021.
- I. Banerjee, M. Paccini, E. Ferrari, C. E. Catalano, S. Biasotti, M. Spagnuolo, *Feature-based Characterization of Patient-specific 3D Anatomical Models*, *Smart Tools and Applications in Graphics*, STAG 2019. <https://doi.org/10.2312/stag.20191362>

Posters

- M. Paccini, G. Patané, M.Spagnuolo, *Comparison and Integration of Erosion Evaluation Methods in Rheumatic Degenerative Diseases*, *Smart Tools and Applications in Graphics*, STAG 2020. DOI: <https://doi.org/10.2312/stag.20201249>
- M. Paccini, G. Patané, M.Spagnuolo, *Mapping grey-levels on 3D Segmented Anatomical Districts*, *Smart Tools and Applications in Graphics*, STAG 2019. DOI: <https://doi.org/10.2312/stag.20191371>

Abstracts

- M. Paccini, R. di Francia, C. K. Golby, M. Elliott, A. Aliverti *Using Data From Low-cost Off the Shelf Devices to Monitor Exercise Adherence in Respiratory Patient, During Their Pulmonary Rehabilitation Programme*, *SAGE journals Digital Health Proceedings of the Second West Midlands Health Informatics Network* vol 2 pp 13. <https://doi.org/10.1177/2055207616676808>

Technical Reports

- M. Paccini, G. Patané, M. Spagnuolo *3D Anatomical Representations and Analysis: an Application to the Spine*, *Arxiv* 2022. DOI: <https://doi.org/10.48550/arXiv.2208.08983>

Scientific Committee and Reviewer

Scientific Committee

PATTERN 2022, Barcelona

International Conference on Pervasive Patterns and Applications

PATTERN 2021, Porto

International Conference on Pervasive Patterns and Applications

GRSI

International Evaluation Committee for the Graphics Replicability Stamp Initiative (<http://www.replicabilitystamp.org/>)

Reviewer

CGI 2022, Computer Graphics International

EUROGRAPHICS 2022, Annual Conference of the European Association for Computer Graphics

IEEE-EMBS 2021, International Conference on Biomedical and Health Informatics (BHI)

Conference Talks and Seminars

- Lecce, June 2022 *Combining Image and Geometry Processing Techniques for the Quantitative Analysis of Muscle-Skeletal Diseases*, International Conference on Image Analysis and Processing (ICIAP) 2021
- Cagliari, November 2019 *Feature Based Characterization of Patient-Specific 3D Anatomical Models*, Smart Tools and Applications in Graphics (STAG) 2019
- Firenze, November 2020 *Comparison and Integration of Erosion Evaluation Methods for Rheumatic Degenerative Diseases*, Smart Tools and Applications in Graphics (STAG) 2020
- Graz, September 2020 *Analysis of 3D segmented anatomical districts through grey levels mapping*, 13th Workshop on 3D Object retrieval (3DOR) 2020
- Warwick, January 2016 M. Paccini, R. di Francia, C. K. Golby, M. Elliott, A. Aliverti *Using Data From Low-cost Off the Shelf Devices to Monitor Exercise Adherence in Respiratory Patient, During Their Pulmonary Rehabilitation Programme*, Second West Midlands Health Informatics Network (WIN) 2016.
- Genova, February 2021 *Novel Representation and Analysis of 3D Segmented Anatomical Districts*, IMATI-CNR and University of Genova
- Genova, May 2020 *Enhanced Visualization of 3D Segmented Anatomical Districts With Grey-Levels Mappings*, IMATI-CNR
- Genova, June 2019 UNIGE seminar on deep learning summer school

Conferences and Seminars Participations

Conferences

- ICIAP International Conference on Image Analysis and Processing May 2022, Lecce
- MI4LS Meet in Italy for Life Sciences September 2021, Genova
- STAG Smart Tools and Applications in Graphics November 2020, online
- 3DOR 3D Object Retrieval, September 2020, online
- STAG Smart Tools and Applications in Graphics November 2019, Cagliari
- EG Eurographics May 2019, Genova
- IEEE VIS Vast Infovis Scivis, October 2018, Genova

Seminars

- CNR IMATI seminars, Genova 2021
- CNR IMATI seminars, Genova 2020
- Malga kickoff event, Genova 2019

Student Volunteer

- 2019 Student Volunteer at Eurographics 2019, the 40th Annual Conference of the European Association for Computer Graphics, 6-10 Maggio Genova.

Technical skills

Languages

- English Proficient level in speaking, reading and writing.

Informatic skills

- Matlab
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Advanced Courses

- November, 2020 Python Programming: A Concise Introduction, Coursera online lectures
- September, 2019 Fundamentals of Digital Image and Video Processing, Coursera online lectures (8 CFU)
- November, 2019 Alle soglie di un mondo nuovo. Etica e sviluppo tecnologico nelle scienze della vita, Scuola di Scienze Mediche e Farmaceutiche (1CFU)
 - July, 2018 2nd international summer school on deep learning (15 CFU)
 - May, 2018 “Machine Learning” course by Andrew Ng from Stanford University, Coursera online lectures (8 CFU)