Gennaro Raiola

Curriculum Vitae

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Fields of interest

Robotics, programming, human-robot interaction, motion control, force control, inverse kinematics and dynamics, whole-body control, hardware integration, embedded, DevOps, ROS.

Profession

04/2021– current

Research fellow, *Leonardo s.p.a.*, Genoa, Italy.

In Leonardo I work in the joint robotic laboratory with the Italian Institute of Technology (IIT) on the development of software algorithms for autonomous navigation and locomotion of unmanned ground vehicles (UGVs) in unstructured environments.

- Given my experience and seniority, I coordinate and lead the daily activities of the laboratory, which include:
  - supervising the research activities of my group,
  - working on european project proposals,
  - definition of the activities and the necessary hardware to develop and build a new quadruped robotic platform for navigation and exploration of unstructured enviroments.
- Technical work:
  - setup of the lab computers and network,
  - DevOps such as setup of the git repository, internal Docker registry, etc... ,
  - setup of the robot software and pilot stations,
  - created the kinematics and dynamics model for the ESA robot Mirror in collaboration with IIT,
  - developed navigation, exploration and detection algorithms for mobile robots,
  - created a state estimation algorithm to track and pick boxes of various shapes with robotic manipulators (internal project with Leonardo automation division),
  - created a state estimation for control and odometry of quadruped robotic platforms,
  - created virtual enviroments with Docker to ease the deployment of AI and vision software on the robots,
  - contributed to the preparation of the following papers:
    - "WoLF: the Whole-body Locomotion Framework for Quadruped Robots" (accepted).
    - "Target-Referred DMPs for Learning Bimanual Tasks from Shared-Autonomy Telemanipulation" (accepted).
    - "FollowMe: a Robust Person Following Framework Based on Visual Re-Identification and Gestures" (under review).
    - "Design and Validation of a Multi-Arm Relocatable Manipulator for Space Applications" (accepted).

09/2019–9/2020 **Postdoctoral researcher**, *Jet Propulsion Laboratory (NASA-JPL)*, Pasadena, CA, United States.

At JPL I worked on demonstration of autonomous berthing, assembly and installation of scientific payloads using a robotic platform mounted on a testbed simulating a scientific space station.

- Autonomous berthing:
  - created a state estimator to track the full pose and velocity of an incoming payload using Kalman filtering via a fiducial detector,
  - developed a new software module for the testbed to generate coordinated motions of the robotic arm in order to intercept and dock the incoming payload by means of inverse kinematics and force control,
  - performed experiments in preparation for the paper *Validating an Architecture for Robotic Assembly and Servicing of Hosted Payloads on a Persistent Platform*,
  - gained experience with the JPL testbed software architecture and the m3tk simulation software,
  - integrated some of the functionalities of the testbed with the robotic operating system (ROS).
- Autonomous assembly:
  - developed code to perform assembly of instruments using fiducial movements for localization and positioning of the instrument and force control for interaction,
  - performed two demos in which the robot is able to autonomously assemble a starshade and a satellite dish,
  - created new modules and autonomous behaviors for the testbed.

06/2017–06/2019 **Postdoctoral researcher**, *Istituto Italiano di Tecnologia (IIT)*, Genoa, Italy.

During my work at IIT, I had the opportunity to work on several aspects of the development and maintenance of software and electronics for the quadruped robots HyQ and HyQReal.

- Developed a real-time control framework and communication system with EtherCAT,
- developed the software control architecture with ROS-Control, in order to make the robot capable of executing different types of gaits (e.g. crawl, trot, etc.) in complex and changing terrains,
- developed the low level safety software layer to protect the robot hardware and human operators.
- DevOps processes, including:
  - creating and maintaining fully automated CI/CD pipelines for code testing and deployment using GitLab-CI,
  - deploying apt servers to track the software dependencies,
  - developing Docker containers for code testing and development.
- Sensor integration and calibration for the HyQReal robot.
- Research work to create a novel whole-body locomotion framework for quadrupedal robots using inverse dynamics and task optimization which led to the publication of the journal paper *A simple yet effective whole-body locomotion framework for quadruped robots*.
- Collaboration with external work groups such as Moog and Vodafone to define the requirements and functionalities of the robots for various real-world scenarios.

03/2017–06/2017 **Postdoctoral researcher**, *Robotics and Mechatronics group, University of Twente*, Enschede, The Netherlands.

At the University of Twente, I worked on the development of a safety- and energy-aware impedance controller for the KUKA LWR 4+ robotic arm.

- publication of the journal paper *Development of a Safety and Energy Aware Impedance Controller for Collaborative Robots* on IEEE Robotics and Automation Letters which was selected for presentation at ICRA 2018.

01/2016-12/2016 **Software engineer**, *CEA-List (French Alternative Energies and Atomic Energy Commission - Laboratory for Integration of Systems and Technology)*, Gif-sur-Yvette, France.

During the last year of my PhD, I had the opportunity to transfer my research results to a startup at CEA-List (ISybot).

- development of a force controller to generate virtual guides through kinesthetic teaching to be used within the software framework of the startup's collaborative robot.

01/2013–12/2013 **Research engineer**, *PAL Robotics S.L.*, Barcelona, Spain.

At PAL Robotics, I worked on a team to design and test the ROS-Control package. The aim of ROS-Control is to implement a Hardware Abstraction Layer for different kinds of robots (e.g. humanoids, manipulators, mobile robots, etc.).

- implemented via ROS-Control an inverse kinematics controller with task optimization for REEM-H and REEM-C robots in collaboration with LAAS-CNRS in France.

06/2012–12/2012 **Intern**, *ENSTA-ParisTech and UPMC-ISIR*, Paris, France.

I developed a library in Matlab and C++ to generate motion primitives and perform skill optimization for humanoid robots (MEKA, NAO, ICub and Pepper). This library has been successfully used with the SoftBank robot Pepper to learn and play the "ball in the cup" dexterous game.

Education

2014–2016 **Ph.D. in Robotics**, *École polytechnique*, Palaiseau, France.

2009–2012 **Master's Degree (M.Sc) cum laude in Automation and Control Engineering**, *University of Naples "Federico II"*, Naples, Italy.

2006–2009 **Bachelor's Degree (B.Sc) in Computer Engineering**, *University of Naples "Federico II"*, Naples, Italy.

Technical skills

- Proficient in the following programming languages: **C**, **C++** and **Matlab**
- Competent with **Python** and **Bash** scripting.
- Competent with **Qt**, **Eigen** and **ROS**
- Excellent knowledge of **GIT**.
- Excellent knowledge of **CMake** and **Makefile** for managing the build process of software and Doxygen for code documentation.
- Competent with **Docker** and **Virtual Machines** deployment for testing and development.

- Deep knowledge of **Linux**-based operating systems (Ubuntu, Kali, Debian).
- Experienced with real time operating systems **RTOS** (RTAI, Xenomai, RT-PREEMPT), Kernel configuration and **EtherCAT**.

Selected projects

- "**wolf-controller** - Whole-body Locomotion Framework for quadruped robots"
- "**wolf-navigation** - Navigation stack for the whole-body locomotion framework WoLF"
- "**ros-controls** - A ROS based hardware interface to make controllers generic to all robots"
- "**DmpBbo** - C++ framework for Dynamic Motion Primitives and Black-Box Optimization"
- "**rt-gui** - A real-time safe and dynamically reconfigurable graphic interface based on QT and ROS"

Publications

Journals

2020 **G. Raiola**, E. Mingo Hoffman, M. Focchi, N. Tsagarakis, C. Semini.
"A simple yet effective whole-body locomotion framework for quadruped robots".
Frontiers in Robotics and AI, special issue on "Bridging the Gap Between the Lab and the Real World: Future Perspectives for Legged Robots".

2019 R. Orsolino, M. Focchi, S. Caron, **G. Raiola**, V. Barasuol, C. Semini.
"Feasible Region: an Actuation-Aware Extension of the Support Region".
IEEE Transactions on Robotics.

2019 F. Stulp, **G. Raiola**.
"DmpBbo: A versatile Python/C++ library for Function Approximation, Dynamical Movement Primitives, and Black-Box Optimization".
The Journal of Open Source Software.

2018 Susana Sánchez Restrepo, **Gennaro Raiola**, Joris Guerry, Evelyn D'Elia, Xavier Lamy and Daniel Sidobre.
"Towards an Intuitive and Iterative 6D Virtual Guides Programming Framework for Human-Robot Comanipulation".
Robotica.

2017 **Gennaro Raiola**, Carlos Cardenas Alberto, Tadele Shiferaw Tadele, Theo De Vries, Stefano Stramigioli.
"Development of a Safety and Energy Aware Impedance Controller for Collaborative Robots".
In *IEEE Robotics and Automation Letters.*
The contents of this paper were also selected by ICRA'18 Program Committee for presentation at the Conference.

2017 S. Chitta, E. Marder-Eppstein, W. Meeussen, V. Pradeep, A. Rodriguez Tsouroukdissian, J. Bohren, D. Coleman, B. Magyar, **G. Raiola**, M. Ludtke and E. Perdomo Fernandez.
"ros_control: A generic and simple control framework for ROS".
The Journal of Open Source Software.

2017 **Gennaro Raiola**, Susana Sanchez Restrepo, Pauline Chevalier, et al.
"Co-manipulation with a Library of Virtual Guiding Fixtures".
Autonomous Robots, special issue on "Learning for Human-Robot Collaboration".

Conferences

2022 Enrico Mingo Hoffman, Arturo Laurenzi, Francesco Ruscelli, Luca Rossini, Lorenzo Baccelliere, Davide Antonucci, Alessio Margan, Paolo Guria, Marco Migliorini, Stefano Cordasco, **Gennaro Raiola**, Luca Muratore, Joaquin Estremera Rodrigo, Andrea Rusconi, Guido Sangiovanni and Nikos G. Tsagaraki
"Design and Validation of a Multi-Arm Relocatable Manipulator for Space Applications".
IEEE International Conference on Robotics and Automation (ICRA).

2022 **Gennaro Raiola**, Michele Focchi, Enrico Mingo Hoffman.
"WoLF: the Whole-body Locomotion Framework for Quadruped Robots".
6th Workshop on Legged Robots at ICRA.

2022 Fabio Amadio, Marco Laghi, Luigi Raiano, Federico Rollo, Andrea Zunino, **Gennaro Raiola**, Arash Ajoudani.
"Target-Referred DMPs for Learning Bimanual Tasks from Shared-Autonomy Telemanipulation".
IEEE-RAS International Conference on Humanoid Robots (Humanoids), best oral paper award finalist.

2022 Federico Rollo, Andrea Zunino, **Gennaro Raiola**, Fabio Amadio, Arash Ajoudani, Nikos Tsagarakis.
"FollowMe: a Robust Person Following Framework Based on Visual Re-Identification and Gestures".
Under review for the IEEE Advanced Robotics and its Social Impacts (ARSO).

2020 Samantha Glassner, **Gennaro Raiola**, Rudranarayan Mukherjee, Spencer Backus, Alexander Brinkmann, Timothy Setterfield.
"Starshade Analog Robotic Assembly Demonstration".
International Conference on Intelligent Robots and Systems (IROS).

2017 Pauline Chevalier, **Gennaro Raiola**, Brice Isableu, Jean-Claude Martin, Christophe Bazile and Adriana Tapus.
"Do Sensory Preferences of Children with Autism Impact an Imitation Task with a Robot?".
Conference on Human-Robot Interaction (HRI).

2017 Susana Sanchez Restrepo, **Gennaro Raiola**, Pauline Chevalier, Xavier Lamy, and Daniel Sidobre.
"Iterative Virtual Guides Programming for Human-Robot Comanipulation".
IEEE International Conference on Advanced Intelligent Mechatronics (AIM).

2015 **Gennaro Raiola**, Xavier Lamy, and Freek Stulp.
"Co-manipulation with Multiple Probabilistic Virtual Guides".
International Conference on Intelligent Robots and Systems (IROS).

2015 **Gennaro Raiola**, Pedro Rodriguez-Ayerbe, Xavier Lamy, Sami Tliba, and Freek Stulp.
"Parallel Guiding Virtual Fixtures: Control and Stability".
IEEE Multi-Conference on Systems and Control (MSC).

2014 Freek Stulp, Laura Herlant, Antoine Hoarau, and **Gennaro Raiola**.
"Simultaneous On-line Discovery and Improvement of Robotic Skill".
International Conference on Intelligent Robots and Systems (IROS).

2013 Freek Stulp, **Gennaro Raiola**, Antoine Hoarau, Serena Ivaldi, and Olivier Sigaud.
"Learning Compact Parameterized Skills with a Single Regression".
IEEE-RAS International Conference on Humanoid Robots (Humanoids).

Languages

italian native proficiency

english professional working proficiency

french limited working proficiency