

# Revisiting Proprioceptive Sensing for Articulated Object Manipulation

Thomas Lips and Francis wyffels  
AI and Robotics Lab, Ghent University  
Thomas.Lips@ugent.be



## Summary

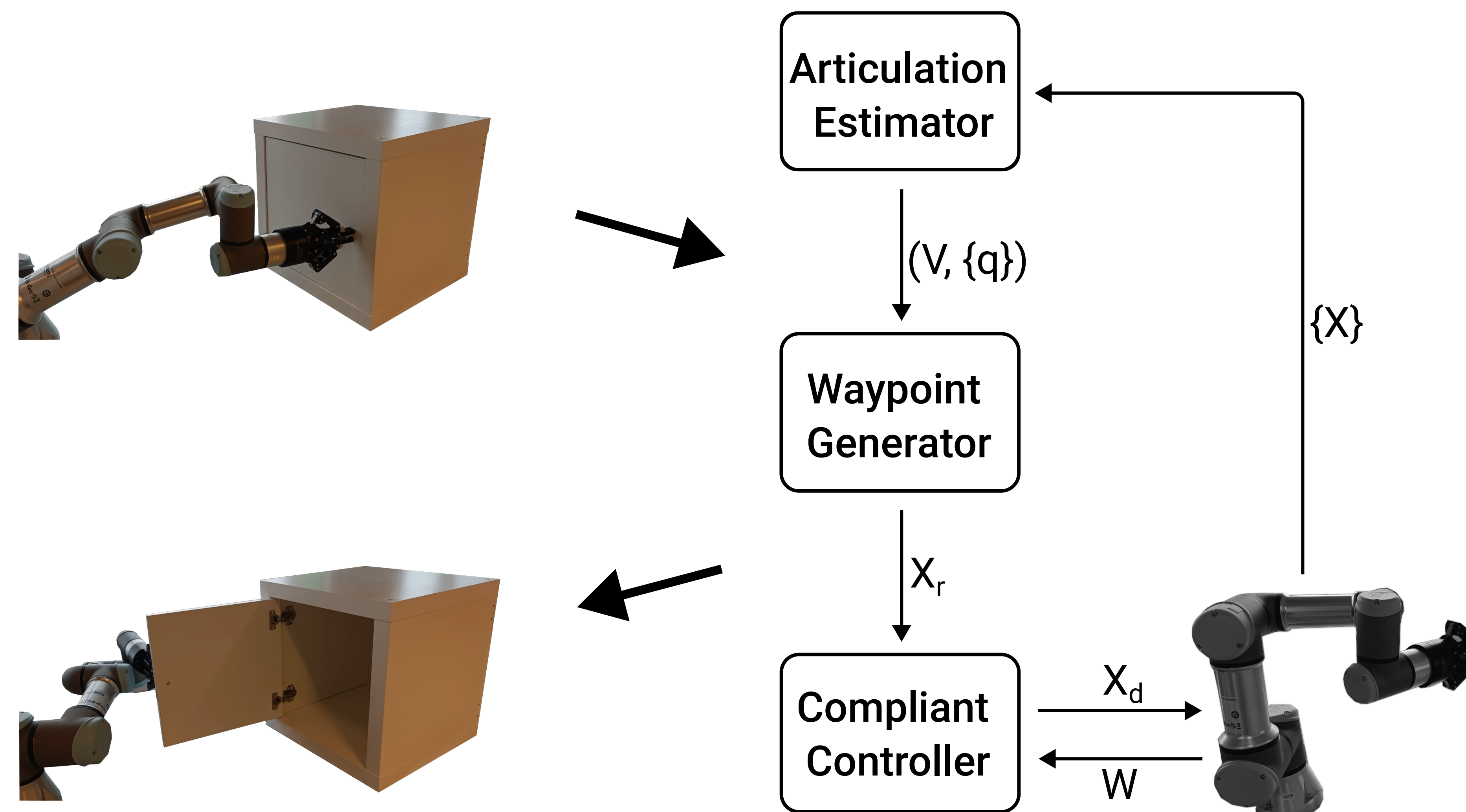
Assistive robots will need to interact with **articulated objects** as these are omnipresent. Previous work has already made significant progress.

However, **most systems only use visual information**, even though proprioceptive information has interesting invariances and has been found effective.

In this work, we create a system that uses **proprioceptive information to open articulated objects** with a position-controlled robot and parallel gripper.

We evaluate the **performance** of this system and explore its **limitations**.

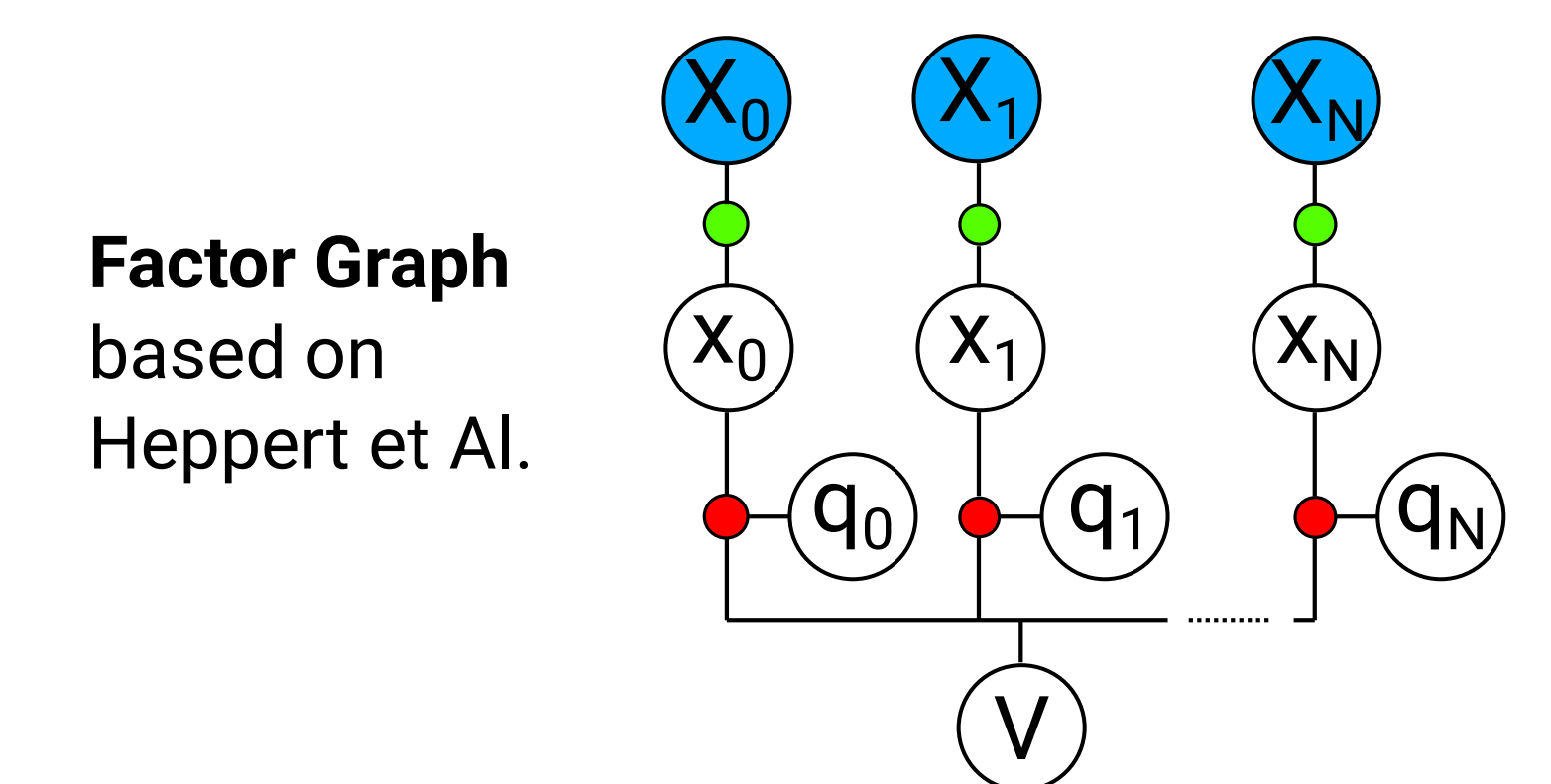
## System Overview



## Articulation Estimator

$$(\hat{V}, \{\hat{q}^t\}) = FG(\{\hat{X}^t\})$$

joint twist      joint configurations      gripper poses



## Waypoint Generator

$$X_r = \text{Exp}(\hat{q}[\hat{V}])$$

Matrix Exponential      Skew-symmetric Matrix

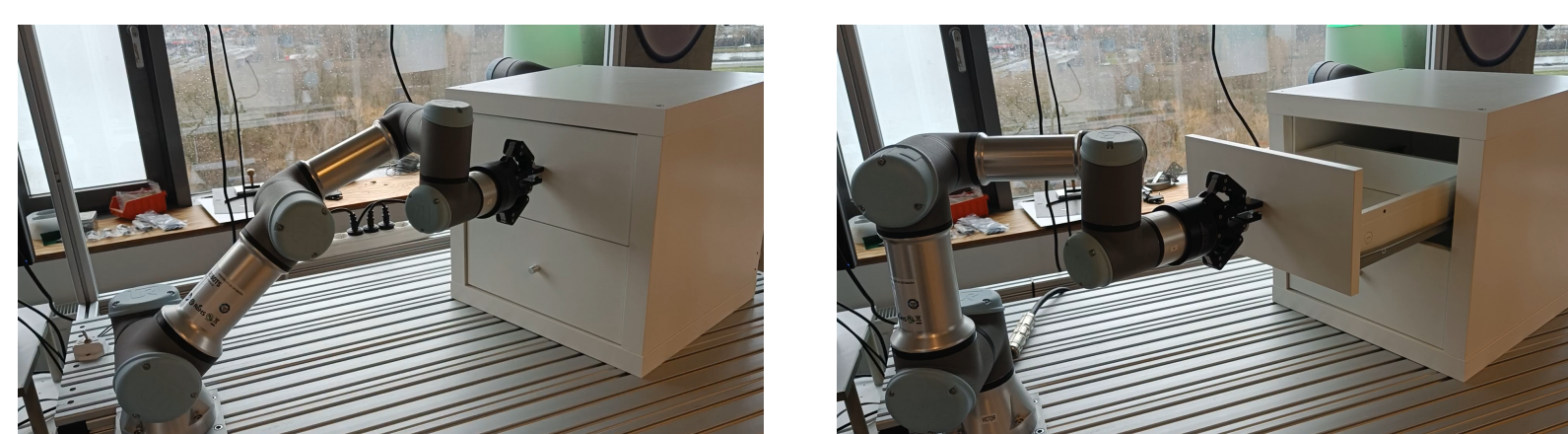
## Compliant Controller

gripper wrench

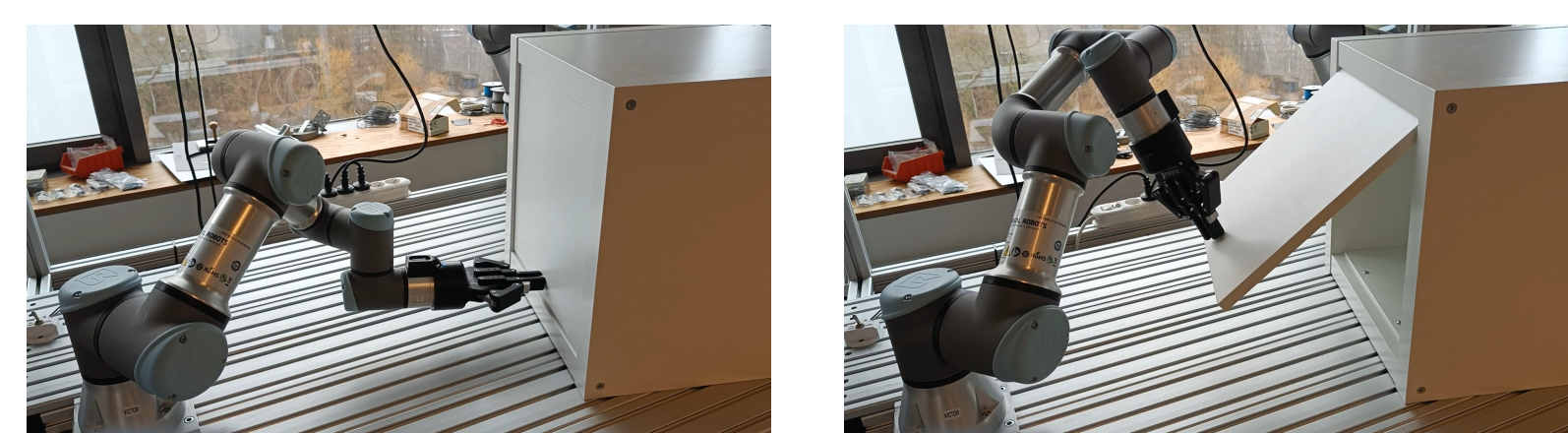
$$W = KX_e + B\dot{X}_e + M\ddot{X}_e$$

$$X_d = X_r + X_e$$

## Results



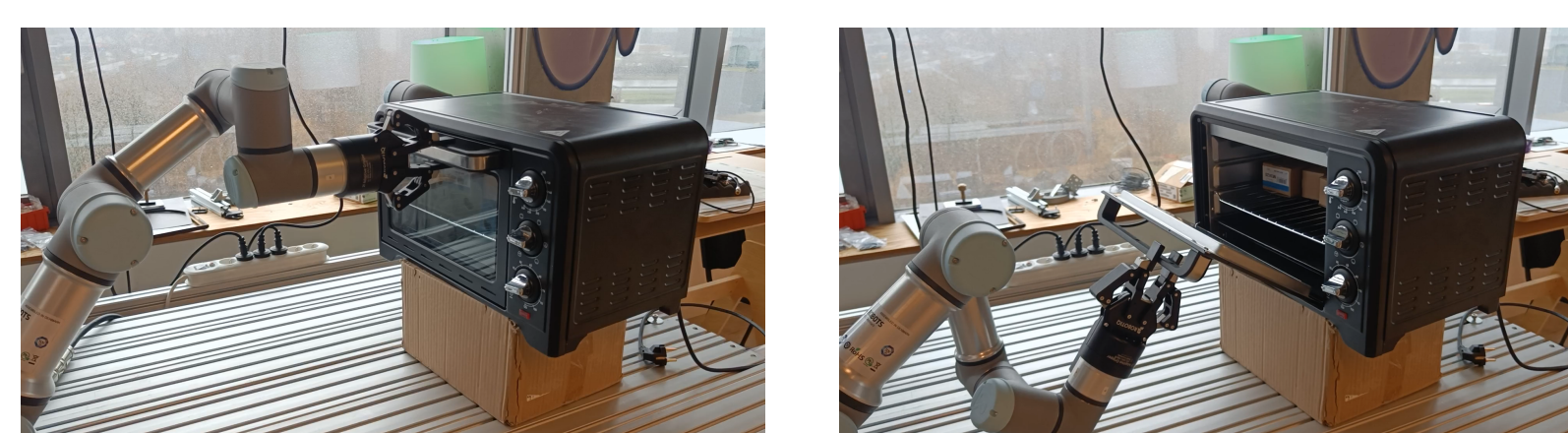
The system is able to open various articulated objects.



Slip between the gripper and handle deteriorates the estimation, but does not necessarily lead to failures.



Using fixed grasps aggravates workspace constraints.



Fixed grasps can cause collisions with the environment.

## Open Questions

We **reconfirmed** that proprioceptive sensing can be used to open articulated objects. Nonetheless, slip between the gripper and handle deteriorates the estimation accuracy and needs to be *handled*.

Furthermore **vision is still required** to find suitable grasp poses.

This begs the question: **Should we incorporate proprioceptive sensing** in our articulated object manipulation systems or is it not worth the additional complexity and can we manage with vision alone?

And if we want to use proprioceptive sensing, how can we **efficiently combine it with visual information**?

## Paper, Videos and Code

