



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



Giancarlo D'Ago

**Dynamic compensation algorithms
for manipulation and transport of
non-rigid robotic platforms**

Tutor:

Prof. Fabio Ruggiero

co-Tutors:

Dr. Eng. Luca Buonocore

Prof. Vincenzo Lippiello

Cycle: XXXVII

Year: 2022 (First)

My background

- **MSc degree** in Automation Engineering (University of Naples “Federico II”)
- **PhD start date:** 01/01/2022
- **Partner:** European Organization for Nuclear Research (CERN)
- **Scholarship type:** CERN Doctoral Student Program
- **Research groups:**
 - CERN Mechatronics, Robotics and Operation Section (BE-CEM-MRO)
 - PRISMA Lab, UNINA



Research field of interest



- Control of non-rigid robotic systems
 - Long-reach cable-suspended robotic systems
 - Ultra-redundant and underactuated articulated systems



- Long-reach cable-suspended robots
 - Operation in high-altitude areas
 - Enlarged end-effector workspace
 - Decreased weight
 - Superior resilience to absorb collisions

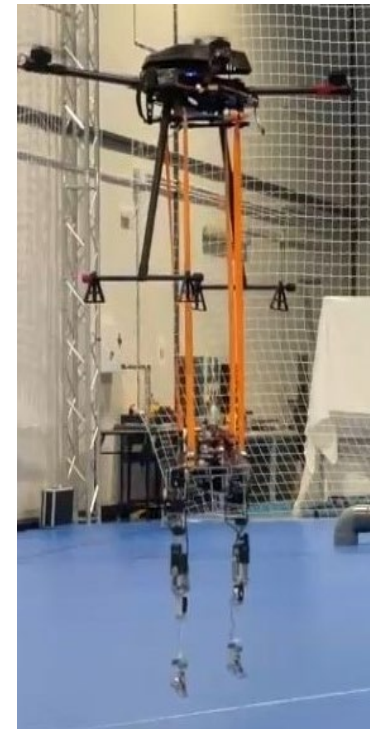


- Development of dynamic model-based compensation control strategies for manipulation and transport



(UNI SEVILLE)
Installation of
bird-diverters on
power lines

(CERN)
Inspection and
maintenance of
accelerators
infrastructures



Summary of study activities

- Ad hoc PhD courses:
 - **“Matrix Analysis for Signal Processing with MATLAB examples”** – Prof. Carotenuto: The course provides an overview on some topics in matrix theory together with their intrinsic interaction with and application to signal processing.
 - **“Statistical data analysis for science and engineering research”** – Prof. Pietrantuono: The course provides an overview of the experimental design and data analysis and is intended for PhD students in science and engineering disciplines who need to use statistical methods and data analysis as part of their research.
 - **“Operational Research: Mathematical Modelling, Methods and Software Tools for Optimization Problems”** – Dr. Masone: The course teaches how to build mathematical models of optimization problems, to be able to classify models and to know the mathematical foundations of algorithmic techniques that allow them to be solved.
- Other Courses (CERN Learning Courses):
 - **“Scientific Writing”** – Prof. Boxman: The course teaches the student how to organize and write "research reports" (journal papers, theses, and internal reports) and how to write a winning research proposal.
 - **“General and Professional French Course (A2.1)”** – Prof. Gontero: The course teaches the student the communication tools of French language for assess the level A2.1 (CECRL) and authorize to access the next level.
 - **“Crane Operator and Slinger”**: The course teaches the student how to use the overhead crane and the slinging in proper and safe conditions, and being aware of rules of driving.
 - **“Fast Forward, the productivity system for researchers”** – Dr. Sinclair: The course teaches the student get more results, by gaining new project management skills (AGILE), reduce stress levels by applying time management techniques, strengthen the foundation for the researcher’s career.

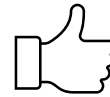
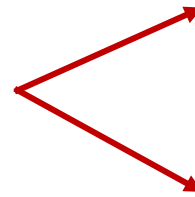
Summary of study activities

- Seminars, conferences and events attended:
 - Global and cluster synchronization in complex networks and beyond
 - IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE
 - Safety mask course
 - MATLAB & Simulink Italian Academic Forum
 - Evento Enel
 - Service and companion robots in healthcare
 - On using simple optimization techniques for tuning of UAVs
 - Using Delays for Control
 - IEEE 2022 ICRA WORKSHOP - Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust
 - Vine robots: design challenges and unique opportunities
 - 9TH BE-CEM Students' Coffee
 - Stabilizer Renyi Entropy and Quantum Complexity

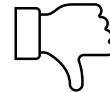
Research activity: Overview



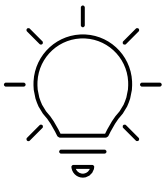
Long-reach
cable-suspended
robots



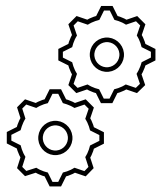
- High altitude
- Safety
- Workspace



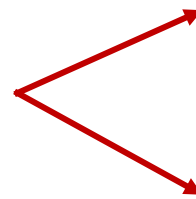
- Oscillation
- Transport and teleoperation



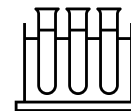
1. Use the arms themselves to reduce oscillations
2. Reactionless manipulation solutions



Modeling
Identification
Control

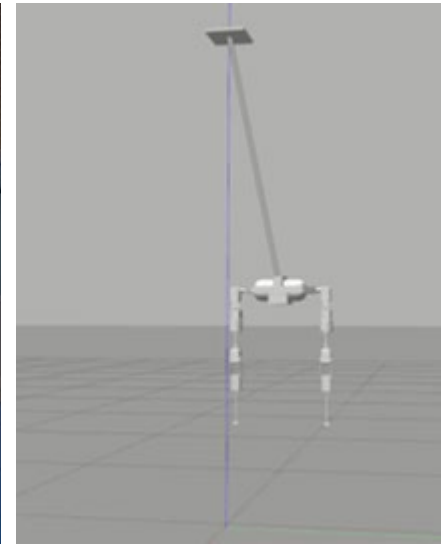
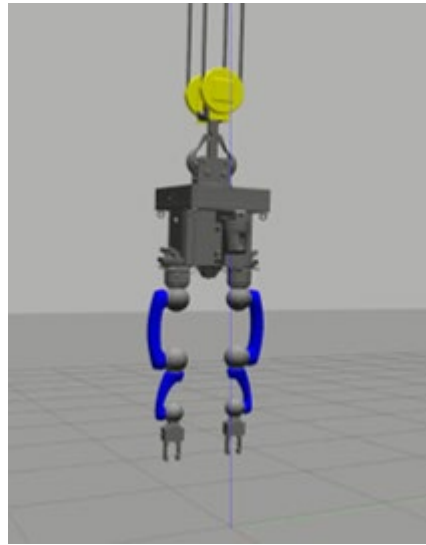
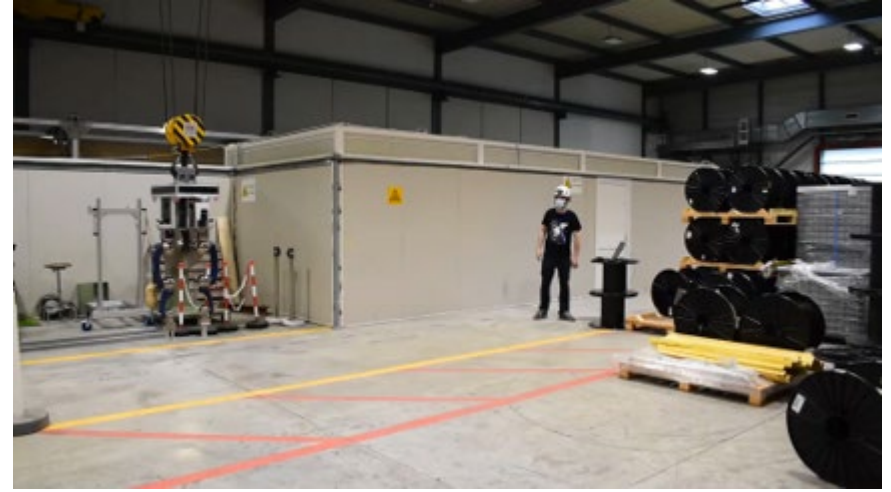


Simulation

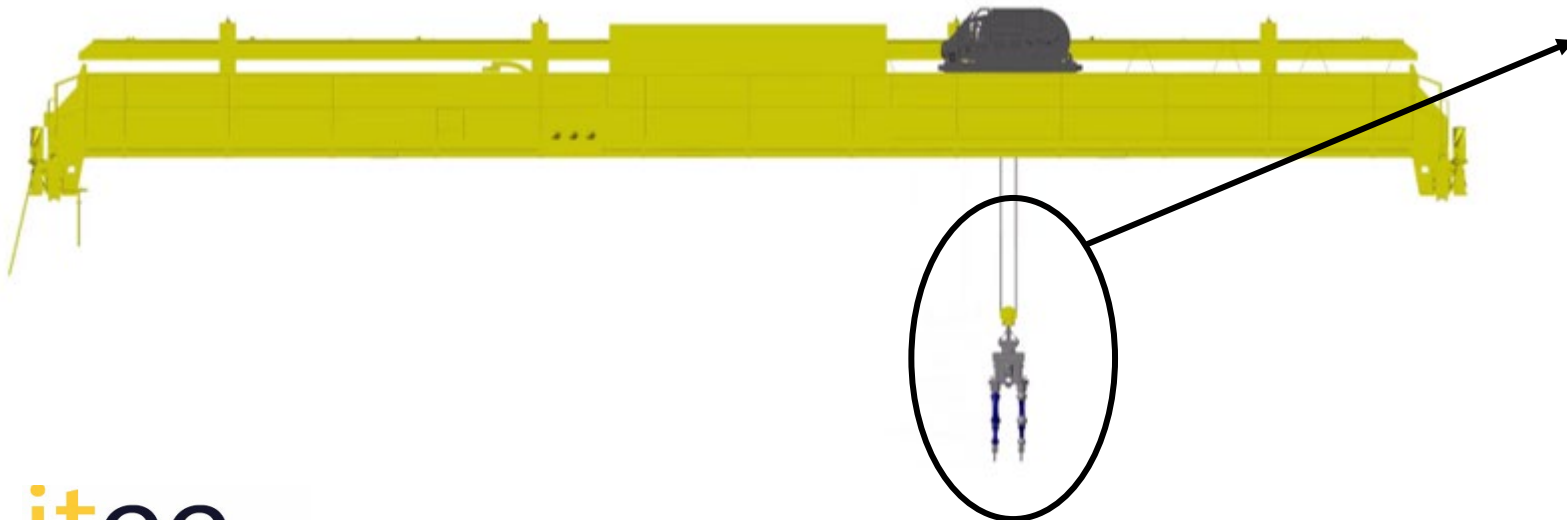
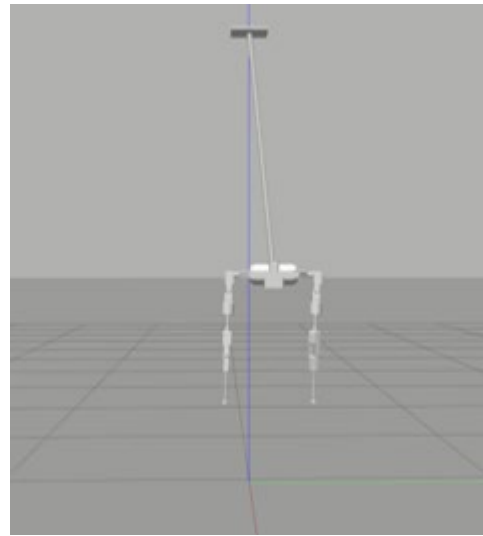
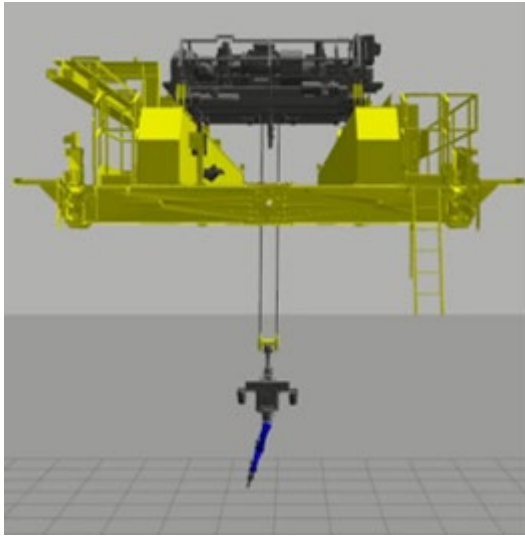


Real experiments

Modeling and Identification



Control: simulation & experiments



Giancarlo D'Ago – YEP

Products

[P1]	G. D'Ago, M. Lefebvre, L. R. Buonocore, F. Ruggiero, M. Di Castro, V. Lippiello, <i>Modelling and control of a variable-length flexible beam on inspection ground robot</i> , IEEE International Conference on Robotics and Automation, 2022.
[P2]	G. D'Ago, M. Selvaggio, A. Suarez, F. J. Ganán Onieva, L. R. Buonocore, V. Lippiello, A. Ollero, F. Ruggiero, <i>Modelling and identification methods for simulation of cable-suspended dual-arm robotic systems</i> , submitted to IEEE International Conference on Robotics and Automation, 2023.

Research activity: Next steps



1. Dynamic model improved and extended
2. New identifications
3. Theoretical study:
 - Performance evaluation
 - Improvements and corrections
4. Experimental tests on both case studies

Thanks
for your kind
attention