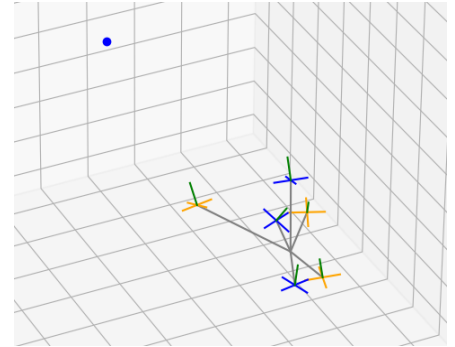


## Efficient Reinforcement Learning for Multirotor Design

**Abstract:** Measuring the quality of the design of a multirotor involves testing the multirotor given a controller. While model based controllers can work for a variety of designs and don't require any training, they are not always able to properly take advantage of the design. Learning based methods produce policies that better take advantage of the design, but they take a long time to train. This makes the co-optimization of design and control of multirotors a challenging optimization problem.



Hexarotor where the position and orientation of the rotors was optimized to minimize the average distance from a target position.

### Tasks:

- Study and understand derivative free optimization problem formulation, terminologies and solvers (Nevergrad, CMA-ES,...).
- Adapt the [Optimal Evaluation Cost Tracking](#) algorithm for the particular case of co-optimization of multirotor design and learning based control on the SPEAR project.
- Optimizing the design of a multirotor does not necessarily require that the policies are trained with a large model, and for the full training procedure.
  - Measure the consistency in multirotor performance when model based methods are used instead of learning based methods.
  - Measure the consistency in multirotor performance when smaller neural network models are considered instead of the full model for learning based controllers.

### Literature (indicative):

- [1] J. Echevarrieta, E. Arza, and A. Pérez, "Speeding-up evolutionary algorithms to solve black-box optimization problems," *IEEE Transactions on Evolutionary Computation*, 2024, doi: 10.1109/TEVC.2024.3352450.
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- [3] P. Bennet, C. Doerr, A. Moreau, J. Rapin, F. Teytaud, and O. Teytaud, "Nevergrad: Black-box optimization platform," *SIGEVolution*, vol. 14, no. 1, pp. 8–15, Apr. 2021, doi: 10.1145/3460310.3460312.
- [4] J. Nocedal and S. J. Wright, *Numerical optimization*, 2nd ed. in Springer series in operations research. New York: Springer, 2006.

### Relevant Funded Project:

- **Title:** SPEAR: Spatial Perception & Embodied Autonomy Research
- **Funding Agency:** European Commission

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