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1944 - 2024

Autonomous Control of Vehicles
Research at E&E Engineering, Stellenbosch

Photo by Stefan Els

Satellite Engineering Ecosystem

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- SunSat (ZASAT-001, SO-35)
  - Africa's first satellite
  - 60kg LEO EO micro-sat, launched 1999, Vanderberg AFB
- SumbandilaSat (ZASAT-002, SO-67)
  - 81kg LEO EO micro-sat, launched 2009, Baikonur Cosmodrome

Short Courses

- Introduction to Satellite Mission Design
- Kalman Filters and Sensor Fusion - Q1 2023
- CanSat Leadership Program - Q4 2023
- Practical System Engineering - TBD

Facilities

- Stellenbosch Ground Station
- Air bearing facility
- Radiation testing (at iThemba Labs and ARC)

SU Satellite Engineering Training

Satellite Program

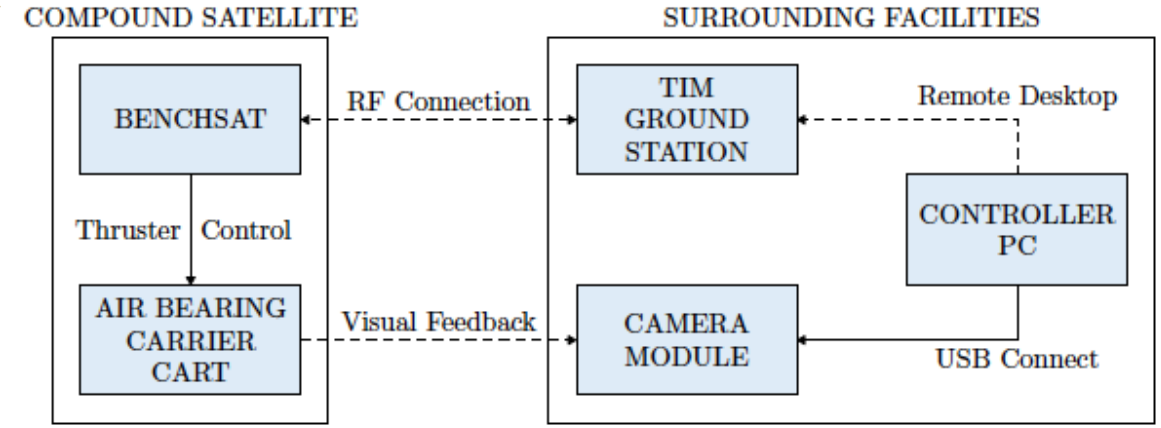
- DockSat
- Multi-Spectral + IOT Satellite
- ZAPocketQube

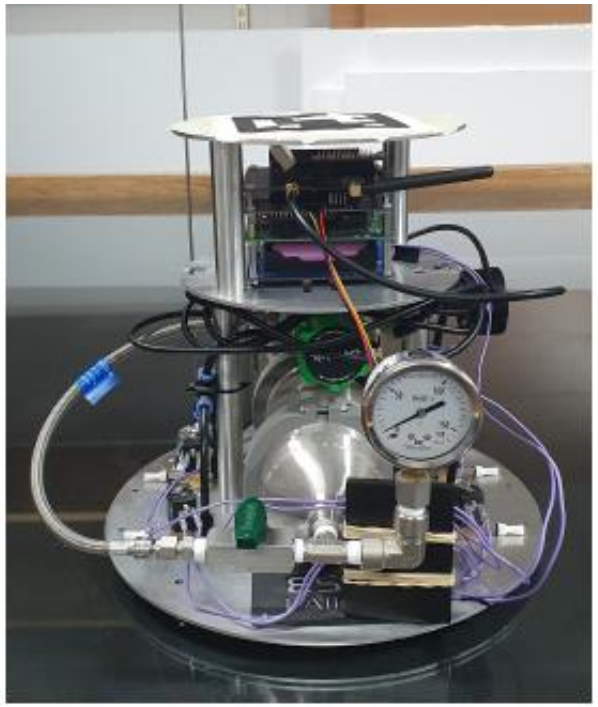
Research

- Masters and PhDs
- Command and Data Handling
- ADCS and Robust Embedded Systems

Past Projects: Generic Flatsat Infrastructure

- Develop ground-based units
  - Emulate generic satellite bus.
- Cheap and easy to produce
  - Steppingstone to flight models.
- Transparent interface to ESL ground station for realistic operational interface.
- Test case ground satellite on air-bearing trolley





Current Projects: Flatsat and Flight software

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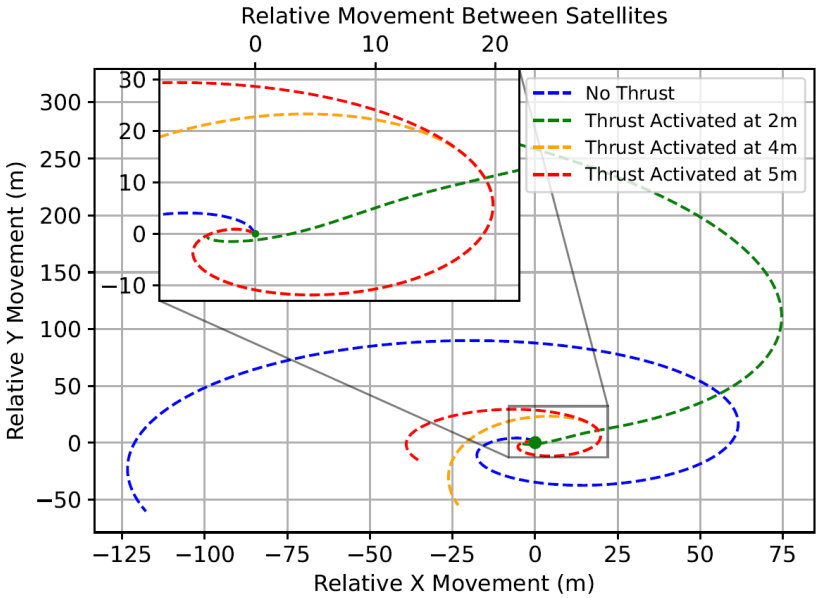
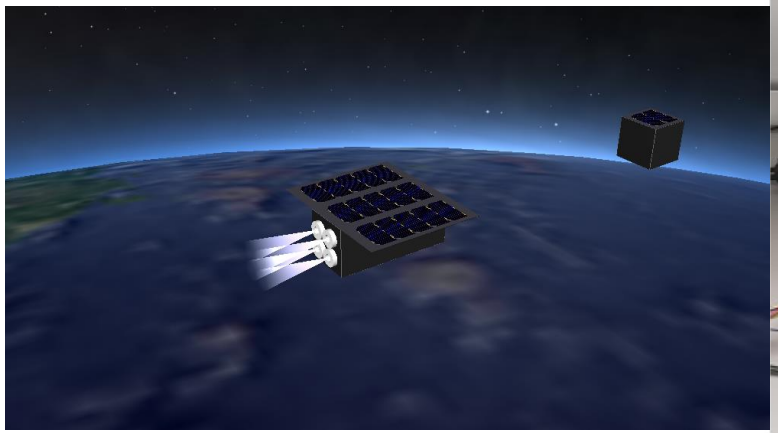
- Make informed component decisions for the satellite bus
- Investigation – perform conventional system engineering through development of flight software.
- Develop interface hardware to integrate D2S2 to get accurate flight software and mission testing
- Calculate rendezvous trajectories and tracking controllers for chaser to reach target using low-thrust propulsion.





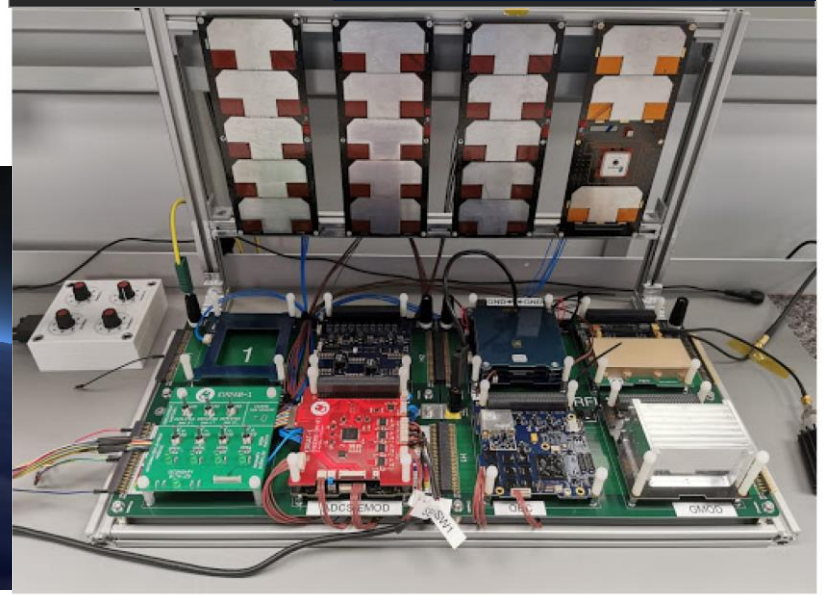
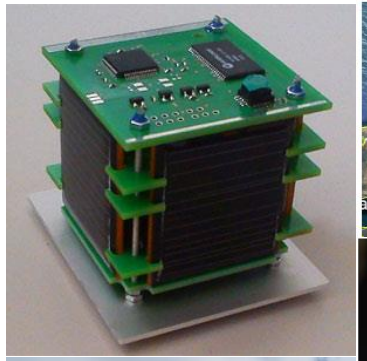
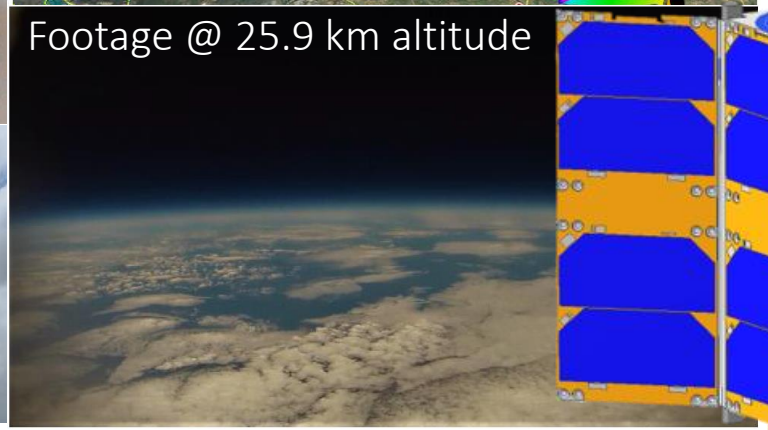


Photo of EIRFLAT-1

ZAPocketQube

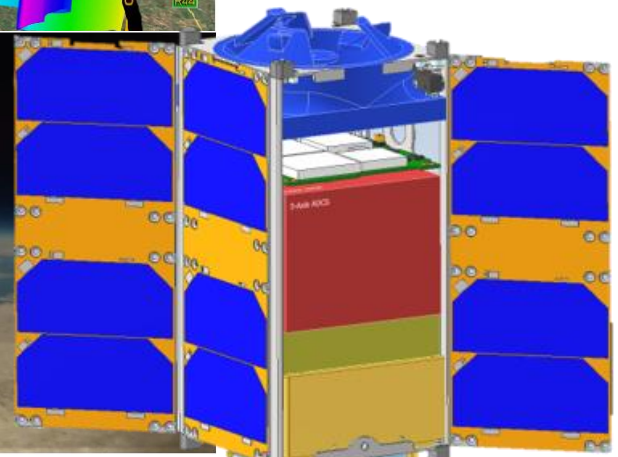
- 5cm x 5cm x 5cm
- Reduces development cost and reduced barrier-to-entry
- Combine with high-altitude balloon activities
- In-house development of all satellite subsystems
- Drive innovation further through miniaturization

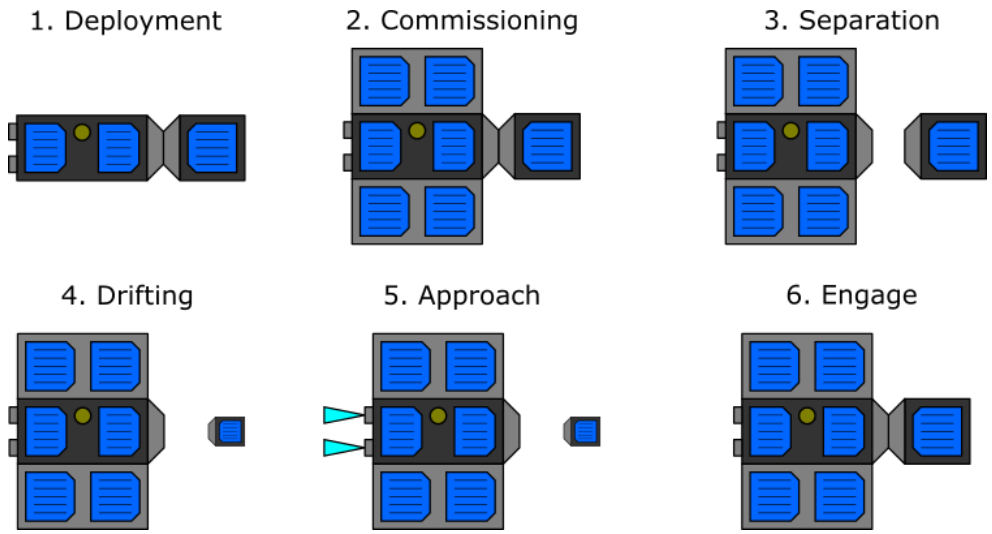




DockSat

- Current conceptual mission = DockSat
- 2021 - 2nd place in the IAF-CSA Space Universities CubeSat Challenge
- Demonstrate the in-orbit undocking and docking of satellites
- Require propulsion, accurate attitude control, pose estimation, custom docking mechanism





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Space Vehicle Research

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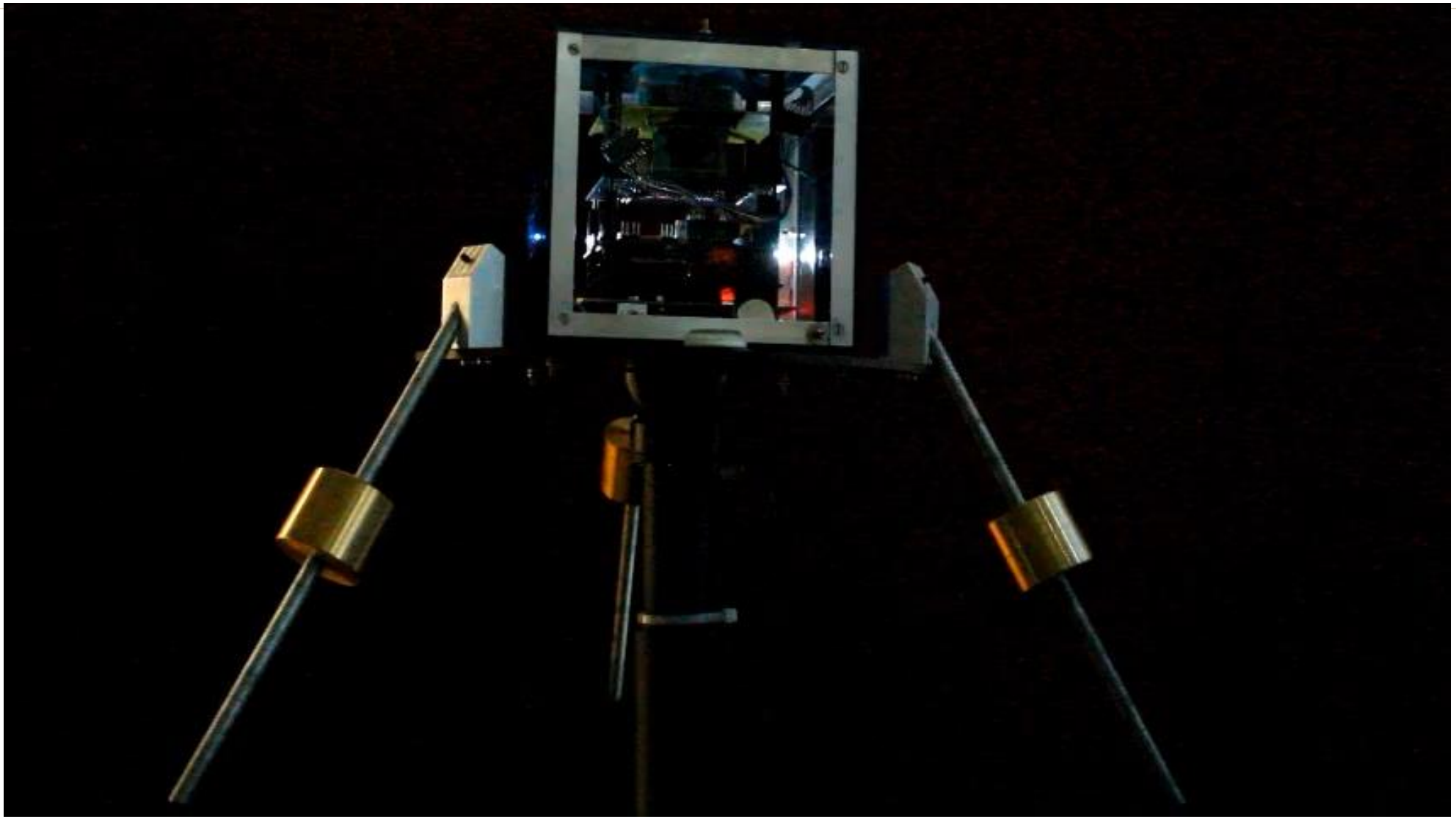
Focus on embedded systems and algorithms for attitude control system (ADCS)



Unmanned Aerial Vehicles

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Automated Landing on a Moving Platform

- Practical landing of a 15 kg quadrotor drone on a platform moving at 30 km/h

Drones with Cable-Suspended Loads

- Robust / adaptive control to accommodate variable cable length and cargo mass

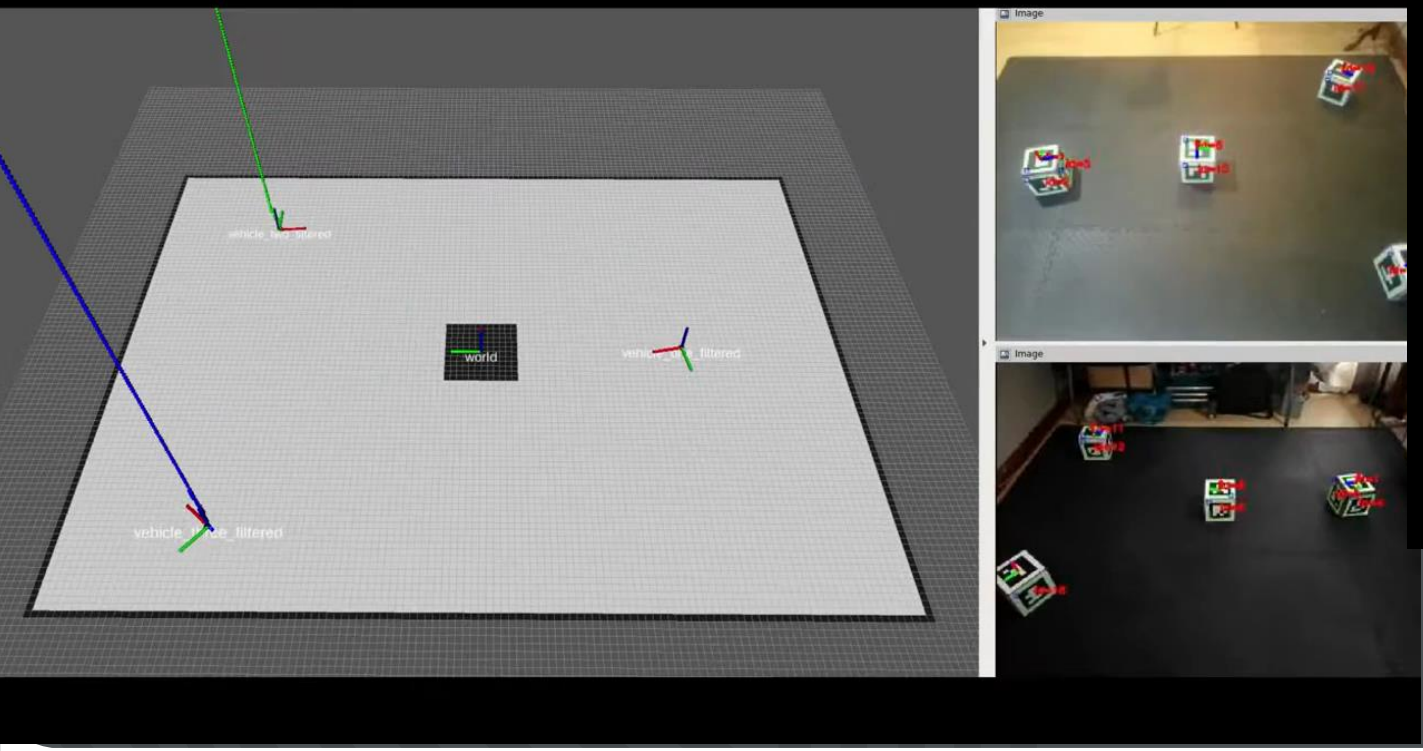
Unmanned Aerial Vehicles

Damage-Tolerant Flight Control

- Robust flight control for partial wing loss

Autonomous Ground Vehicles

Decentralised cooperative navigation



Vision-Based “GPS”

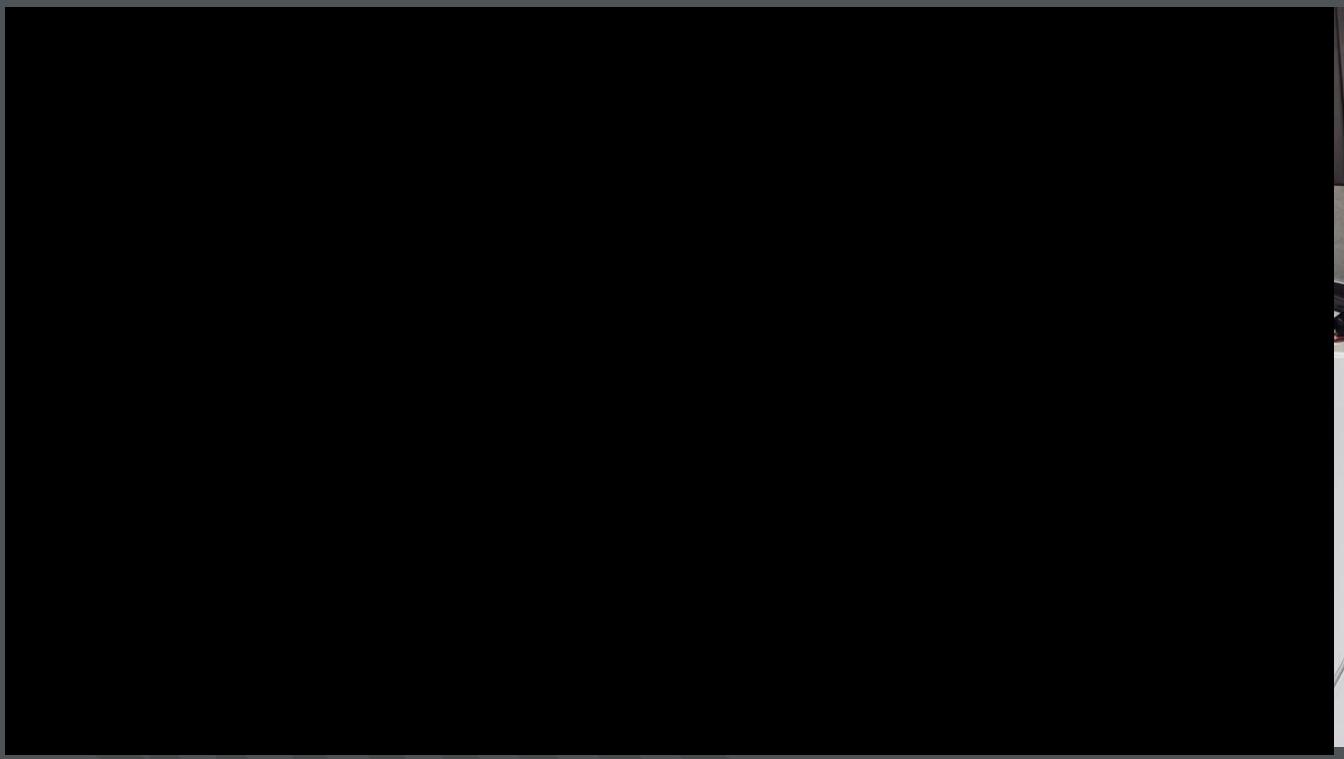
Autonomous Ground Vehicles

Self-Driving Quadbike

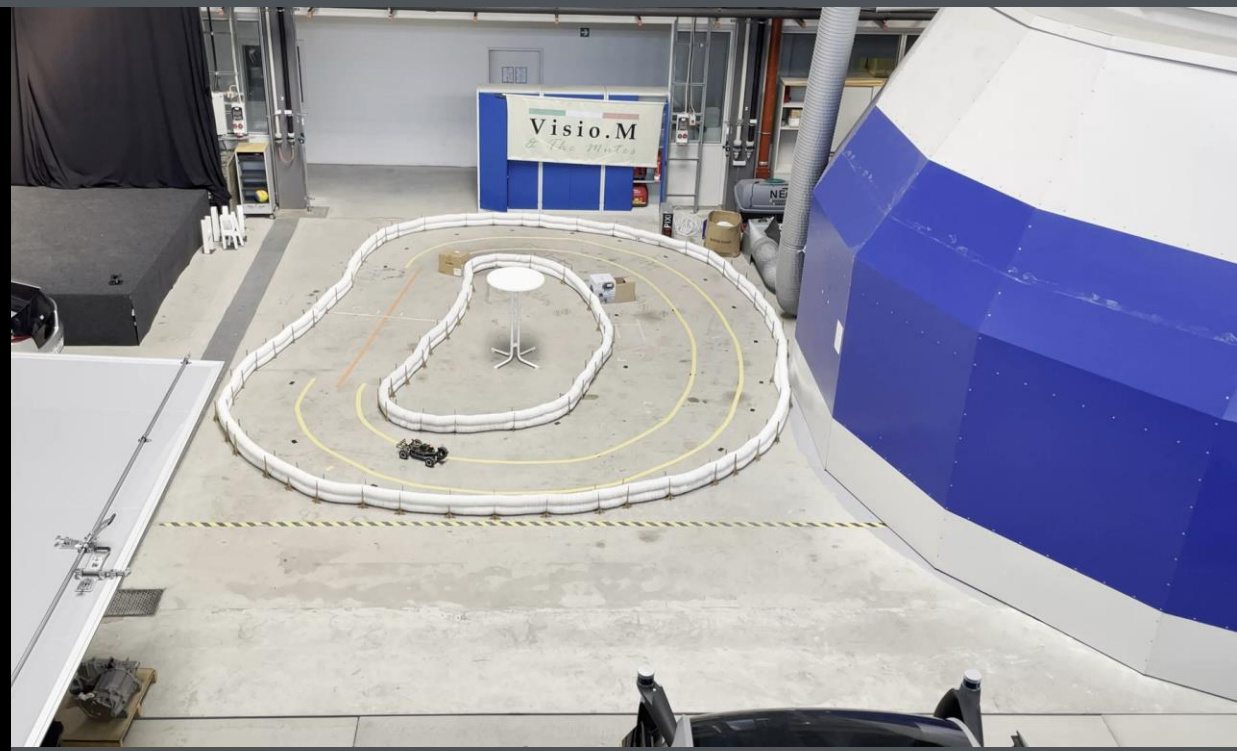
Plans and executes path, avoiding obstacles

F1tenth Racing

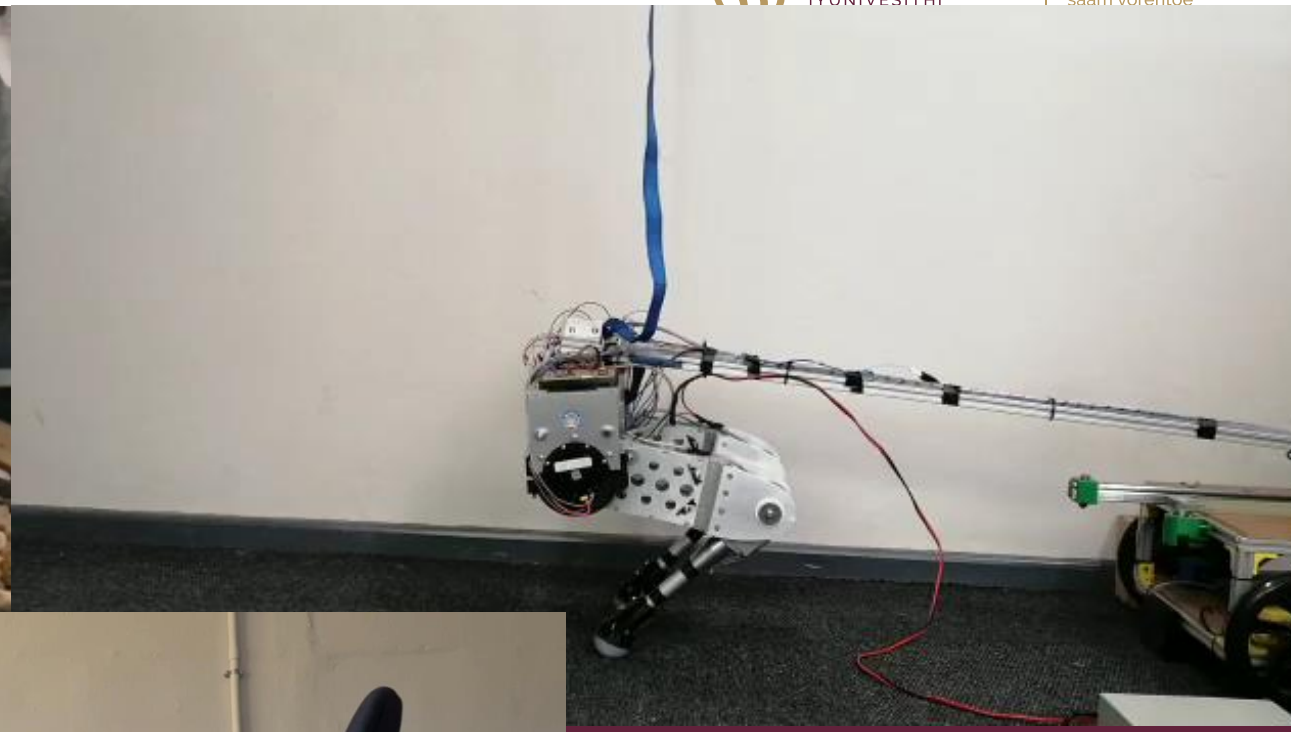
RL agent trained in Simulation



Obstacle Test



Legged Robots



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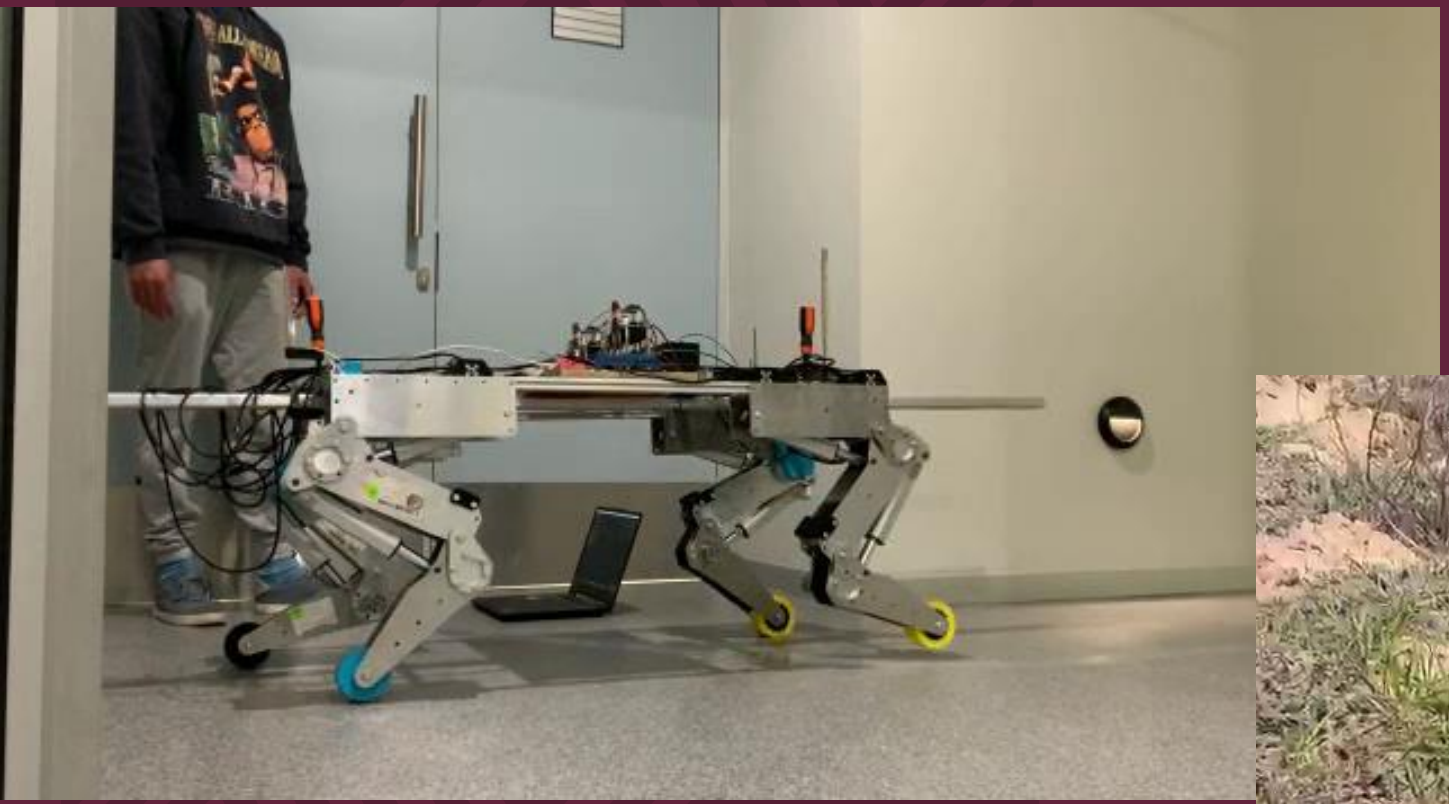
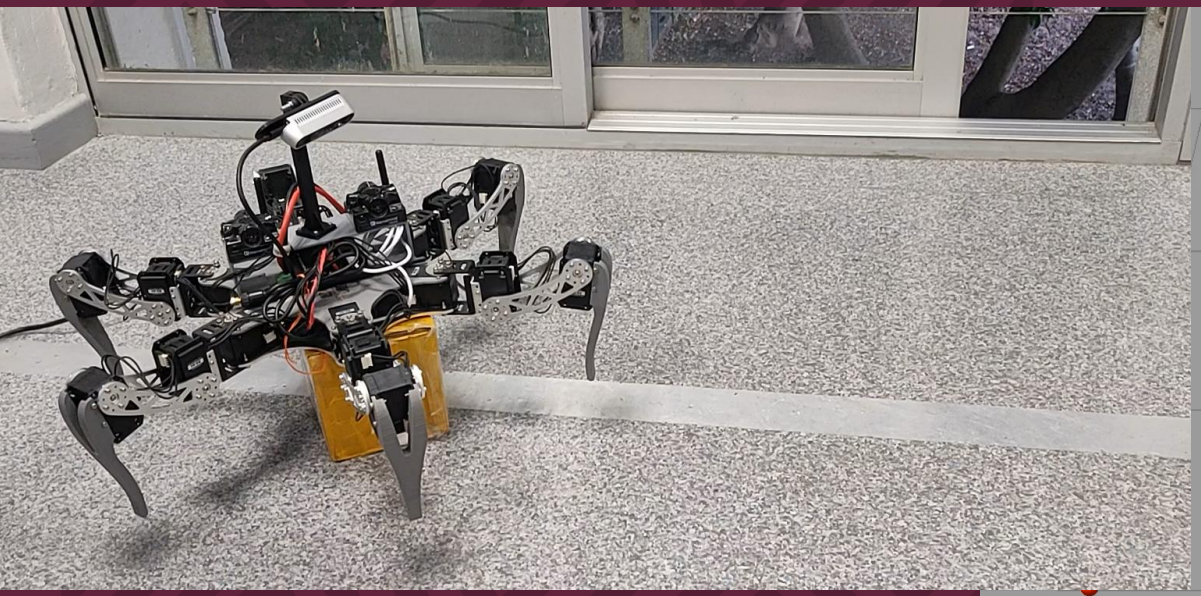


Open Loop Walking

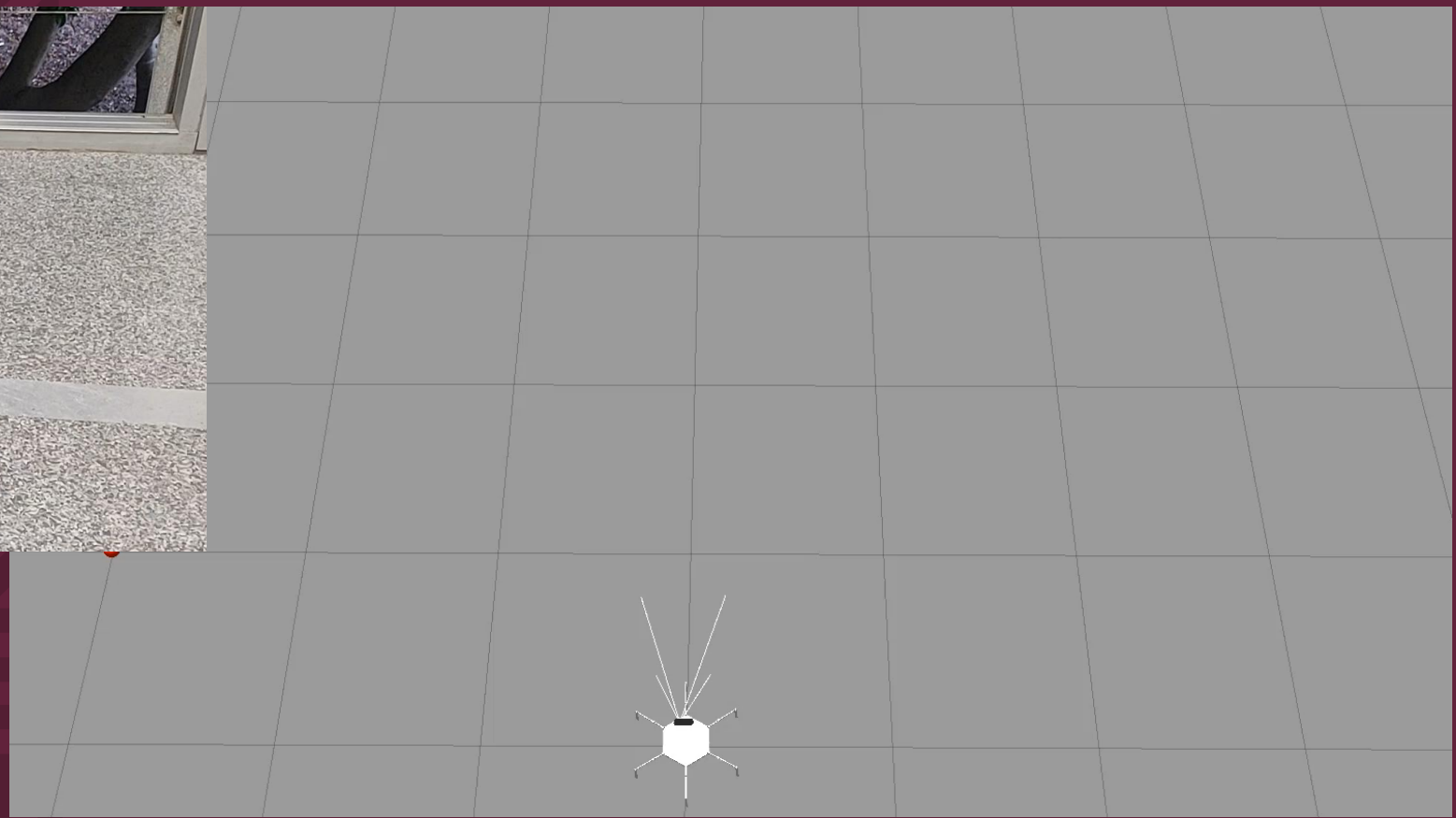
RHex

Legged Robots: Hexapod

Leg Actuation



Waypoint Navigation



Robotic Arms and Hands

Robotic Arms

EMG controlled robotic hand

Mining Robotics

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AI in mining robotics for improved safety in hazardous environments

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Thank you
Enkosi
Dankie

Photo by Stefan Els

Any Questions?

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