Multi-objective tuning for torque PD controllers of cobots

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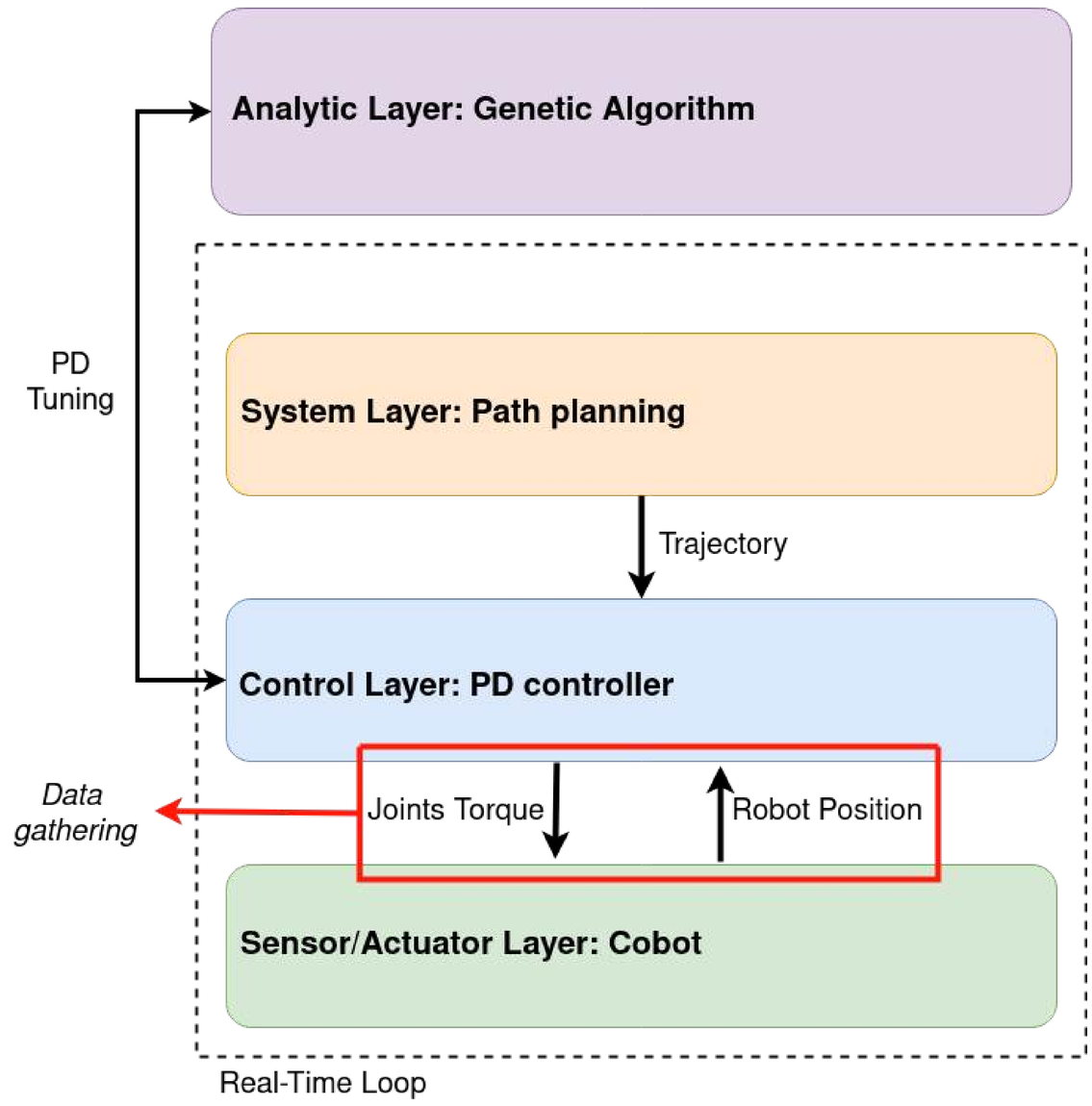
Problem

Compliant control demands torque control, however torque control strategies based on dynamic modeling cannot be efficiently applied due to the presence of non-linearities and elastic components. These non-linearities make dynamic modeling extremely complex.

We use data-driven dynamic models to predict the sequence of torque commands needed to operate a multi-joint robotic arm when following a desired trajectory.

We explore the cobot dynamics by torque operating its actuators via a PD. The torque-position/velocity values obtained are used as a database for dynamic model training. We optimize those PD controllers by using multi-objective genetic algorithms (GA).

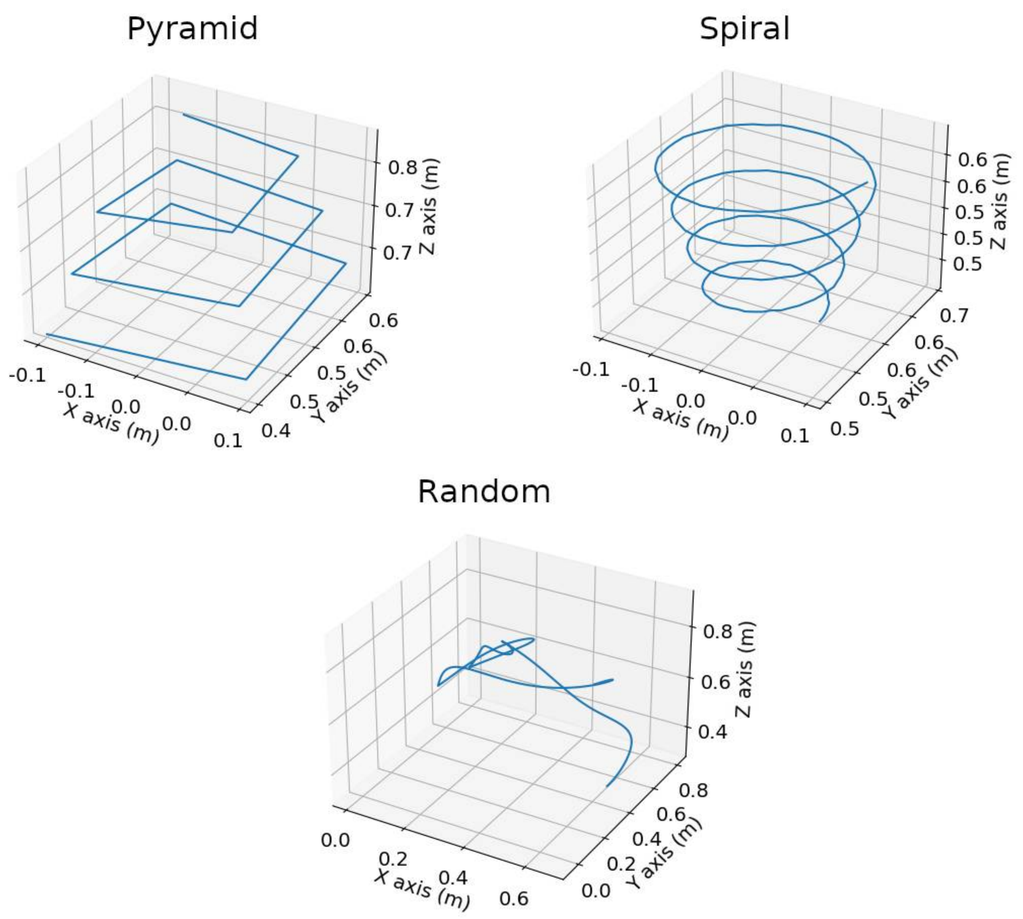
Setup



Methodology

We first define a set of representative trajectories. We then fit a set of PD controllers via multi-objective GA (NSGA-II) and choose the controller with the best torque-accuracy balance.

Once we have the desired controllers we can capture the position, velocity and torque obtained during each trajectory and apply machine learning to model the relationship between them.

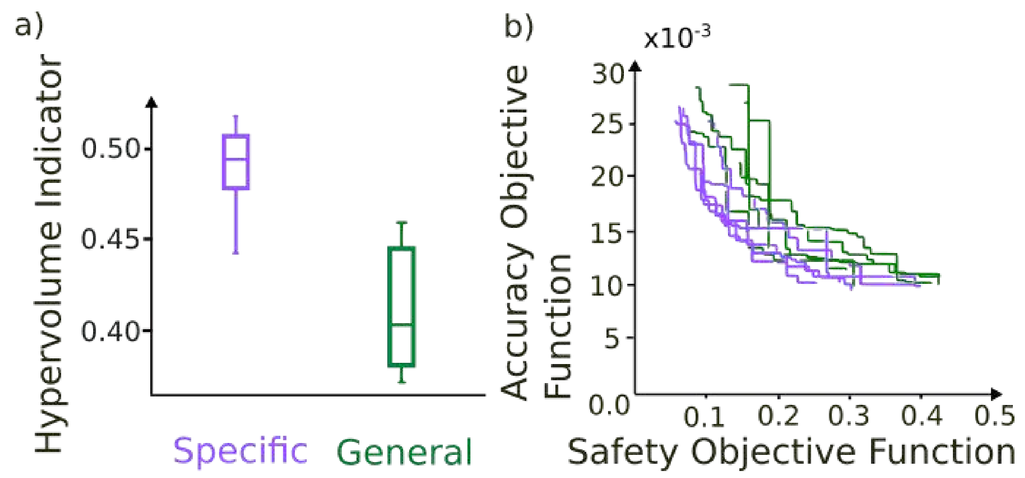


Results

We can see a clear difference between the PD controllers fitted and used in a single trajectory (purple) and the ones fitted and tested using all the trajectories (green).

This is due to the specific controller being used only around a single working point, which allows for a better fit.

A better fit for a more accurate and safer controller will allow us to capture better quality data which should translate to a better dynamic model.



Acknowledgment

This work was supported by the EU with the IMOCOe4.0 [EU H2020RIA-101007311] project and by Spanish national funding [PCI2021-121925].

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