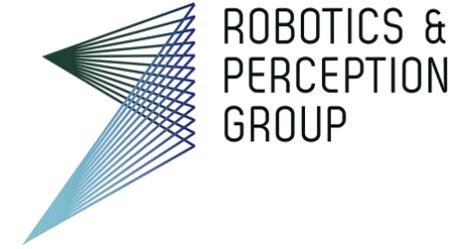




**University of
Zurich**^{UZH}



Robots, Drones, and more...

Daive Scaramuzza

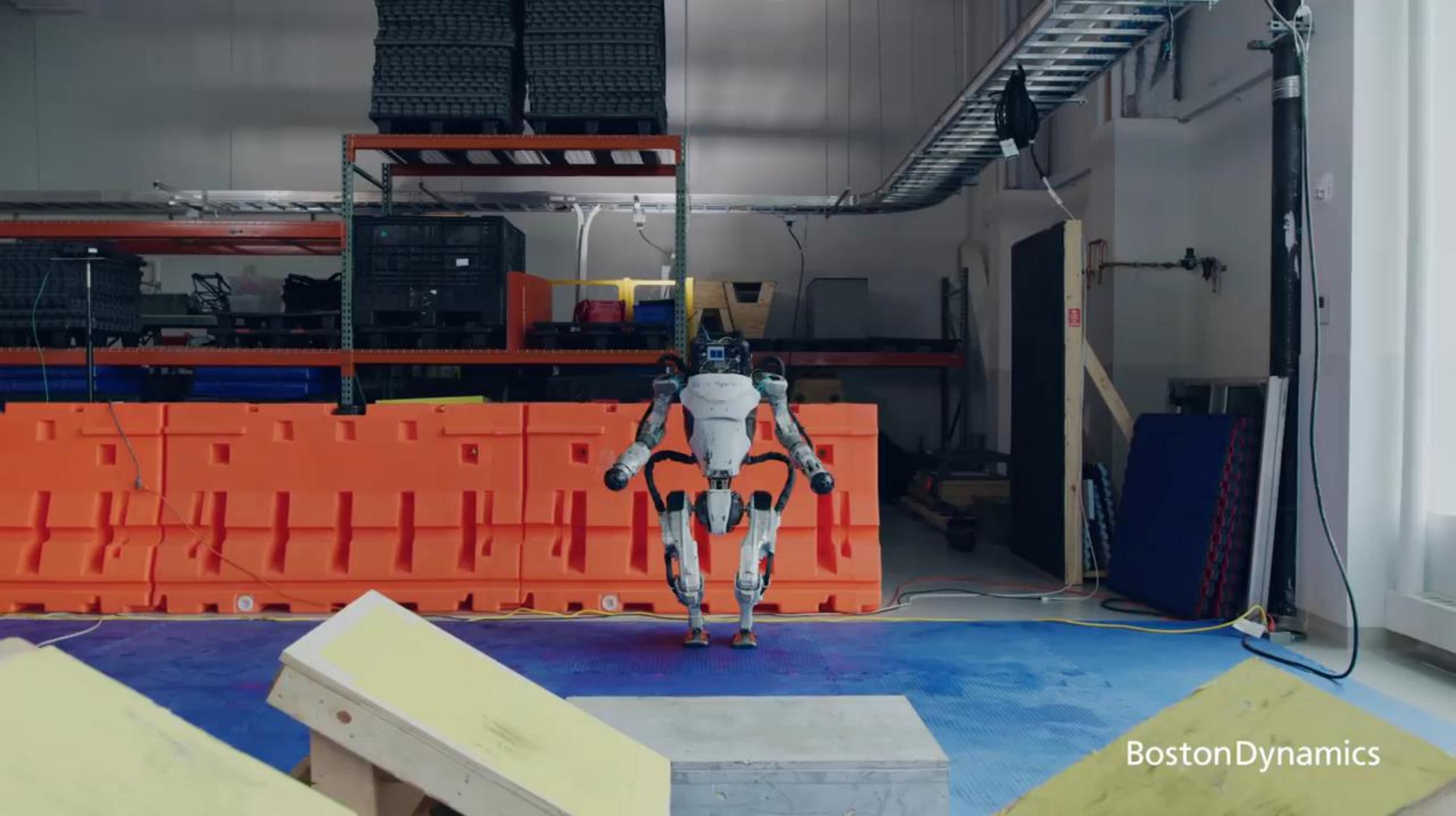
<http://rpg.ifi.uzh.ch/>



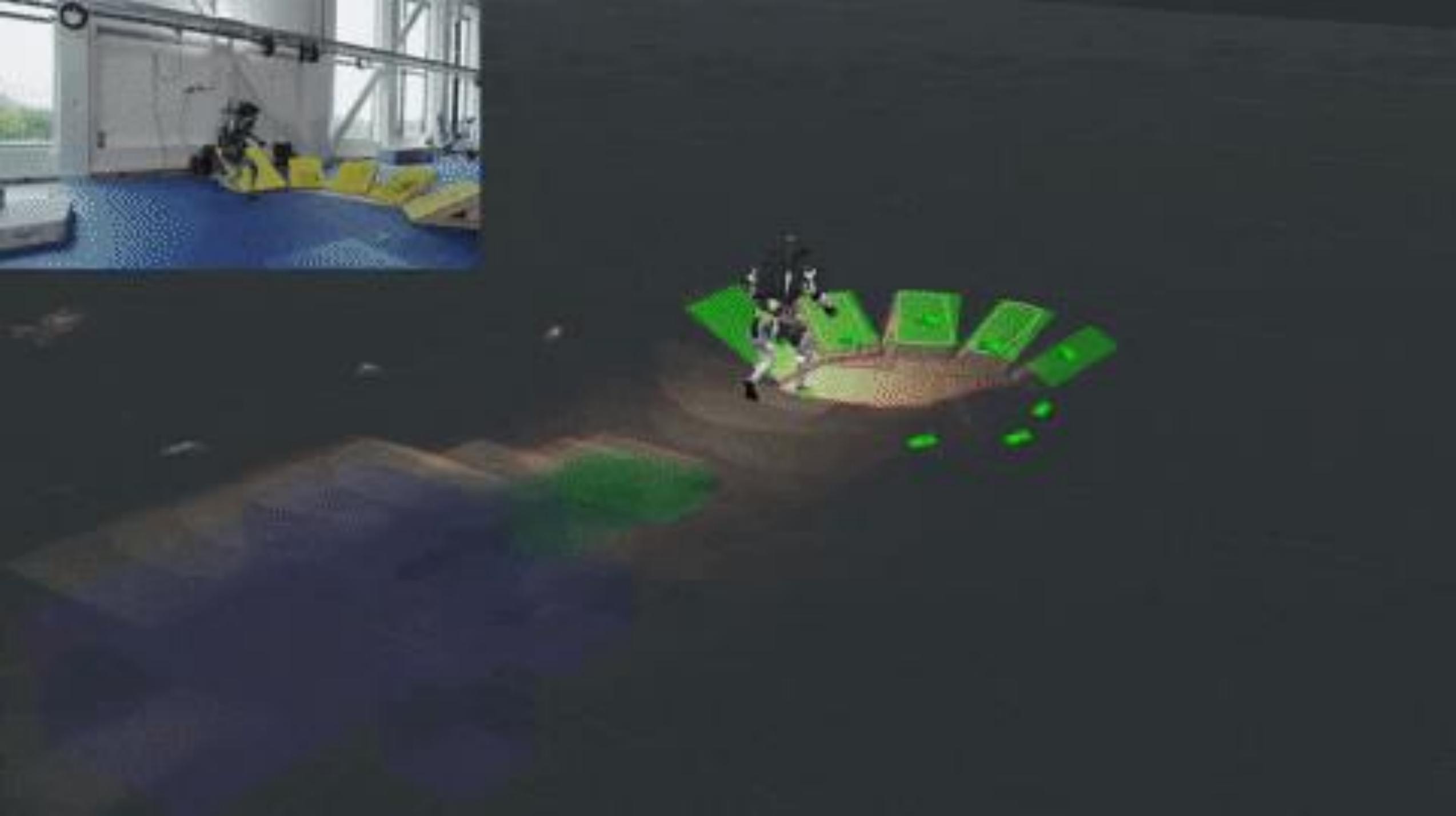
Roomba vacuum cleaner until 2018.
Average cleaning time: **20 minutes**



Roomba vacuum cleaner after 2018.
Average cleaning time: **5 minutes**



BostonDynamics



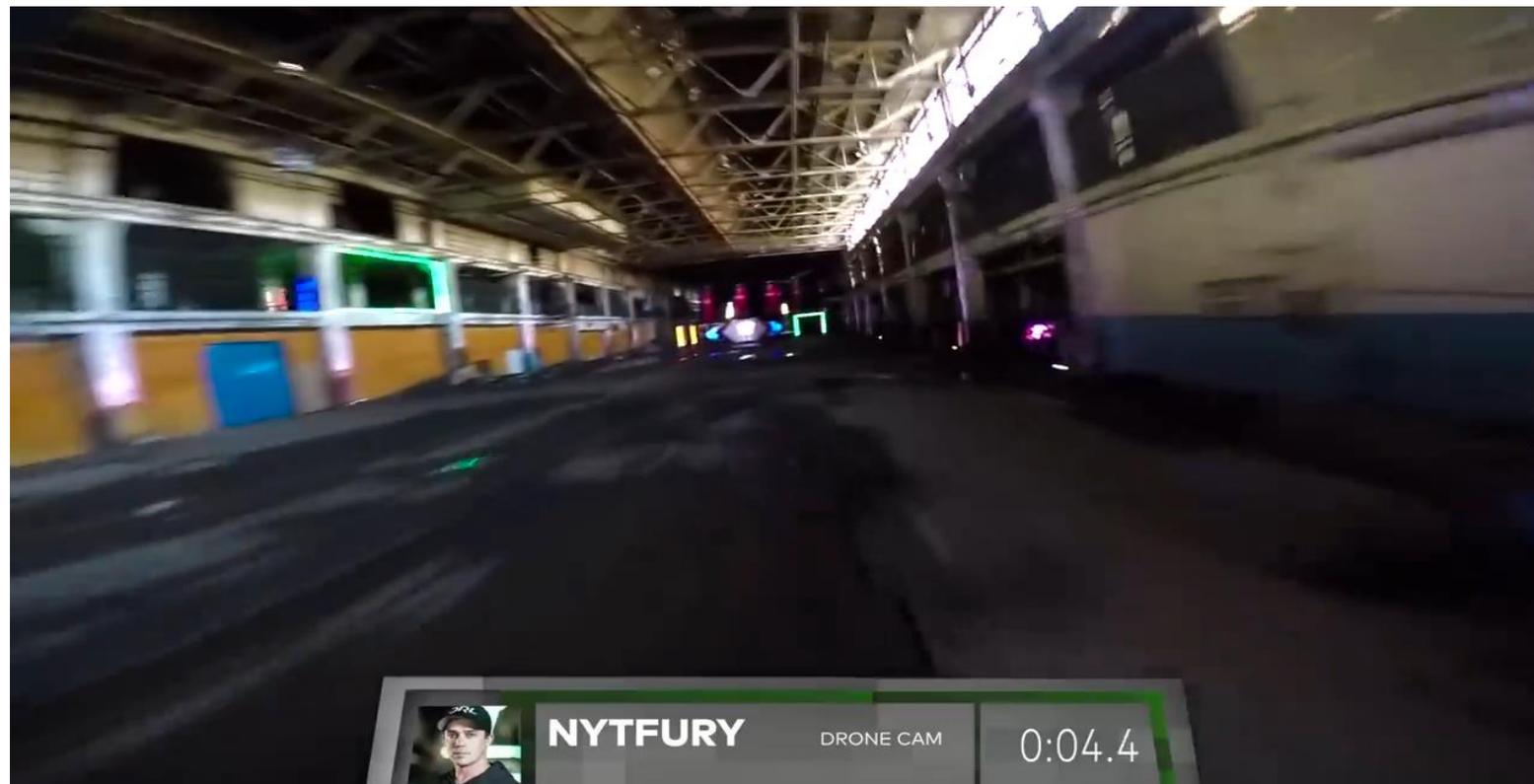




Perception is making mobile robots useful,
but are they more productive than humans?

No, current robots are far from humans regarding
agility, versatility, robustness!

What does it take to make robots as **agile** as expert humans?



WARNING! This drone is NOT autonomous; it is operated by a human pilot.
Human pilots take years to become agile!

Why Agile? To increase Productivity

By flying faster, we can fly farther!



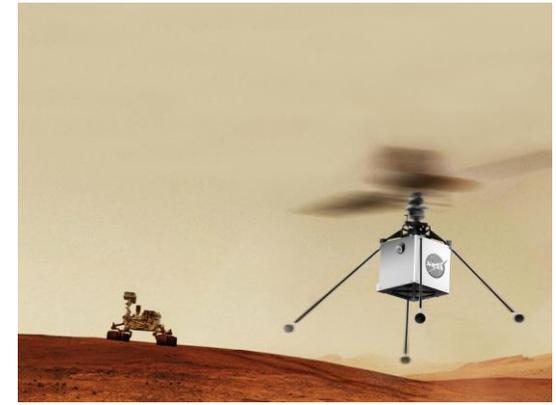
Search & rescue



Exploration & Inspection

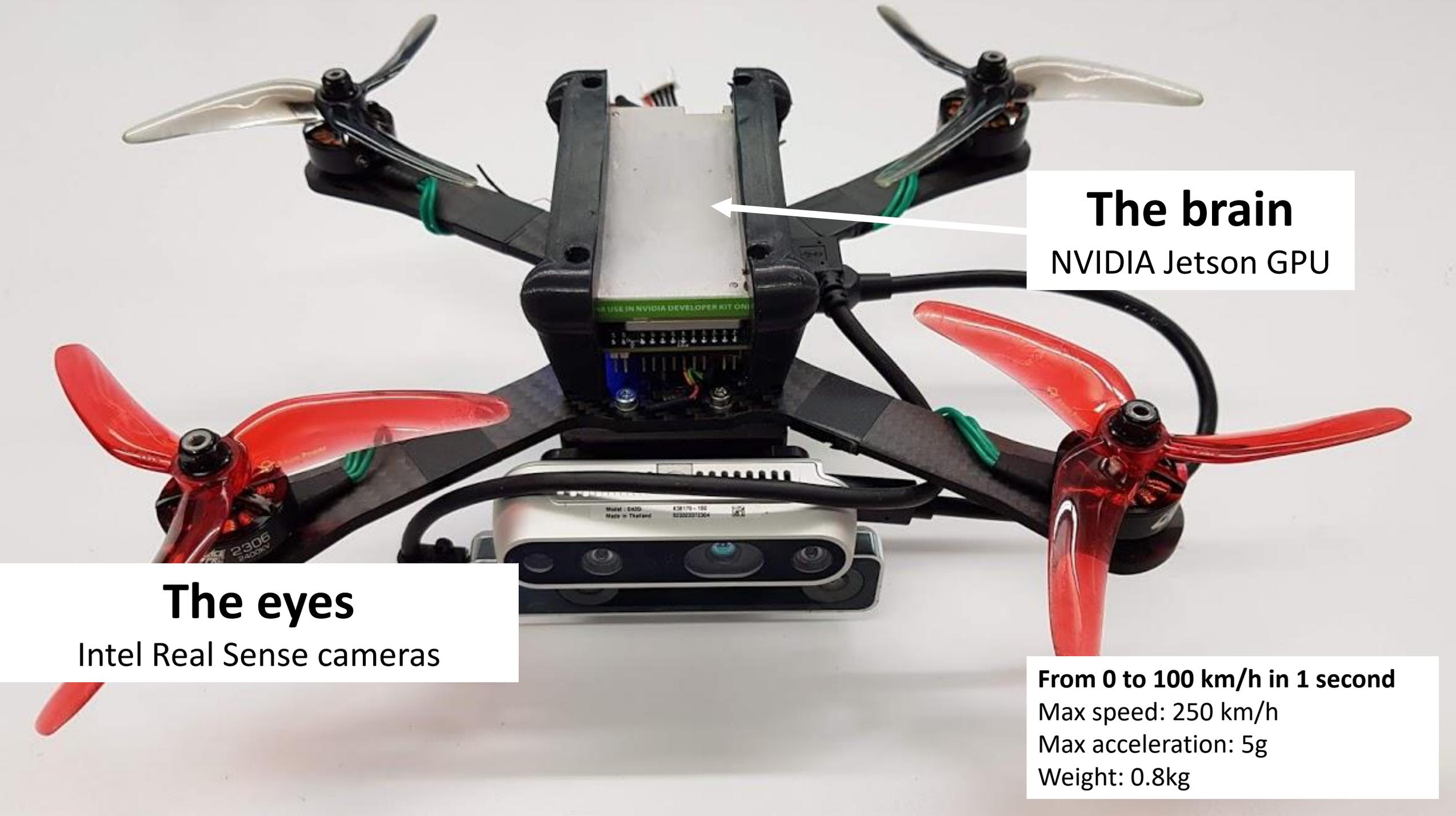


Personal air vehicles



Space

Bauersfeld, Scaramuzza, *Range, Endurance, and Optimal Speed Estimates for Multicopters*, IEEE RAL, 2022. [PDF](#).



The brain
NVIDIA Jetson GPU

The eyes
Intel Real Sense cameras

From 0 to 100 km/h in 1 second
Max speed: 250 km/h
Max acceleration: 5g
Weight: 0.8kg



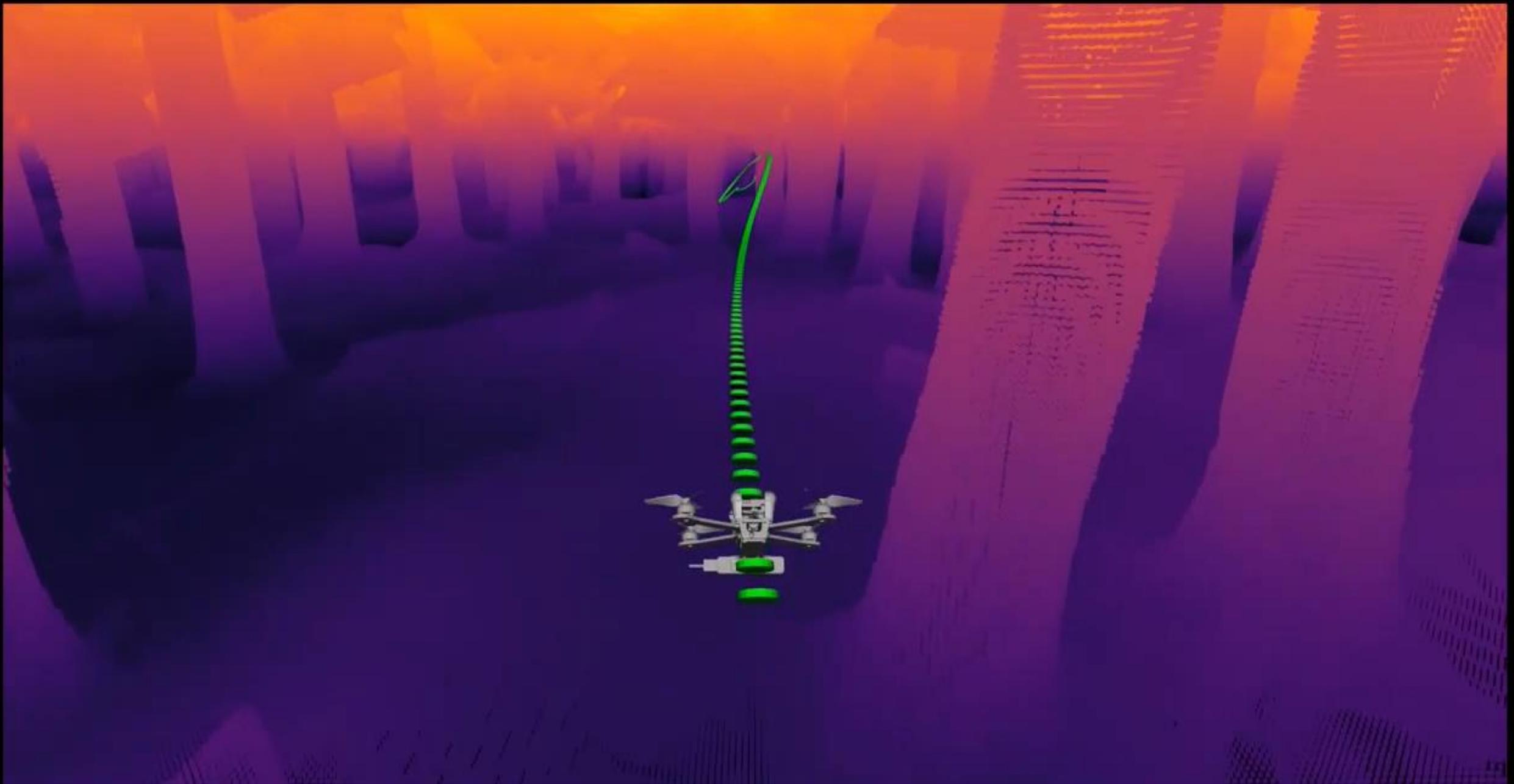
Loquercio, Kaufmann, Ranftl, Mueller, Koltun, Scaramuzza, *Learning High Speed Flight in the Wild*, **Science Robotics**, 2021

Kaufmann et al., *Deep Drone Acrobatics*, **RSS 2020. Best Paper Award Finalist**



Loquercio, Kaufmann, Ranftl, Mueller, Koltun, Scaramuzza, *Learning High Speed Flight in the Wild*, **Science Robotics**, 2021

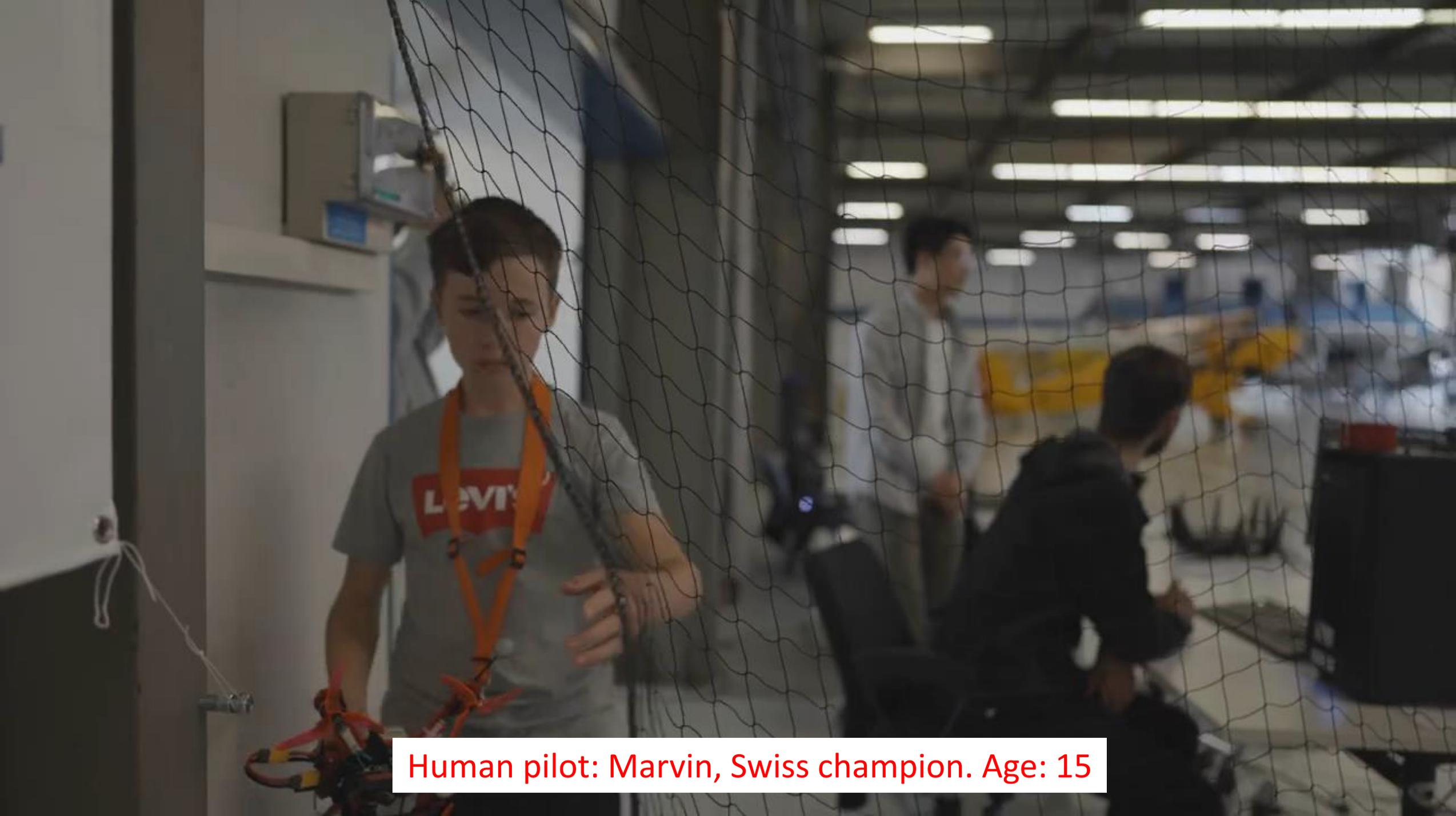
Kaufmann et al., *Deep Drone Acrobatics*, **RSS 2020. Best Paper Award Finalist**



Loquercio, Kaufmann, Ranftl, Mueller, Koltun, Scaramuzza, *Learning High Speed Flight in the Wild*, **Science Robotics**, 2021

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But how far are we from
expert humans pilots?



Human pilot: Marvin, Swiss champion. Age: 15

Can we outrace the best human pilot?

In June 2022, we invited the world champions of drone racing



Alex Vanover

DRL World
Champion



**Thomas
Bitmatta**

MultiGP
International
World Champion



**Marvin
Schaepper**

Swiss Drone
League
Champion



AI Drone

Media coverage: <https://spectrum.ieee.org/zurich-autonomous-drone-race>

Drone Racing

**Autonomous
Drone**

"Barracuda"

**World's Best
Human Pilots**

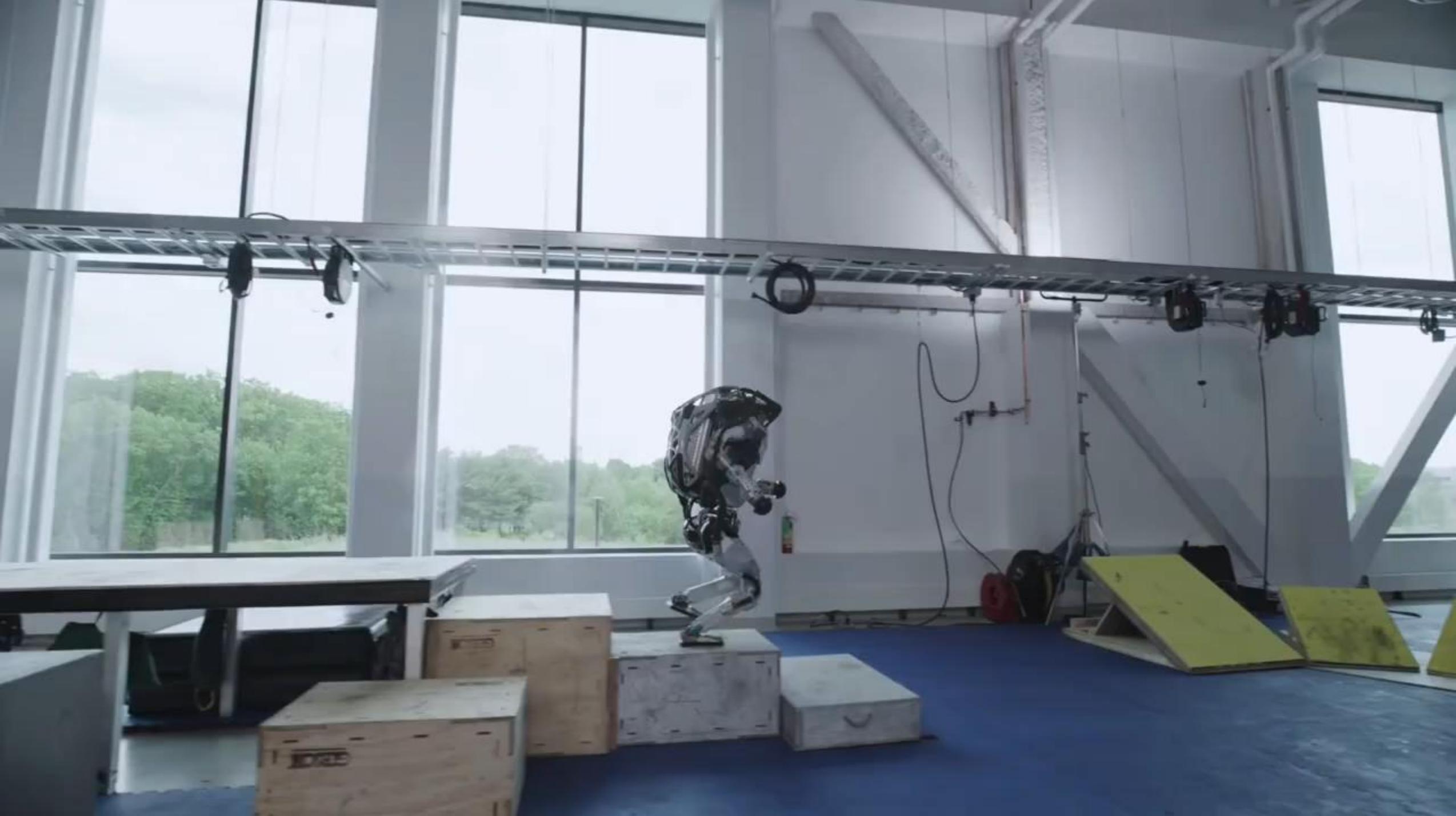
**A. Vanover,
T. Bitmatta,
M. Schaepper**

Is therefore the game over?
Is AI better than humans?

**No, robustness and versatility are
the next grand challenges!**

In racing, drones are constantly pushed to their physical limits.
Any small mistake can lead to a crash!





Future of Drones?



Palossi, Loquercio, Conti, Flamand, Scaramuzza, Benini, *A 64mW DNN-based Visual Navigation Engine for Autonomous Nano-Drones*
IEEE Internet of Things Journal, 2019.



Volocopter

LINA Project: Funded by Canton of Zurich

- **Largest European infrastructure** for the **development, safe testing, and certification** of autonomous systems, equipped with **digital twin** simulations and **5G compute zone**
- Location: Dubendorf airport, Canton of Zurich
- **Automatic booking and scheduling approval process** and the outdoor test area



Team:



University of Zurich **z**
UZH

hdk
Zürcher Hochschule der Künste
Zurich University of the Arts



SOMNIACS

Thanks!



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