

# MASTER PROJECT COURSE ET/ESE/CE

## Design and development of automated simulation for aerial (soft) robots

### Background

In this master project, you will develop a simulation environment for aerial robotics by co-optimizing robot morphology ("body") and navigation policies ("brain") through evolutionary algorithms and deep reinforcement learning (DRL). Current simulation frameworks lack tools for efficiently modeling soft robotic components, origami structures, and mission-specific sensor suites. This project builds on NVIDIA Isaac Sim and Omniverse — high-fidelity, GPU-accelerated simulation platforms — to address these gaps, enabling parametric modeling of novel flying robots and environments.

### Project goals

The project aims to develop a simulation framework to optimize the morphology (body) of the aerial robots. The overarching idea is to challenge the traditional design paradigm of aerial robots by co-optimizing robot morphology and the corresponding navigation policies. The project will focus on the following tasks:

**Parametric robot embodiment simulation:** develop a modular framework in Isaac Sim to automate the simulation of propeller-driven aerial robots with hybrid rigid-soft structures (e.g., origami-inspired designs) This include designing a parametric model template for aerial robots, capturing different rotor configurations, soft-body dynamics (e.g., via reduced-order FEM approximations), and optimal sensor placements

### Develop evolutionary based simulation environment:

survey existing evolutionary algorithms and implement custom environments with increasing complexities (e.g., increasing clutter, non-convex terrains) to challenge the robot navigation policies.

### Requirements

- Motivated and self-driven with a strong interest in robotics and data-driven design
- Object oriented programming experience in Python and C++
- Background on programming simple neural networks
- Expected duration: 12 months (but can also be adjusted to 6 months)

Not required, but a big +:

- Experience with reinforcement learning frameworks and gym environments

### What you gain

- Hands-on experience with NVIDIA Isaac Sim and Omniverse which are becoming industry standards for robotics simulation and data driven design and learning
- Research experience in aerial (soft) robotics and deep reinforcement learning algorithms
- Contribute to open-source projects

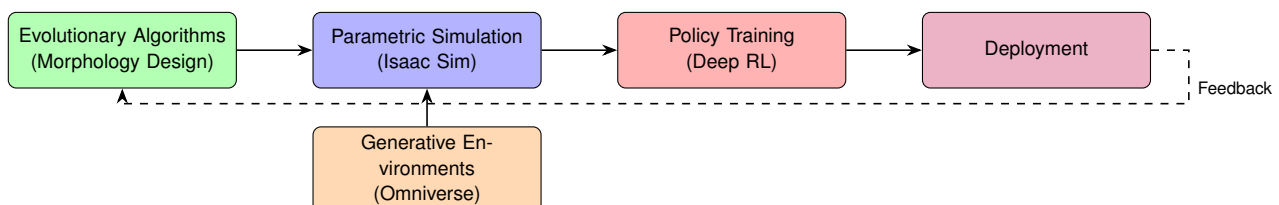


Figure 1: Aerial robot design optimization through simulation and learning.