

# ANYmal parkour: Learning agile navigation for quadrupedal robots

MICRO-507 - Legged Robots

TRINCA-VESPAN Maria

FOUBERT Oscar

DUBOIS Victor

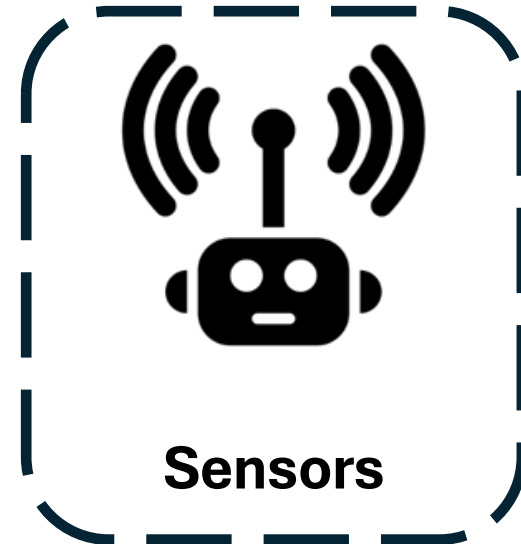
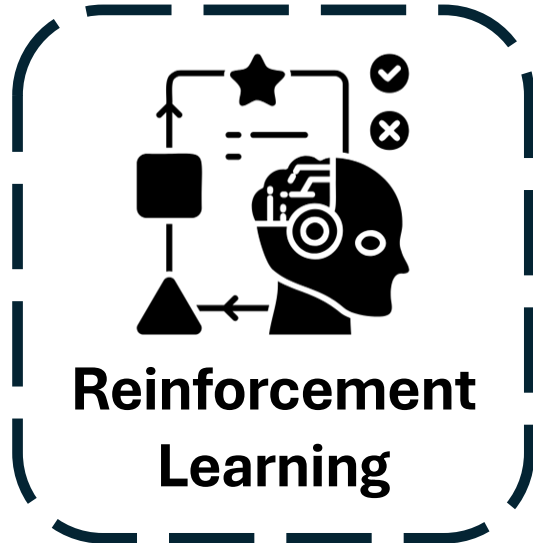
# Introduction

- Fully learned approach
- Highly dynamic motion
- Three Interdependent Modules:
  - Perception
  - Navigation
  - Locomotion

**ETH** zürich



# Key aspects



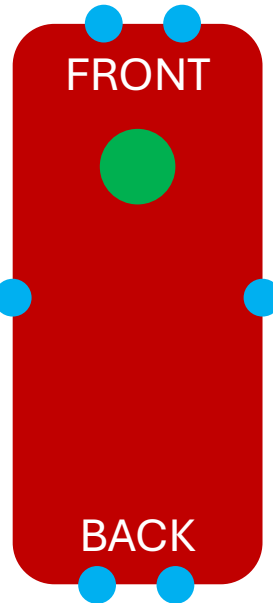
# Key aspects



Depth Camera



LiDAR



Top View

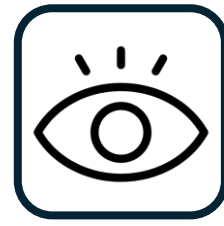
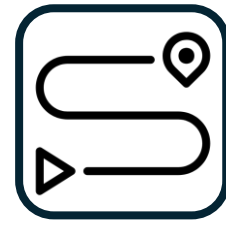
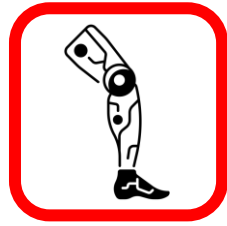


ANYmal



Sensors

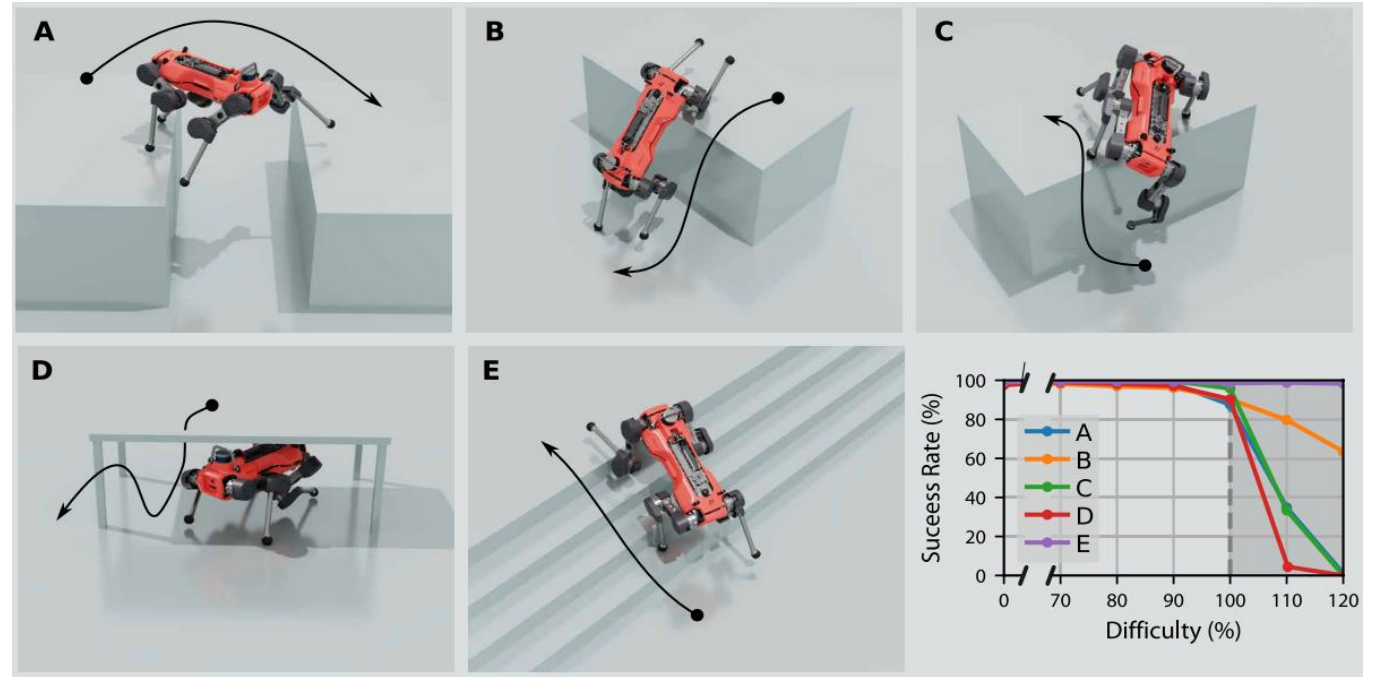
# Locomotion



## Method

5 policies trained for a specific locomotion skill

- A. Jumping
- B. Climbing Down
- C. Climbing Up
- D. Crouching
- E. Walking



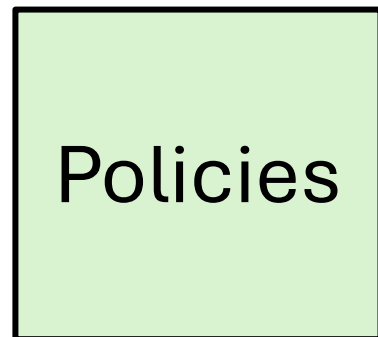
Proprioceptive state

Local Map

Position

Heading command

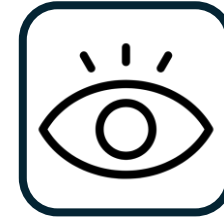
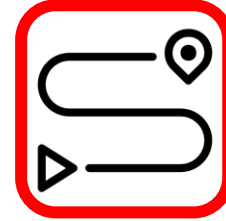
+ Time



Position  
Commands to  
the motor

**Results :** All skills perform well up to 90% of their respective difficulties

# Navigation

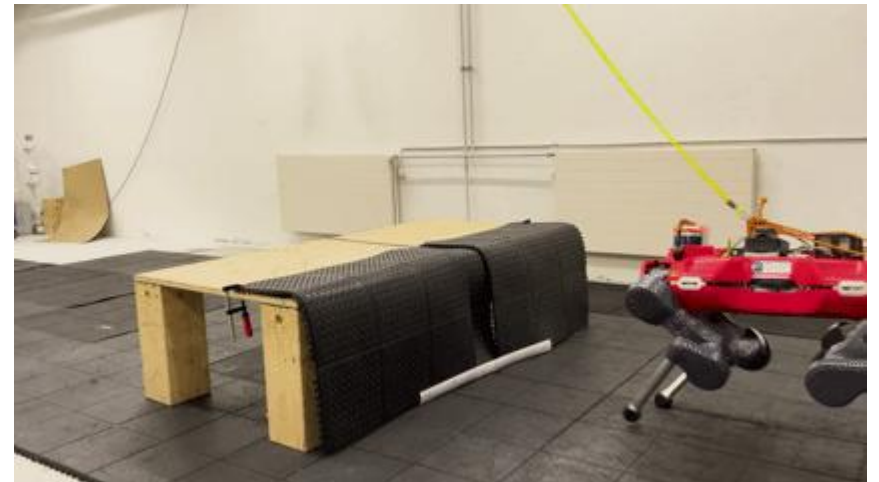


## Method

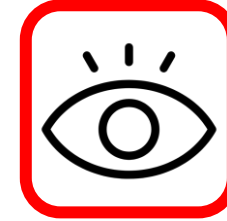
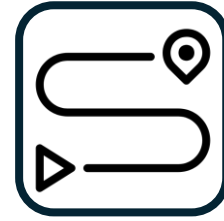
- Hierarchical RL
- Input
  - Perception
  - Goal position
- Output
  - Skill
  - Local position and heading command

## Results

- Perfect use of all 5 skills
- Combine position, heading and timing
- Outperforms static setpoints

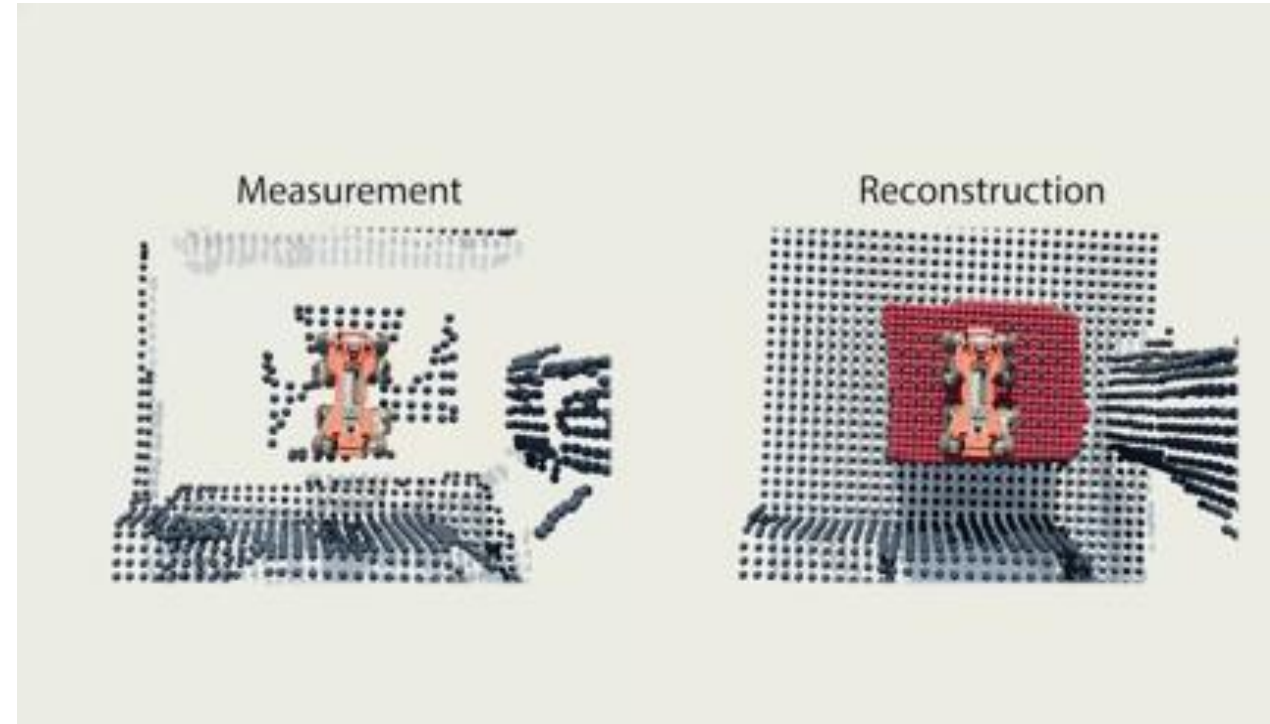


# Perception



## Method

- Convolutional Encoder-Decoder 3D
- Input : Noisy and incomplete point cloud estimate from the sensors
- Process :
  - Sensor fusion
  - Filling occupation 3D grid (Voxel)
  - Encoding into a compact latent tensor
  - Filling missing information with a learned model (wall, box, step, ...)
- Output : Occupation probability of each Voxel



## Results

- Complete understanding of the surrounding environment, high reconstruction performances, complex obstacle segmentation

# Citations

121

Citations in Crossref

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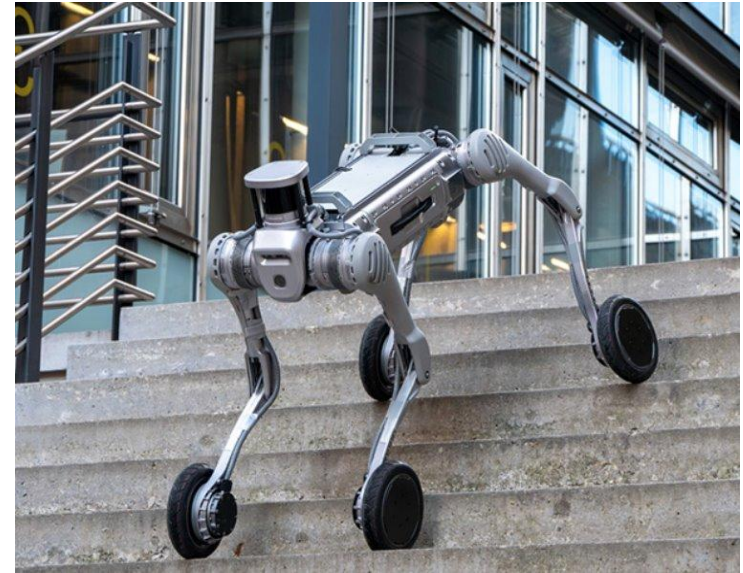


SCIENCE ROBOTICS

Volume 9 | Issue 88

March 2024

Published In



RIVR (Swiss-Mile)

79

Citations in Web of Science

# Citations Examples

ANYmal employs **reinforcement learning** techniques to achieve locomotion across diverse environments, including mountainous trails, loose rubble, and even parkour scenarios.

Guanglin Lu, Yifan Zhang, Teng Chen, Xuewen Rong, Guoteng Zhang, Yibin Li, Planning and Control Framework for a Quadruped Robot With Changeable Configuration, Advanced Intelligent Systems, (2025). <https://doi.org/10.1002/aisy.202500713>



Fully learned hierarchical approaches like Barkour and ANYmal Parkour demonstrate **impressive** quadrupedal **navigation** using diverse locomotion skills and elevation maps but often face **challenges** with **generalization** and the **complexity of training** due to tightly coupled modules

Dewei Wang, Chenjia Bai, Chenhui Li, Jiyuan Shi, Yan Ding, Chi Zhang, Bin Zhao, Skill-Nav: enhanced navigation with versatile quadrupedal locomotion via waypoint interface, Vicinagearth, 2, 1, (2025). <https://doi.org/10.1007/s44336-025-00015-y>

**RL methods** have been **successfully** applied to various quadruped platforms, ANYmal [...]

Wenhao Feng, Zhipeng Wang, Haozhe Xu, Yanmin Zhou, Bin He, Chenhui Dong, Multiple gait locomotion generation for quadruped robots based on trajectory planning and reinforcement learning, Control Engineering Practice, Volume 165, 2025

# Pros and Cons

## Pros



- Sim-to-Real Learning
- Robust 3D perception
- Dynamic and precise movements
- Robust to perturbations
- Intelligent navigation

# Pros and Cons

## Cons



- Limited training scenarios
- Limited number of competences
- Interdependent modules
- Computational cost of training

# Questions

