Viviana Morlando

Control of legged robotic systems

Tutor: Dr. Ing. Fabio Ruggiero

Cycle: XXXV

Year: Second

My background

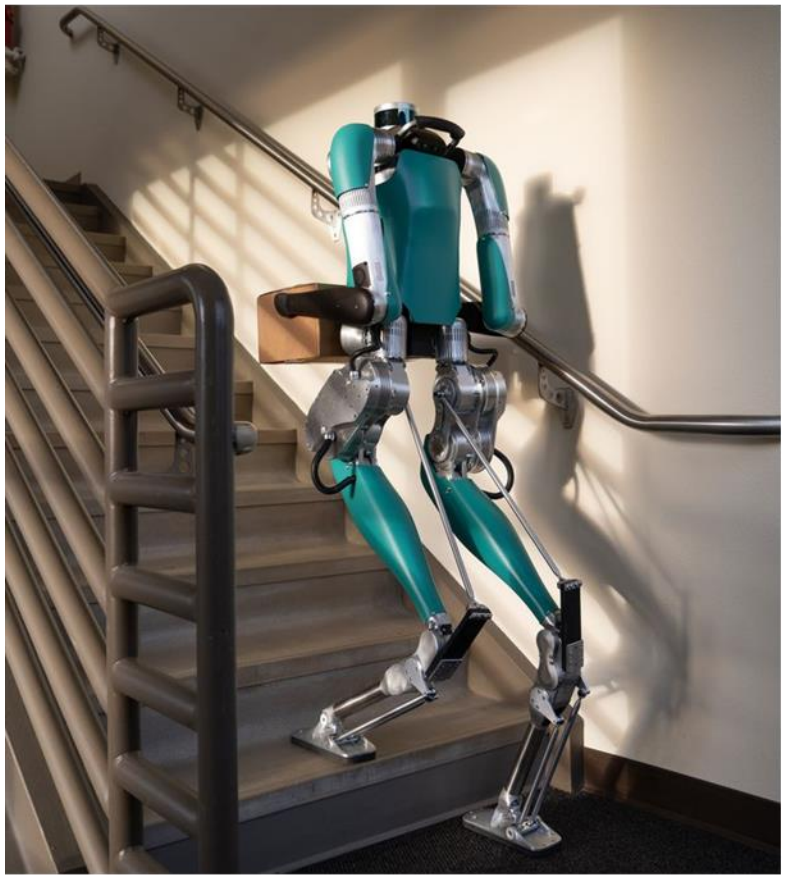
- M.Sc. in Automation Engineering Università degli Studi di Napoli Federico II

- Group: PRISMA Lab

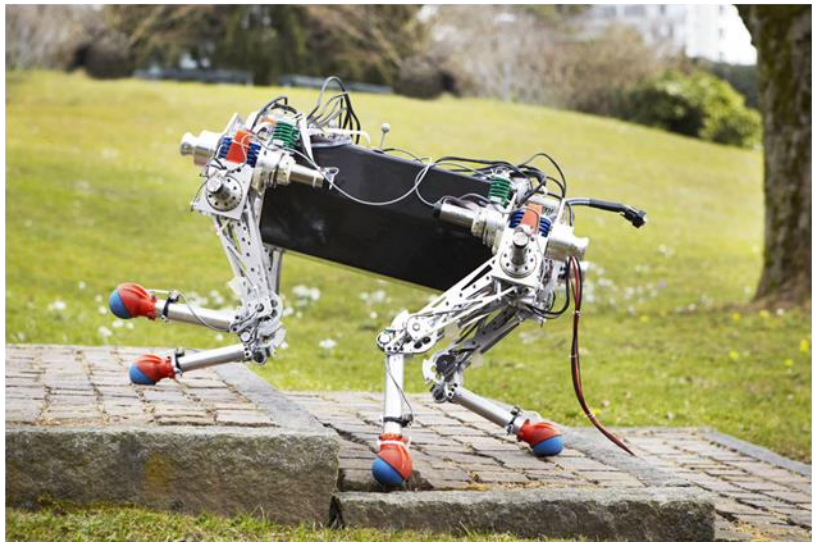
- PhD start date: 1/11/2019

- Scholarship type: DIETI PRIN 2017 "PRINBOT"

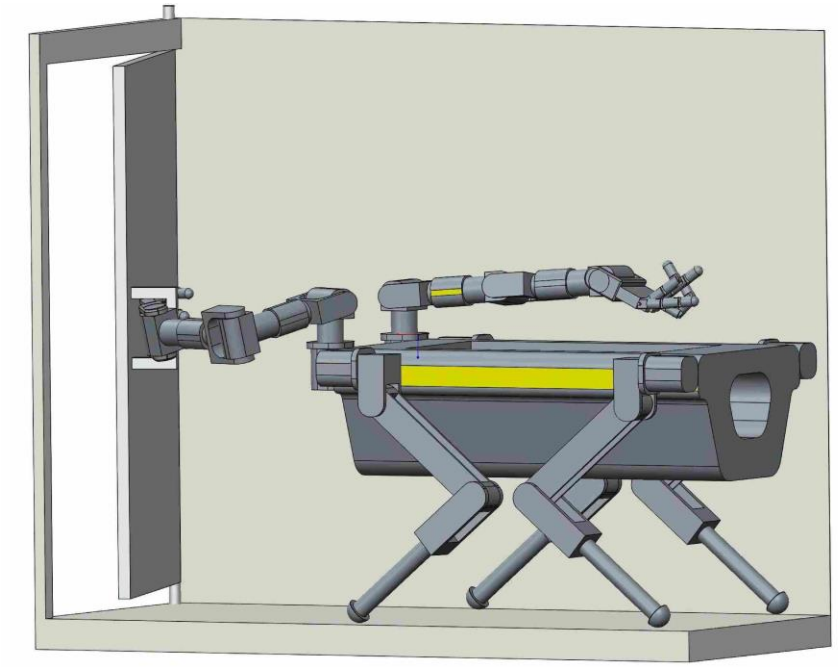
Research field of interest

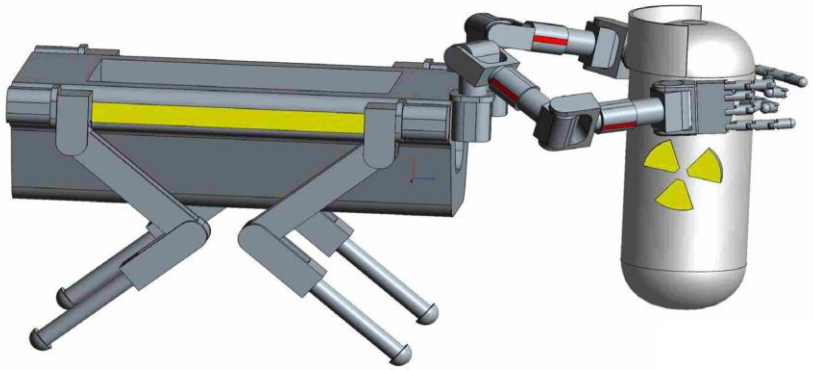


- Objective: development of autonomous systems in unstructured environments.
- Importance of legged systems: can adapt their foothold and overcome obstacles.
- Able to walk through challenging terrain inaccessible for wheeled robots.



- Number of legs: quadruped robots are the most used.
- Open challenges regarding the rejection of external disturbance and the balance.
- Quadruped with robotic arms can cooperate with humans in daily life tasks.





Summary of study activities

- **PhD school**: SIDRA 2021 PhD Summer School -Bertinoro University Residential Centre – July 12-17
  - **"Game Theory and Network Systems"** : basic concepts and notation from classical competitive game theory with a focus on network games and learning dynamics and their convergence properties.
  - **"Modeling and Control of Soft Robots"** : modeling of soft robots basing on the physics and the continuum formulation of soft robot dynamics; control oriented discretization strategies.

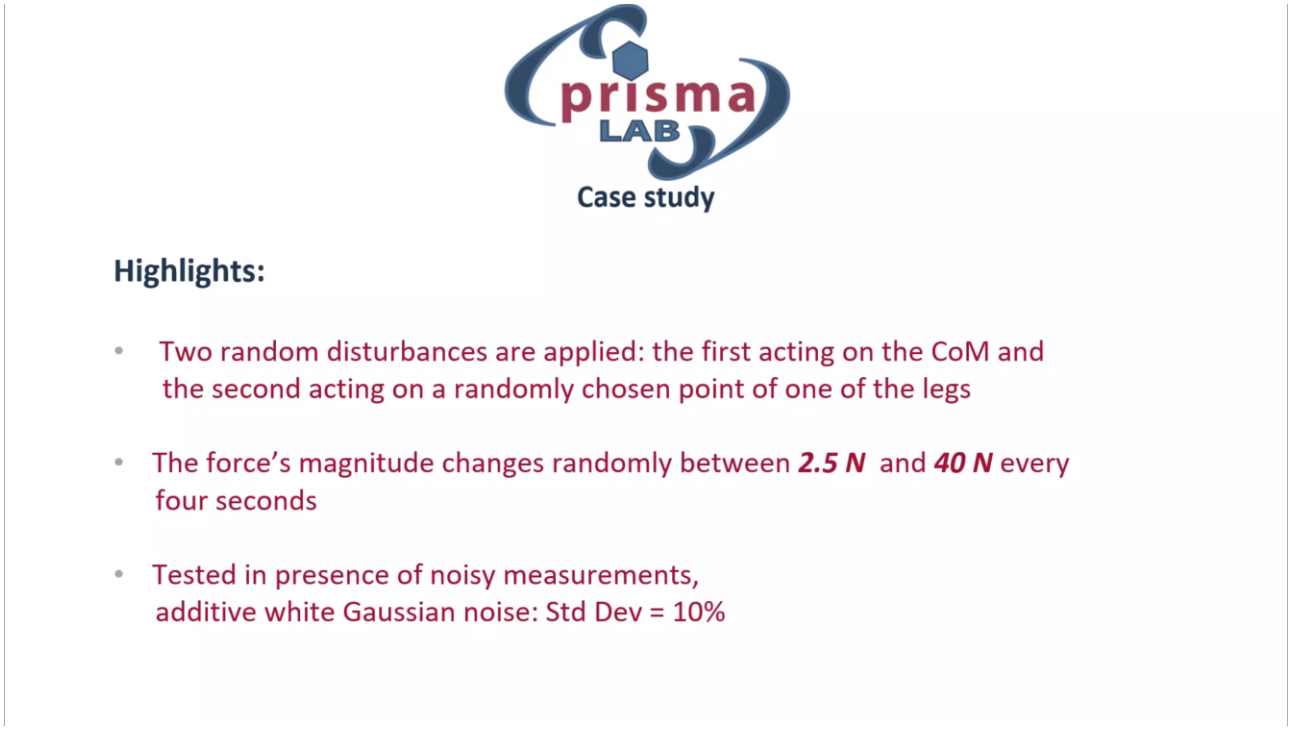
- **Ad hoc Courses**:

1. **"Scientific Programming and Visualization with Python", Lecturer:** Prof. Alessio Botta: The course gave the basic knowledge about the scientific programming language Python
2. **"Statistical data analysis for science and engineering research", Lecturer:** Prof. Roberto Pietrantuono : The course provided an overview of the experimental design and data analysis in order to use statistical methods and data analysis as part of the research.

Research activity 1

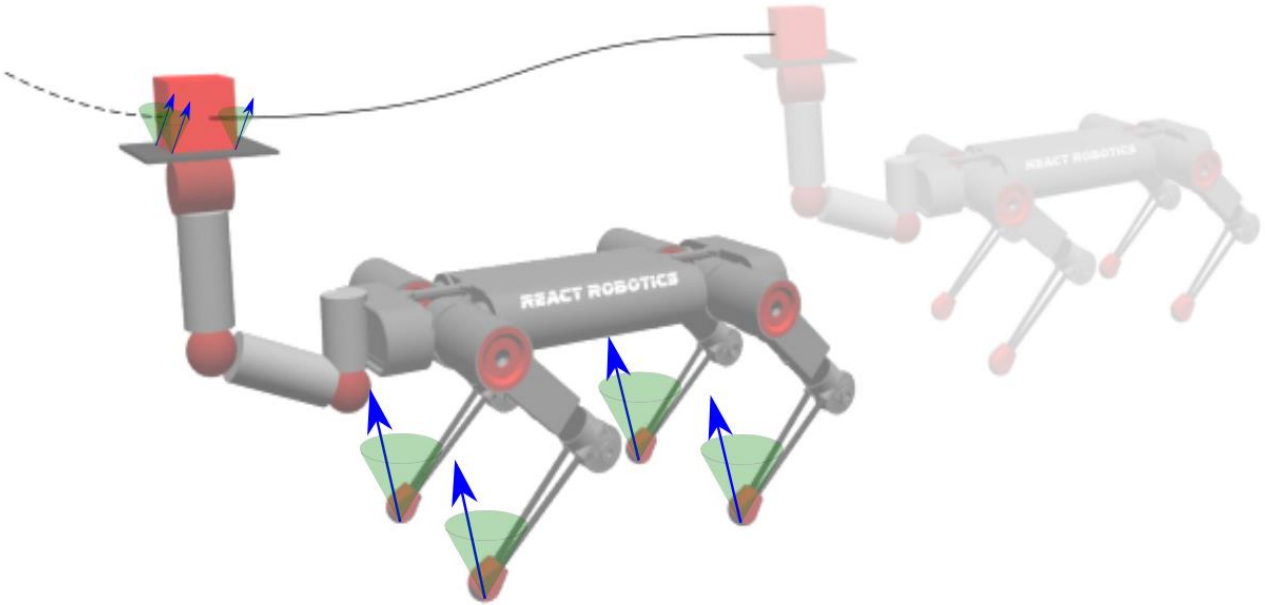
- ***Problem:*** *robust locomotion on irregular terrains*
  - *Retain the balance*
  - *Adapt foothold to the roughness of the terrain*
  - *Reject external disturbances*

- ***Solution:*** *Whole-body control with momentum-based disturbance observer*
- ***Methodologies:***
  - *Decouple the centroidal's dynamics (the dynamics of the center of mass) from the legs' ones*
  - *Consider the disturbances acting both on the CoM's and on the swing and stance legs*

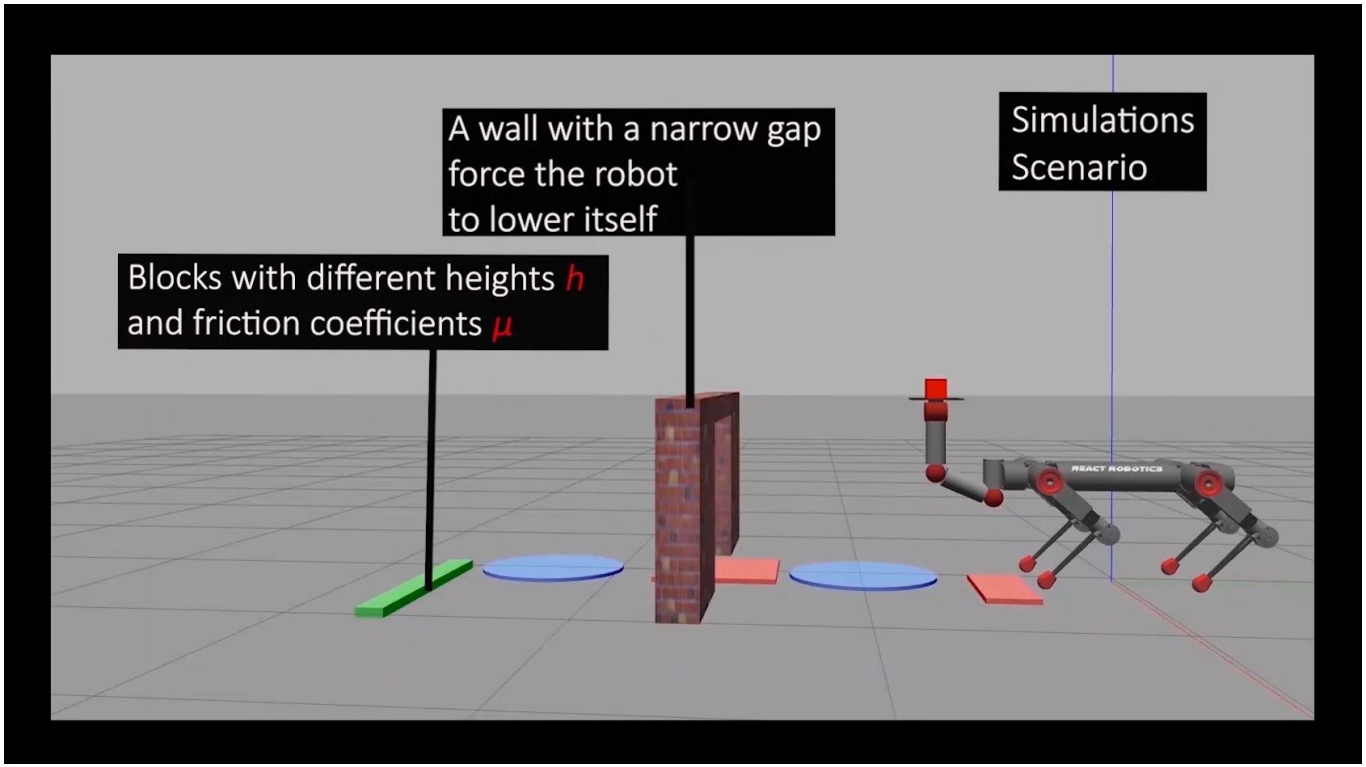


Research activity 2

- ***Problem:*** *Nonprehensile transportation with a legged manipulator*
  - Transportation of an object from an initial to a goal pose without firmly grasping it using a legged robot endowed with a manipulator arm.



- ***Solution:*** Optimization-based whole-body control architecture
- ***Methodologies:***
  - Taking into account both nonprehensile manipulation and locomotion constraints in a unified and principled way



Products

[P1]	V. Morlando, A. Teimoorzadeh, F. Ruggiero, "Whole-body control with disturbance rejection through a momentum-based observer for quadruped robots", published in Mechanism and Machine Theory 164, 2021, DOI: 10.1016/j.mechmachtheory.2021.104412 .
[P2]	V. Morlando, M. Selvaggio, F. Ruggiero, " Nonprehensile Object Transportation with a Legged Manipulator", submitted to Robotics and Automation Letters (IEEE RAL), 2022
[P3]	V. Morlando, F. Ruggiero, " Disturbance rejection for legged robots through a hybrid observer", submitted to IEEE International Conference on Robotics and Automation 2022 (ICRA 2022)

Thank you for the attention!