

PERSONAL INFORMATION Giulia Pagnanelli

EDUCATION AND TRAINING Ph.D. in Robotics and Automation Engineering: 'Design and validation 11/2022of advanced sensing and wearable feedback devices for rehabilitation and assessment' University of Pisa, Pisa (Italy) Affiliation: Research Centre 'Enrico Piaggio' Research Activity: My research focuses on the design and validation of wearable haptic devices and related control feedback interfaces. The aim is to obtain an artificial reproduction of tactile sensing to improve the upper-limb prosthesis and provide rehabilitation support. I am in collaboration with Bristol University in the development of a model-based system with a biomimetic approach for the recognition of compliance properties of objects in manipulation tasks by exploiting a soft biomimetic tactile sensor. I am involved in the ERC Synergy Grant "Natural BionicS" project which deals with the development of latest-generation prostheses, in order to obtain "natural" limbs to be connected to the central nervous system. I am involved in the Tuscany Health Ecosystem project of PNRR, for which I deal with haptic feedback interfaces for prostheses and supernumerary extra-hands. I work on a project in collaboration with the gynecology unit of the Santa Chiara Hospital concerning the development of a tactile feedback system for the execution of promontosacropexy with robotic telesurgery. Keywords: haptics, soft tactile sensing, computational models for perception. Master Degree in Robotic and Automation Engineering 09/2020-07/07/2022 University of Pisa, Pisa (Italy) Mark: 110 cum laude Computer Engineering exams: Informatica e Sistemi in Tempo Reale (30); Computational Intelligence (30L); Meccatronica (28); Thesis: Energy-based control for a continuum soft robot: taming and exploiting the dynamic behavior Bachelor Degree in Biomedical Engineering 09/2015-13/02/2020 University of Pisa, Pisa (Italy) Mark: 96 Computer Engineering exams: Fondamenti di Informatica-Java (19); Elettronica (with Reti Logiche) (23); Thesis: Force Feedback in Minimally-Invasive Surgery SPECIALIZATION COURSES S.I.D.R.A. Ph.D. Summer School 2021 12/07/2021-17/07/2021 held in Bertinoro, Forlì-Cesena, Italy **Topic:** Modeling and Control of Soft Robots Coordinators and Teachers: Prof. Antonio Bicchi (University of Pisa and IIT, Pisa, Italy), Prof. Alessandro De Luca (University of Rome, La Sapienza, Rome, Italy), Prof. Bruno Siciliano (University of Naples Federico II, Naples, Italy), Prof. Cosimo Della Santina (TU Delft, Delft, Netherlands) and Prof. Stanislao Grazioso (University of Naples Federico II, Naples, Italy) SSNR Ph.D. Summer School 2023 11/06/2023-16/06/2023 held in Baiona, Spain





Control of Uncertain Systems **Robust Control of a hard disk drive**: The project considers the design of a robust servo system of a hard disk drive. Since the trend in hard disk design is to build smaller disks with increasingly larger capacities, it is necessary to have a smaller track for the read/write heads. A smaller track means that there is a smaller tolerance in the positioning of the head. The controller for track following has to achieve tighter regulation in the presence of parameter variations, nonlinearities, and noises. Hence, it is appropriate to use advanced design methods in order to achieve robust stability and robust performance of the closed-loop servo system. In the project, the LQG/LTR with μ -analisys is applied as a robust design method. The project is developed on the software Matlab.

Emergency drone landing: looking for a safe landing point using a semantic segmenta-Guidance and Navigation systems tion neural network: Study of drone emergency landing employing a semantic segmentation neural network. A drone has to land in an emergency, on a safe point, using a camera that looks downward. The objective is to exploit a segmentation neural network and computer vision to analyze the underlying environment and find a good landing point. The Multi-Scale-Dilation Net (MSDNet) is used as a segmentation network and was trained on the UAVid dataset composed of images in an oblique view. The training was done in Ubuntu on an Nvidia GeForce RTX 3070, using the TensorFlow 1.3 library and Python 2.7. The vision algorithm that looks for a safe landing point was developed by using the OpenCV library. The segmentation network, combined with the vision algorithm, is tested on a simulator created in the Unity environment. The simulator simulates the drone and the camera and has a pilot to command the drone manually or automatically. The camera in Unity and the MSD-Net communicate with a UDP connection: the camera sends the image to the Net, the Net predicts the image and the vision algorithm returns pixel coordinates of the point. These coordinates are transformed into a 3D space coordinate exploiting the drone's altitude. Speed control for the drone, which takes the 3D coordinates of the landing point as a reference, has been realized. Thanks to a UDP connection, the controller communicates with the pilot, and the drone can automatically land on the artificial point safely.

> Robotics **Study of a Soft and Rigid Robot**: Study of KUKA and FRANKA manipulators with the application of Computed-Torque Control, Backstepping Control, and Adaptive Backstepping Control for trajectory tracking. Study of an under-actuated system with the application of a partial feedback linearization as a preliminary phase for the application on the soft robot. Study of the model and the characteristics of a soft robot and control design to exploit the intrinsic capabilities of the robot. The work is developed in Matlab-Simulink.

Ph.D. Projects

Model-Based Approaches for Compliance Discrimination via Biomimetic Optical Tactile Sensors: Development of a custom C++ application for experimental data collection using optical tactile sensors, force/torque sensors, and actuators (classical motors and variable stiffness actuators). Development of vision algorithms in Python, as well as Python and MATLAB code for method implementation and data analysis, respectively. See publication [5, 3].

Model-Free Approaches with Optical Tactile Sensors (OTS) for tactile information extraction: Development of Neural Networks for classification and Optical Flow Estimation based on OTS images using Pytorch libraries. Development of ROS architecture using both C++ and Python programming languages for implementing: (i) autonomous framework for object compliance estimation using robot-manipulator and OTS; (ii) autonomous framework for Robot Trajectory Control (Haptic Retargeting task) using tactile information estimated from optical flow inference. Both works are under review.

Wearable Haptic Devices: Development of C++ code for motion-tracking system and Matlab-Simulink code employed for device characterization. Development of a custom C++ application for device usage in various experimental validation scenarios, both with and without human participants. See publication [4, 1]

Bilateral Teleoperation Framework for Robot-Assisted Surgical Procedures: Development of MPL Network for tissue classification (using Tensorflow and Keras libraries). Development of a ROS architecture using C++ and Python for haptic-based teleoperation between a haptic device and a robot manipulator. The system incorporates Time-Domain Passivity Control to respect passivity constraints while providing haptic feedback of implemented Virtual Fixtures (VFs). VFs are implemented via a custom vision-based framework developed in Python, leveraging network inferences.



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PUBLICATIONS
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Peer-Reviewed Journals

- [1] **Giulia Pagnanelli**, Giovanni Latella, Manuel G Catalano, and Matteo Bianchi. "A Pneumatic-Actuated Feel-Through Wearable Haptic Display for Multi-Cue Delivery". In: *IEEE Robotics and Automation Letters* (2024).
- [2] **Giulia Pagnanelli**, Michele Pierallini, Franco Angelini, and Antonio Bicchi. "Assessing An Energy-Based Control for the Soft Inverted Pendulum in Hamiltonian Form". In: *IEEE Control Systems Letters* (2024).
- [3] **Giulia Pagnanelli**, Lucia Zinelli, Nathan Lepora, Manuel Catalano, Antonio Bicchi, and Matteo Bianchi. "Integrating Human-Like Impedance Regulation and Model-Based Approaches for Compliance Discrimination via Biomimetic Optical Tactile Sensors". In: *IEEE Transactions on Robotics* (2024).
- [4] Simone Fani, Simone Ciotti, **Giulia Pagnanelli**, Alessandro Moscatelli, Yuri De Pra, and Matteo Bianchi. "Modulating the Perceived Softness of Real Objects Through Wearable Haptics". In: *IEEE Transactions on Haptics* 16.4 (2023), pp. 543–548.
- [5] Giulia Pagnanelli, Simone Ciotti, Nathan Lepora, Antonio Bicchi, and Matteo Bianchi. "Model-Based Compliance Discrimination via Soft Tactile Optical Sensing and Optical Flow Computation: A Biomimetic Approach". In: *IEEE Robotics and Automation Letters* 8.10 (2023), pp. 6611–6618.

Peer-Reviewed Conferences

[1] Océane Duvert, **Giulia Pagnanelli**, Alessandro Moscatelli, and Matteo Bianchi. "On the role of tactile motion estimates and hand side in bimanual reaching tasks". In: *2024 IEEE Haptics Symposium (HAPTICS)*. IEEE. 2024, pp. 47–52.

Peer-Reviewed Short-Conference/Workshop Contribution

- [1] **Giulia Pagnanelli**, Manuel G. Catalano, and Matteo Bianchi. *A Pneumatic Feel-Through Wearable Haptic Device*. Proc. I-RIM Conf. I-RIM. Rome (Italy). 2024.
- [2] Paolo Susini, Giulia Pagnanelli, Marco Greco, and Matteo Bianchi. Human-Inspired Haptic-Based Planning and Control for Robotic Sliding Movements. Proc. I-RIM Conf. I-RIM. Rome (Italy). 2024.
- [3] Lucia Zinelli, **Giulia Pagnanelli**, Nathan Lepora, Manuel G. Catalano, Antonio Bicchi, and Matteo Bianchi. *Compliance discrimination via biomimetic optical tactile sensors and human-like impedance re-gulation*. Proc. I-RIM Conf. I-RIM. Rome (Italy). 2024.
- [4] **Giulia Pagnanelli**, Nathan Lepora, Antonio Bicchi, and Matteo Bianchi. *Model-based biomimetic approach for compliance discrimination through soft tactile optical sensing*. Proc. I-RIM Conf. I-RIM. Rome (Italy). 2023.

Maria Oddo, Domenico Prattichizzo, Eckehard Steinbach. University of Pisa, 2023.

REVIEW ACTIVITIES	
International Journals	 IEEE Transaction on Haptics IEEE Robotics and Automation Letters (RA-L)
International Conferences	 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2024) IEEE International Symposium on Robotics Research (ISRR 2024)
ORGANIZED ACTIVITY	
	 Seminar Challenges and trends in haptics: Sensing, Feedback, and Communication. Invited speakers, Monica Gori, Lucia Seminara, Matteo Bianchi, Nathan Lepora, Calogero



PRESENTATIONS	
Conferences	 - 5th Institute of Robotics and Machine Intelligence (I-RIM) 3D Conference, 20th - 22th October 2023, Rome, Italy (Poster and Teaser Presentation)
	 International Conference of Robotics and Automation (ICRA2024), 13th - 17th May 2024, Yokohama, Japan (Poster and Teaser Presentation)
	 - 6th Institute of Robotics and Machine Intelligence (I-RIM) 3D Conference, 25th - 27th October 2024, Rome, Italy (Poster and Teaser Presentation)
	 Conference on Decision and Control (CDC2024), 16th - 19th December 2024, Milan, Italy (Poster and Teaser Presentation)
Invited talks	 University of Pisa, Seminar 'Challenges and trends in haptics: Sensing, Feedback and Communication' - Title: Model-based compliance discrimination via soft tactile optical sensing and optical flow computation: a biomimetic approach.
	 IEEE-Day, Italy Section - Title: Energy-Based Control for a Continuum Soft Robot: taming and exploiting the dynamic behavior
	 Reconcycle summer school - Title: Model-based compliance discrimination via soft tactile optical sensing and optical flow computation: a biomimetic approach.
	 University of Pisa, Forelab - Title: I robot hanno tatto! Come riprodurre i sensi naturali nell'artificiale.
	 Workshop ViTac held at conference ICRA2024 - Title: From Optical Flow to Tactile Flow: Background and new Results.
	- IEEE Women in Engineering Day (Italy Section) - Title: Advanced Technologies in Mini- mally Invasive Surgery and Tele-Surgery
	- BRIGHT Nigth 2024, Pisa - Title: Il tatto del futuro: tra mondo reale e mondo virtuale
WORK EXPRIENCE	
	 Peer tutoring with the Information Engineering Department at the University of Pisa
	 Teaching support for master's degree of Robotics and Automation Engineering - Course of 'Controllo dei Processi' - Module: 'Sensori per robotica e automazione' - at the University of Pisa.
PERSONAL SKILLS	
Languages	 Italian: Native Speaker English: Complete Professional Skills
Organisational / managerial skills	 Ability to work in situations of stress related to the deadlines of work projects. Team Working Problem Solving

- Ease of adaptation to new situations or sudden changes.



Curriculum vitae

Job-related skills Knowledge of different programming languages:

- C/C++
- C/C++
 Python
- Javascript

Knowledge of different frameworks, libraries, and tools:

- MATLAB Simulink Sisotool RoboticsToolbox
- Boost
- ROS
- Docker, LVM
- OpenCV
- Tensorflow Keras
- Pytorch
- Solidworks
- Arduino-Code
- git

Knowledge of different Operating Systems:

- Windows
- Linux

Skills regarding control, vision, and AI systems applied to robotics

Digital skills Excellent office suite skills. Knowledge of LaTeX. Expertise in the creation of digital presentations and photo editing programs.

ADDITIONAL INFORMATION

Processing of personal data

I authorize the processing of personal data contained in my curriculum vitae based on art.
 13 of Legislative Decree 196/2003 and art.
 13 of EU Regulation 2016/679 concerning the protection of individuals with regard to the processing of personal data.