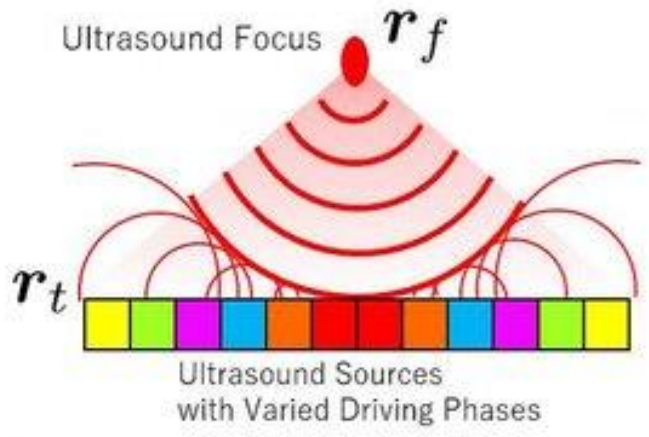
Cultural relics cleaning based on phased array of transducers

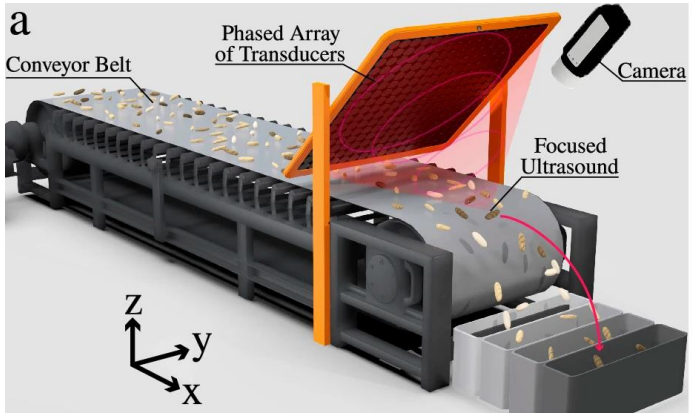
Pengyuan Wei, Valerio M.

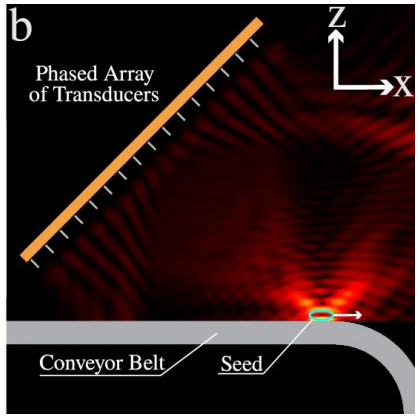
Phased Array of Transducers

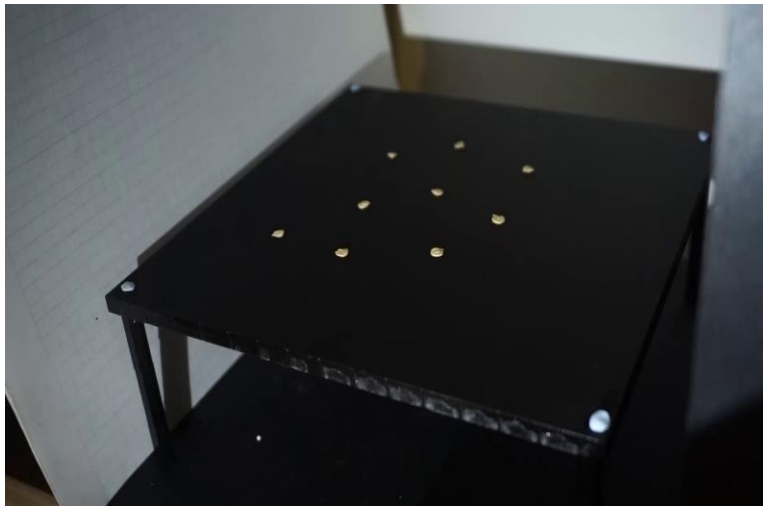
- By controlling the phase of each transducer, the interference between sound waves is used to create focal points or acoustic traps at target locations.

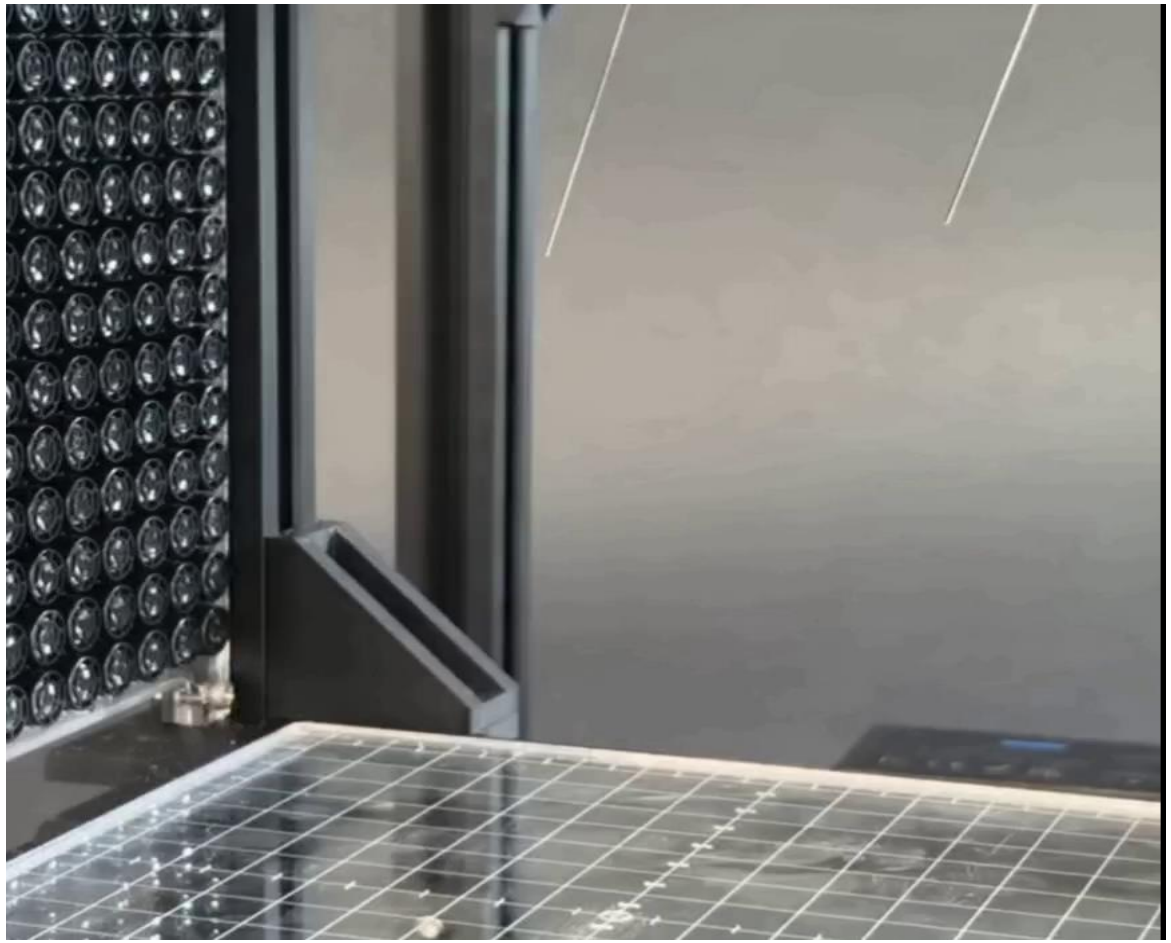


Phased Array of Transducers









Cultural Relics Cleaning

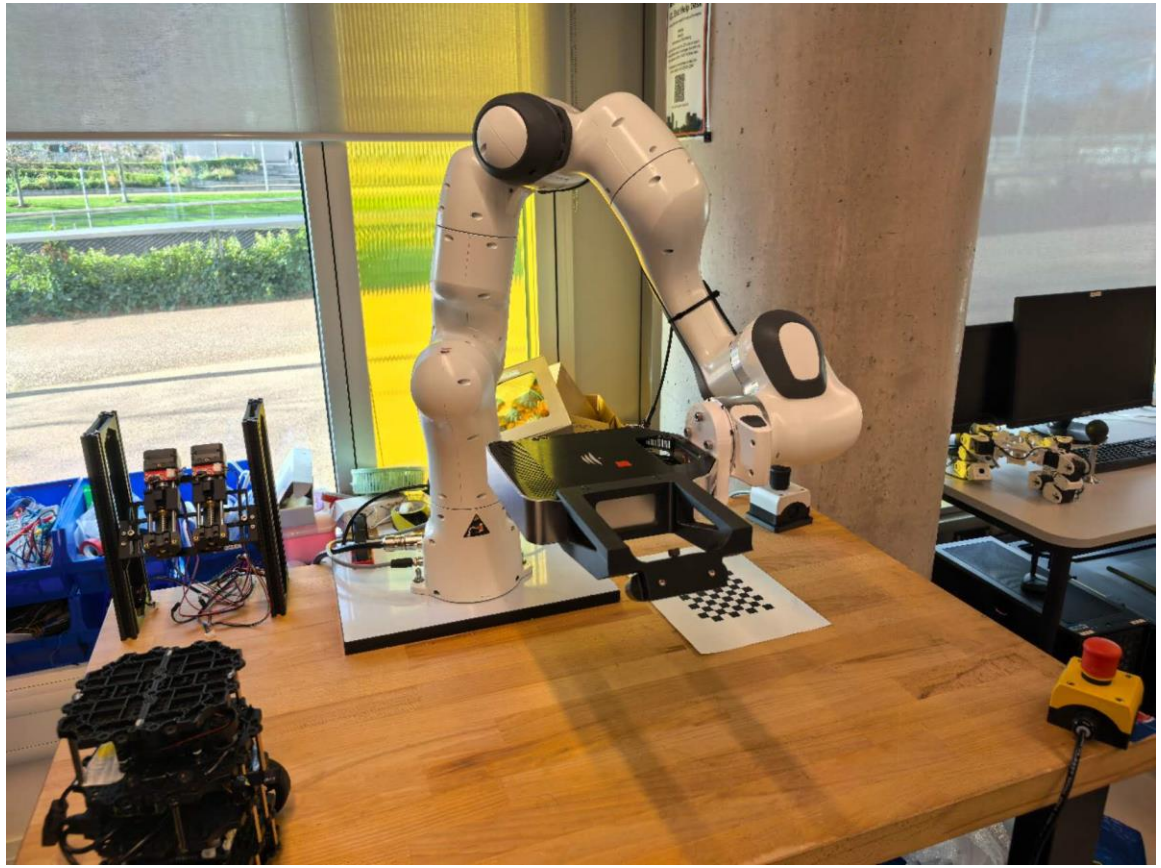
- Replaces human labor: some reagents can be harmful to humans during reactions or volatilization.
- Precise force control: minimizes secondary damage to relics.





Joint control of robotic arm and phased array

- Coordinated Planning and Control of Robotic Arms and Acoustic Fields
- Long-distance Transport and Precise Extraction of Millimeter-scale Particles
- UCL-ZJU partner funds：AcoustoClean: A Robotic Phased-Array Acoustic Platform for Non-Contact Cleaning of Heritage Objects



UCL MSC ROBOTICS & AI SHOWCASE 2026

Frontiers in Aerial Robotics

Edge deployment, Vision-Language-Action models, and language-guided indoor missions.

Three Core System Challenges

High-Speed Autonomy

Coupled constraints in compute, sensing, and rendering.

Aerial Manipulation

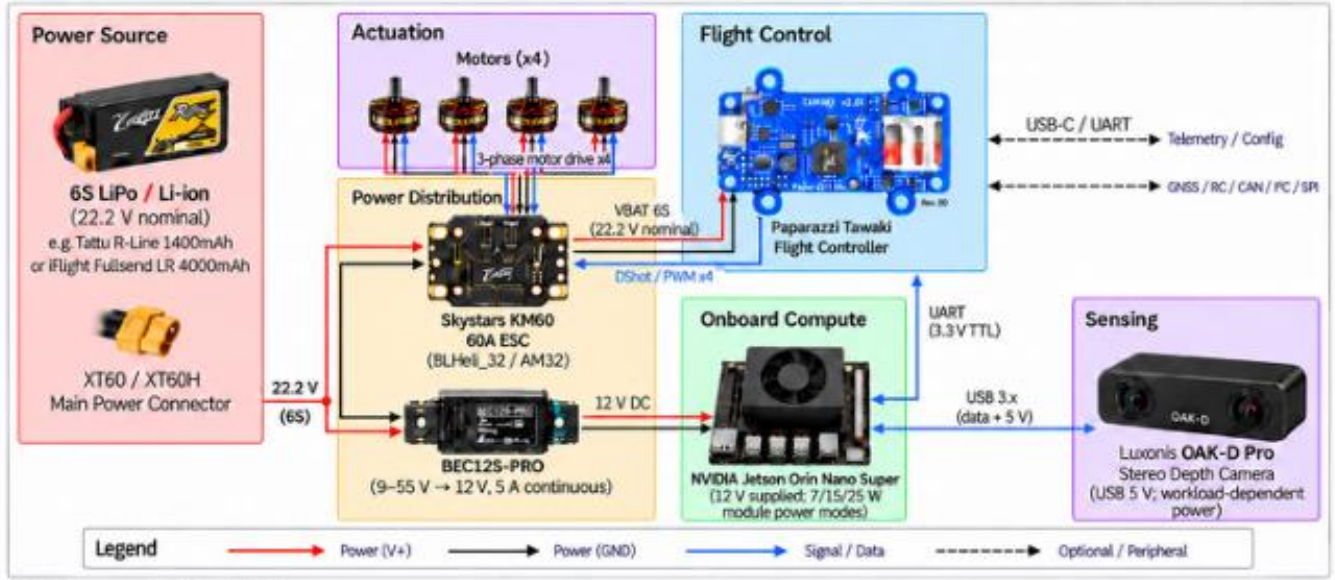
Adapting Vision-Language-Action models to shifting physics.

Language Guidance

Translating natural language into verified simulation pipelines.

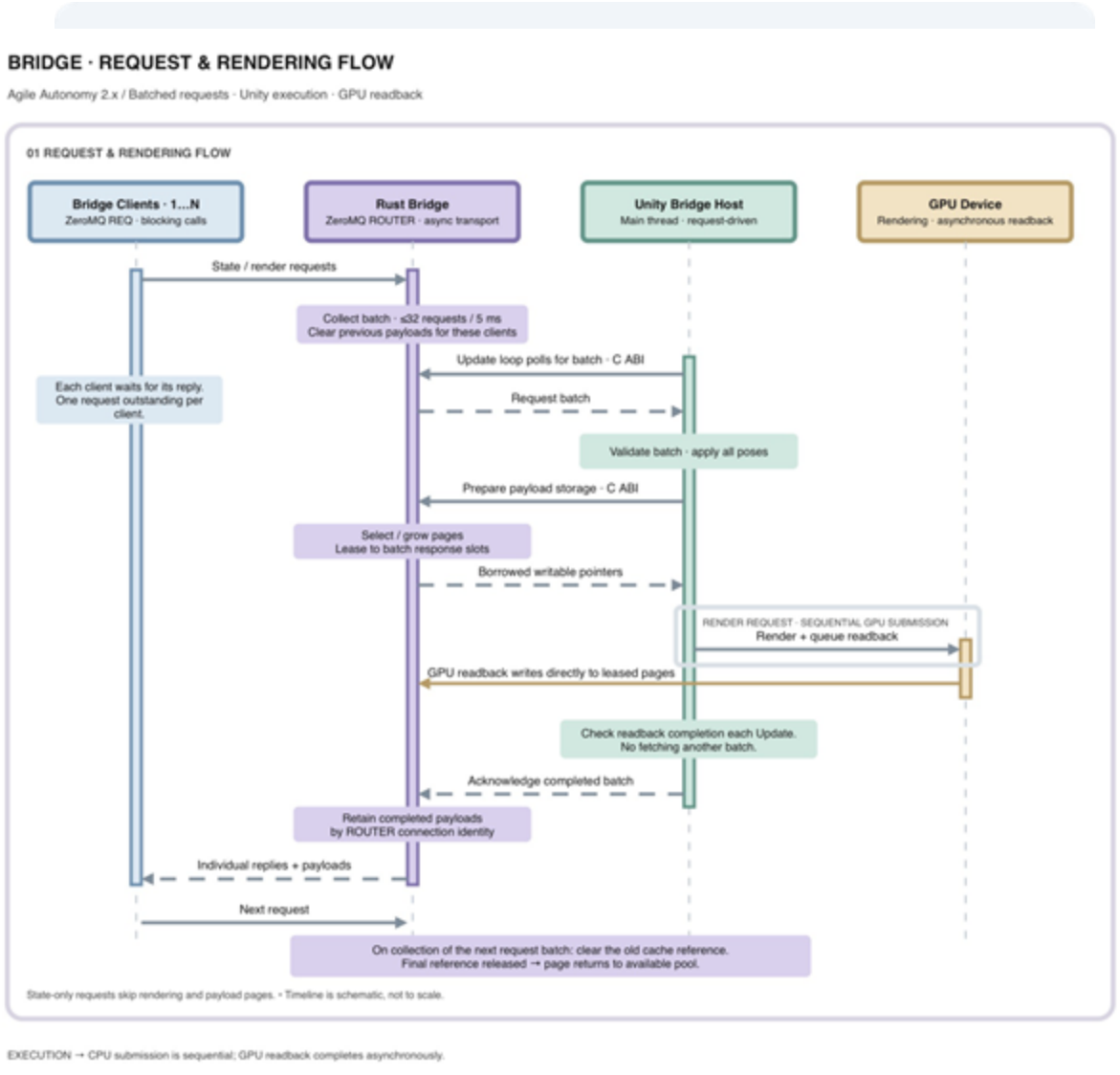
Edge Deployment Costs

- **Jetson Orin Nano:** 29.6x inference speedup at FP16.
- **Accuracy preserved:** 0/4 mode changes in both precisions.
- **New bottleneck:** Preparation cost limits overall frequency.



Key Components and Specifications

Subsystem	Component	Specification / Model	Rated / Configured Parameters	Function
Power Source	Performance battery	Tattu R-Line V5.0 1400 mAh 6S LiPo	6S1P; 22.2 V nominal; 1400 mAh; manufacturer-rated 150C; XT60	High-discharge supply for aggressive flight
	Endurance battery	iFlight FULLSEND 4000 mAh 6S1P Li-ion	6S1P; 22.2 V nominal; 4000 mAh; XT90H	Higher-capacity supply for endurance-oriented operation
Actuation	Motors	AOS Supernova 2207-1980KV	2207 stator; 1980 KV; x4	Convert electrical drive into rotor torque and thrust
Motor Drive	ESC	Skystars KM60 60 A 4-in-1	3–6S input; manufacturer-rated 60 A continuous; DShot600/1200; no integrated BEC	Electronic commutation and independent drive of four motors
Power Conversion	DC–DC regulator	Matek BEC12S-PRO	9–55 V input; configured 12 V output; 5 A continuous, 9 A peak	Regulated 12 V rail for companion compute
Flight Control	Flight controller	Paparazzi Tawaki v2.01	STM32H753VIH Cortex-M7, 480 MHz; 6–26 V input; PWM/OneShot/DShot ESC outputs	Real-time stabilisation, motor commands and vehicle I/O
Onboard Compute	Companion computer	NVIDIA Jetson Orin Nano Super Developer Kit, 8 GB	9–20 V carrier input; supplied at 12 V; 7/15/25 W module power modes; 67 INT8 TOPS	Onboard perception, inference and high-level autonomy
Sensing	Stereo-depth camera	Luxonis OAK-D Pro	2 x OV9282 global-shutter mono sensors; IMX378 RGB; BNO086 IMU; USB 2/3	Stereo-depth observations and auxiliary visual/inertial sensing
Airframe	Frame	FlyFishRC Volador II V3S	6-inch Squashed-X freestyle frame	Mechanical structure and component mounting
	Propellers	Gemfan Hurricane 51466 V2	131.8 mm diameter; tri-blade; 4.2 g	Convert motor torque into aerodynamic thrust
Integration	Main power connector	XT60 / XT60H	6S battery interface	High-current connection between battery and vehicle
	Mounting	Custom plate, nylon standoffs and M2.5/M3 fasteners	As-built configuration	Secure flight, compute and sensing hardware
	Cabling	Power, USB and UART harnesses	As-built configuration	Power distribution and inter-device communication



SCALABLE SIMULATION

Shared Rendering Architecture

- **Decoupled physics:** Independent workers, shared renderer.
- **Throughput leap:** 2.5x gain with 32 parallel clients.
- **Saturation limits:** Batch latency climbs sharply.
- **Core lesson:** Latency variance is a systems property.

CONTROL STRATEGY

Execution-Aware Expert Flight

Local Candidates

Native MPCC contouring control drives local trajectory execution.

Feature Search

Closed-loop scoring selects the most efficient route variations.

Promotion Gate

Strict held-out execution tests ensure robust policy transfer.

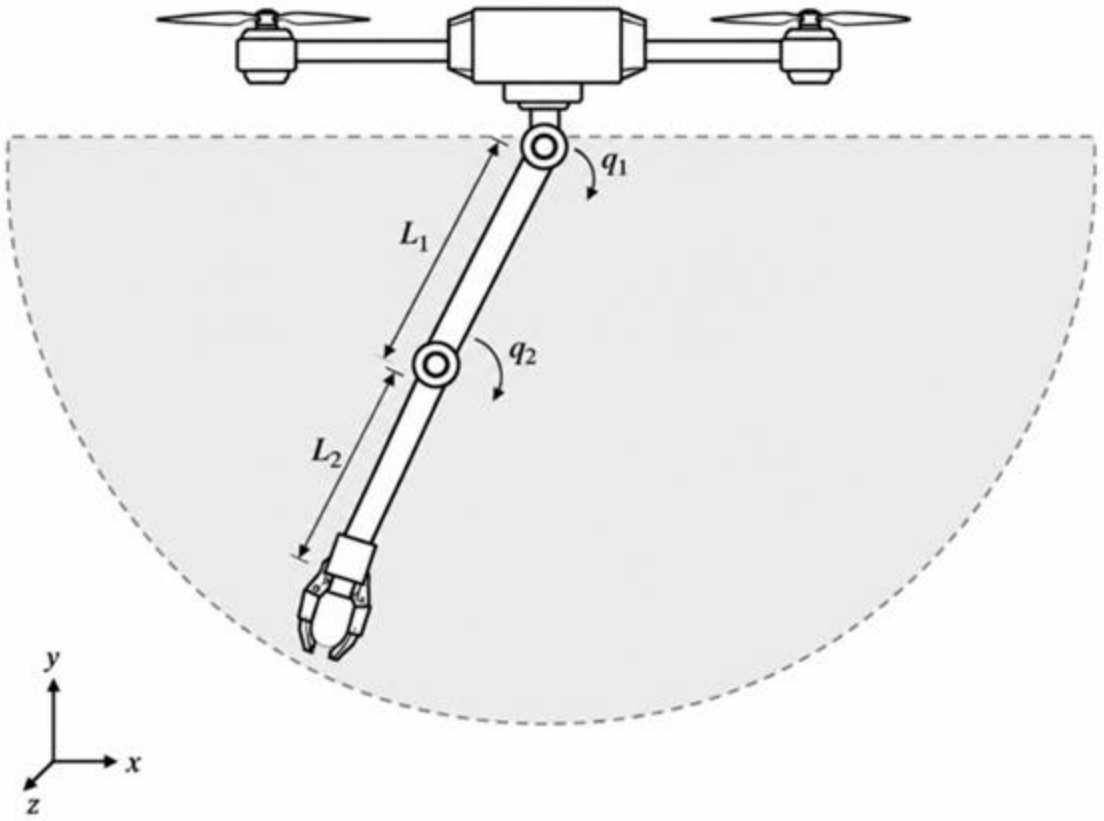




PROJECT 2 • AERIAL MANIPULATION

The Aerial Deficit

- **Fixed-base failure:** Standard VLAs assume static ground.
- **Dynamic workspace:** Center of mass shifts constantly.
- **Moving perspective:** Wrist camera alters observations.
- **Payload variance:** Mass changes affect flight response.

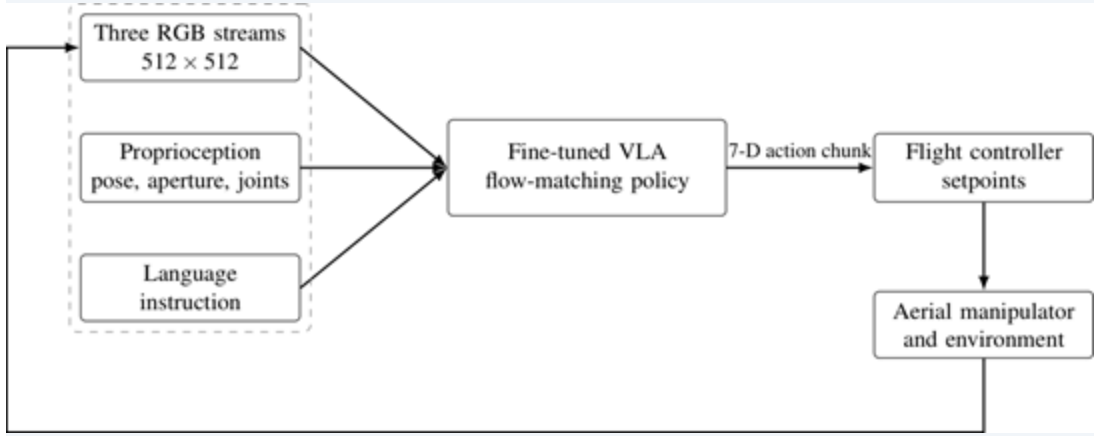




DIGITAL TWIN & SYSTEM

Gaussian Splat Simulation

- **Photogrammetry:** Gaussian splat digital twin of the physical lab.
- **Multimodal input:** Three RGB streams, proprioception, and language.
- **Sim-to-real:** Scripted-expert demonstrations drive fine-tuning.
- **Action space:** Pretrained interface retained without extension.



SYSTEM ARCHITECTURE

Fine-Tuned Aerial VLA

- **Multimodal input:** Three RGB streams, proprioception, and language.
- **Flow-matching backbone:** Predicts 7-D action chunks directly.
- **System integration:** Arm controlled at platform flight-setpoint level.
- **Action space:** Pretrained interface retained without extension.

TERMINAL CONTROL

Hybrid Control Success

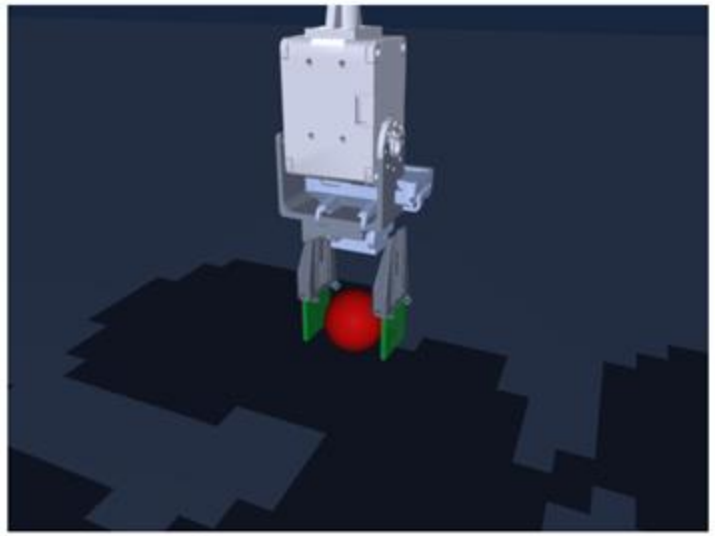
- **Baseline failure:** VLA alone achieves 1/60 grasps.
- **Phase separation:** VLA drives approach and transport.
- **Terminal handover:** Specialised servo triggers at 0.15m radius.
- **Outcome:** 60% grasp success with hybrid architecture.



(a) Drone and onboard arm



(b) Gripper detail



PROJECT 3 • LANGUAGE GUIDANCE

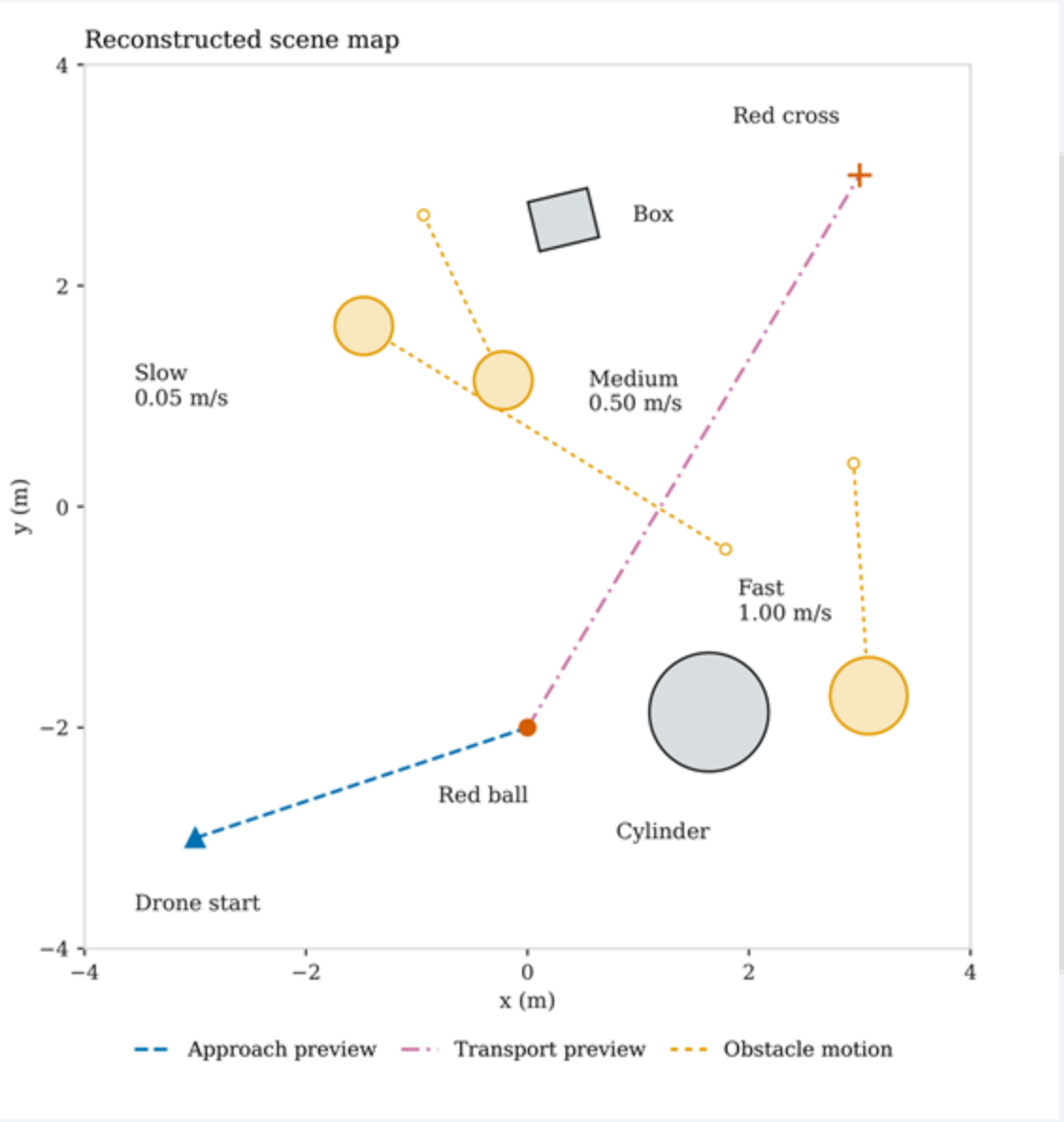
SkyGripper Physical Platform

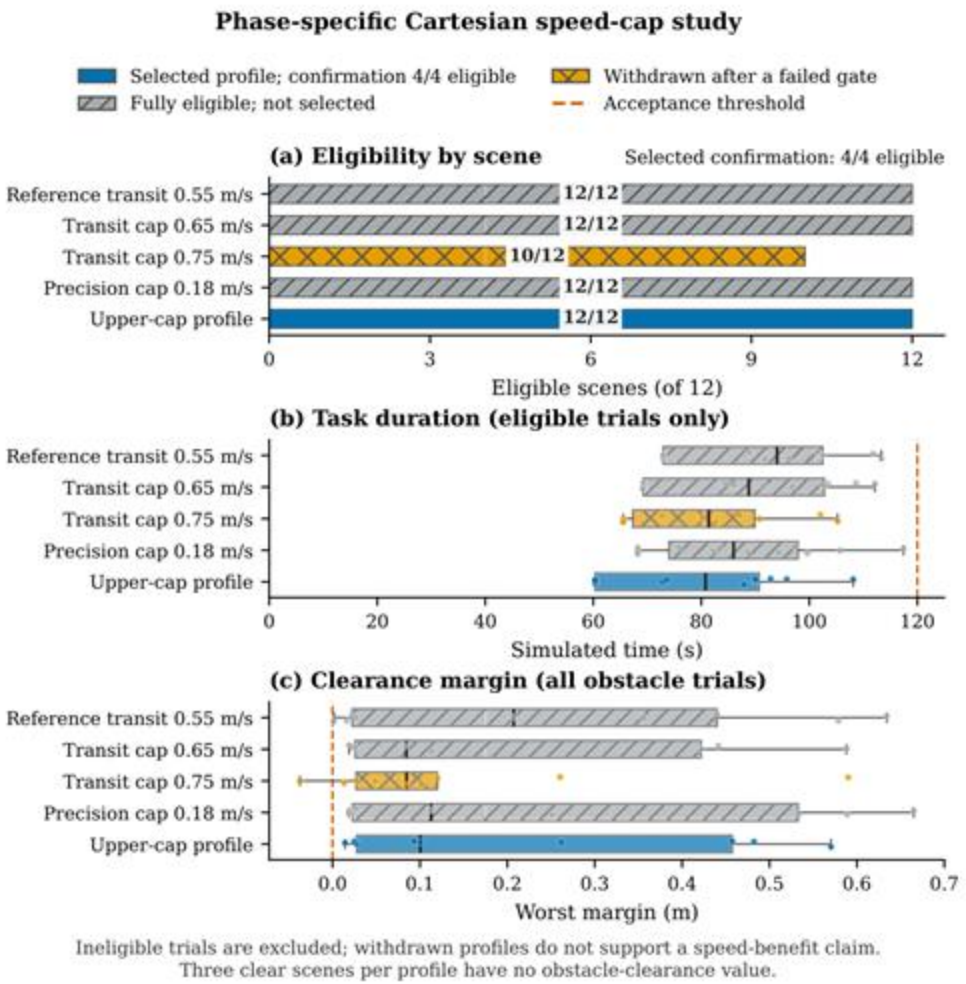
- **Hardware profile:** Articulated arm with two-jaw gripper.
- **Decoupled architecture:** Separate aircraft and observation systems.
- **Predictable autonomy:** Finite vocabulary limits unsafe actions.
- **Structured logic:** Language mapped only to verified scenes.

MISSION TUNING

Verified Scene Execution

- **Checked states:** Parsed maps verified before flight.
- **Replayable records:** Mission outcomes driven by saved states.
- **Vector confirmation:** Parsed world matches language instruction.
- **Safe deployment:** Prevents blind execution of free-form text.





MOTION ANALYSIS

Phase-Specific Mission Tuning

- **Layered planning:** A* planner anticipates obstacle motion.
- **Speed tuning:** 13% mission time reduction via phase limits.
- **Strict testing:** 40 matched scenes reveal exact planner bounds.
- **Honest result:** No net completion benefit from adaptive planner.

Autonomy is fundamentally a systems co-design problem.

Hardware-Software Sync

Compute bottlenecks shift immediately when isolated limits are relieved.

Hybrid Architectures Win

Deep learning excels at approach; classic control secures the final physical interaction.

Rigorous Verification

Natural language promises require deterministic physics simulation before deployment.

RIVERGUARD · STUDENT VOLUNTEERS

Short pollution events are easy to miss

In cities like London, heavy rain can overwhelm sewers, spills happen and happen and dirty runoff washes into the water. These events often last a often last a few hours and affect one stretch of river. Fixed stations can stations can miss them between sites, and weekly or monthly sampling sampling can miss them entirely.



Underwater picture from Norfolk.

THE RIVERGUARD IDEA

A layered safety net for the river

Forecasts

Weather and river-level level data flag when events are likely

Fixed sensors

Continuous background background readings at at set points

Citizen reports

People on the river flag flag problems as they happen

Drones

Map discoloured water water and surface signs signs from above

Robots

Measure below the surface and trace pollution to its source

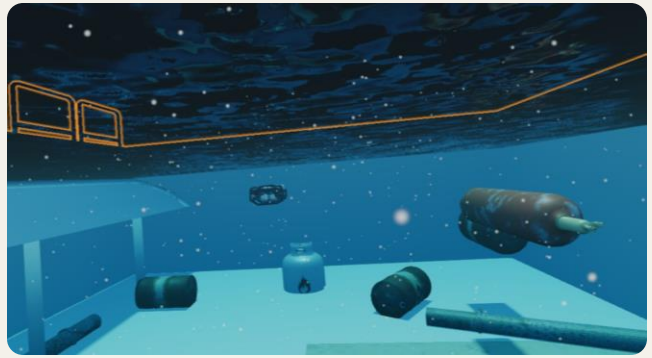
Our focus

HOW THE LAYERS WORK TOGETHER

A sensor spots something something odd → A drone outlines the affected area → A robot follows the trail trail upstream → A clear alert: “investigate now”

WHERE WE ARE · SIMULATION

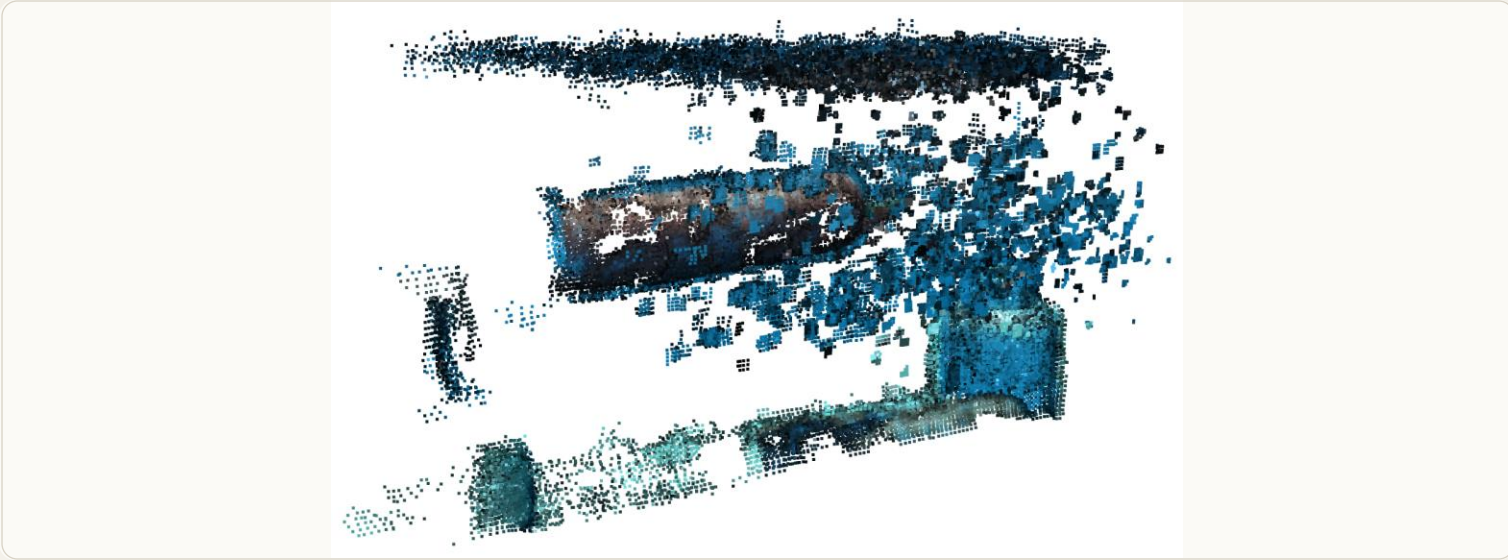
Testing underwater, before the river



Clear water



River-murky water



A 3D map of the test scene, built by SLAM from simulated camera data

We've built a full underwater test environment on the open-source Stonefish simulator, from clear to river-murky water. SLAM systems running on it map the scene in 3D and track where the robot is as it moves.

WHERE WE ARE · INTO THE FIELD

Next stop: a real river

30 Oct

Norfolk
First data trip

A BlueBoat surface robot carries a submerged sensor pod: sonar, a DVL that tracks speed over the riverbed, cameras and a lidar. Ecology sensors from the Life Sciences team join it on board.

Software and sensor bring-up	**Largely done**
Sensor pod mount	**Being built now**
Ecology sensors	**Coming soon**



The BlueBoat in the lab



The stereo camera bar, mid-build

GET INVOLVED

Come build it with us

NOW

Build the mount

The frame, braces and stereo camera bar, plus sealing and leak-testing the enclosure

NEXT

Get ready for Norfolk

Water tests before the trip, and fitting the ecology sensors once they arrive

AFTER

Make sense of the data

3D reconstruction, mapping and analysis on real river datasets

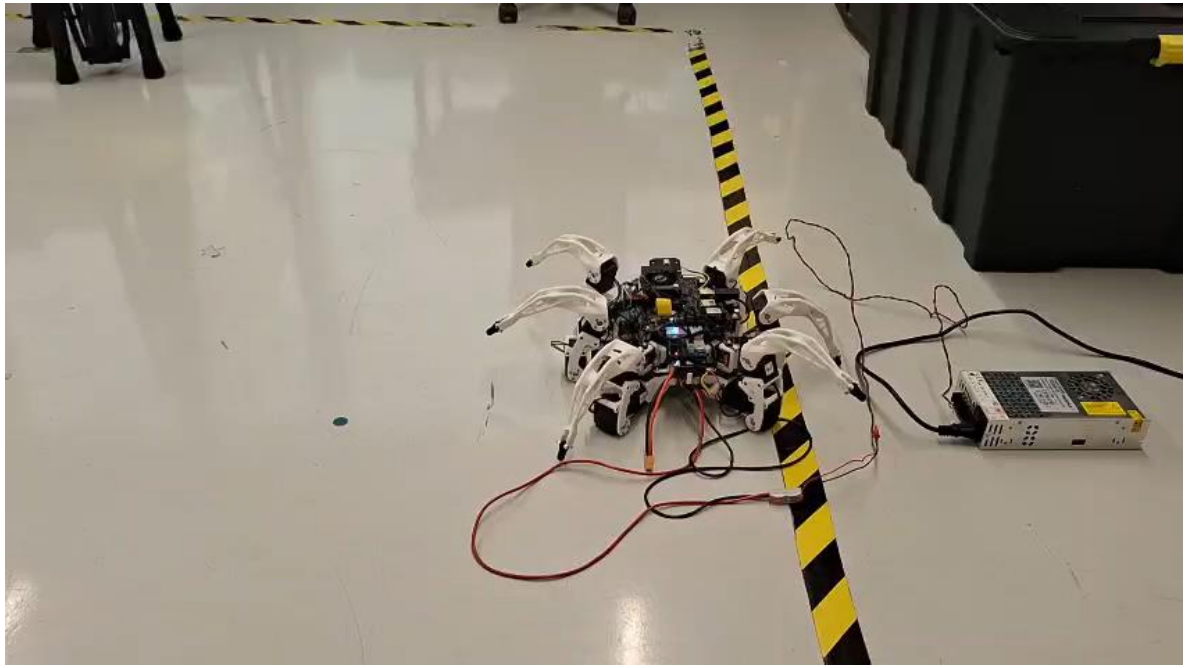
You'll work alongside the project team and pick up field robotics hands-on, with mentoring mentoring along the way.

Dr Izzy Bishop · Life Sciences

Dr Valerio Modugno · Engineering Sciences

Aydin Orhan · Research Assistant, Robotics

Robot Locomotion in Real Environment





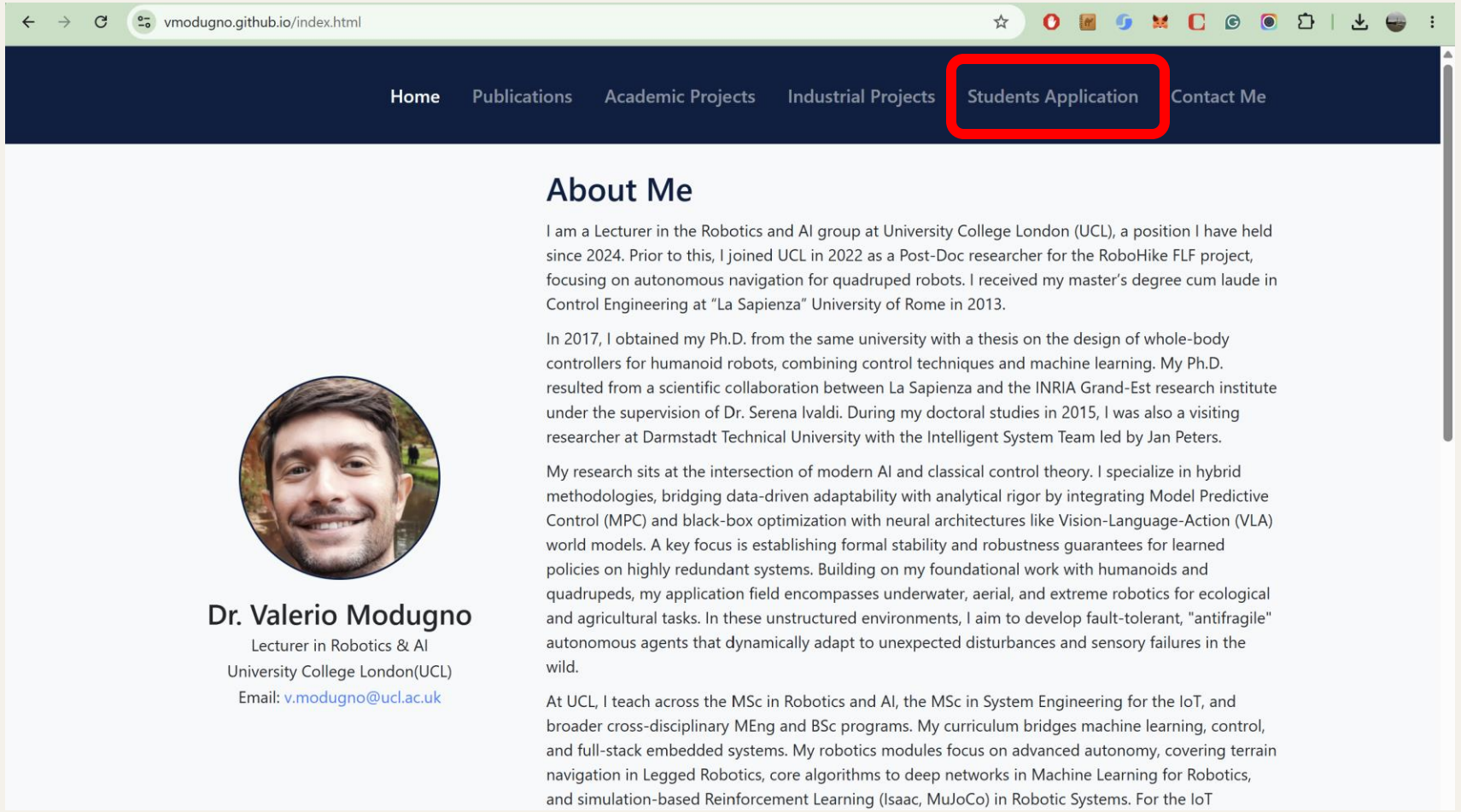
Morphological Adaptation



Locomotion in Rough Terrain



How to Sign Up 1



How to Sign Up 2

