# Virtual Reality via Object Poses and Active Learning: Realizing Telepresence Robots with Aerial Manipulation Capabilities

## A. Highlights

- A VR-based telepresence system for aerial manipulation with a 3D view and a haptic guidance.
- Object pose estimation and active learning pipelines for industrial objects of both known and unknown geometry.
- Extensive outdoor experiments over extended durations, including flight tests at night.

## B. Motivation

- A real-time VR of the robot workspace for (a) enhancing the sense of vision, and (b) provide signals for shared control.
- How to scale a machine learning based pose estimation techniques to field deployment of extended durations?

## C. The Proposed System

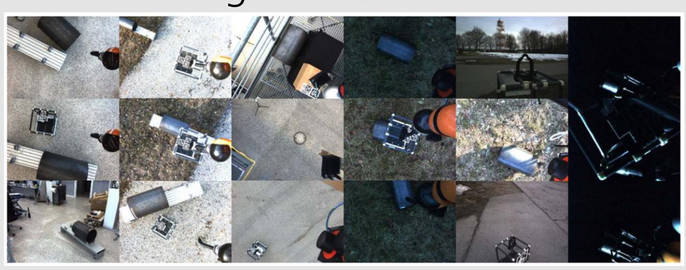
- Scene graph based approach.

If known geometry: use marker tracking with onboard SLAM!

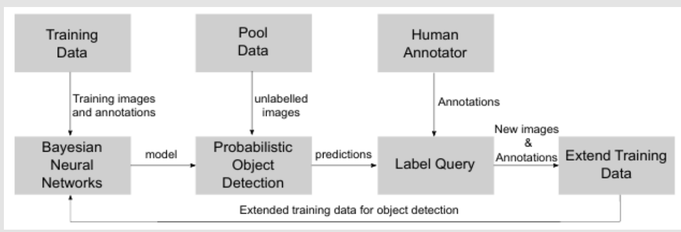
If unknown geometry: use deep learning based object detectors.

- Active learning pipeline.

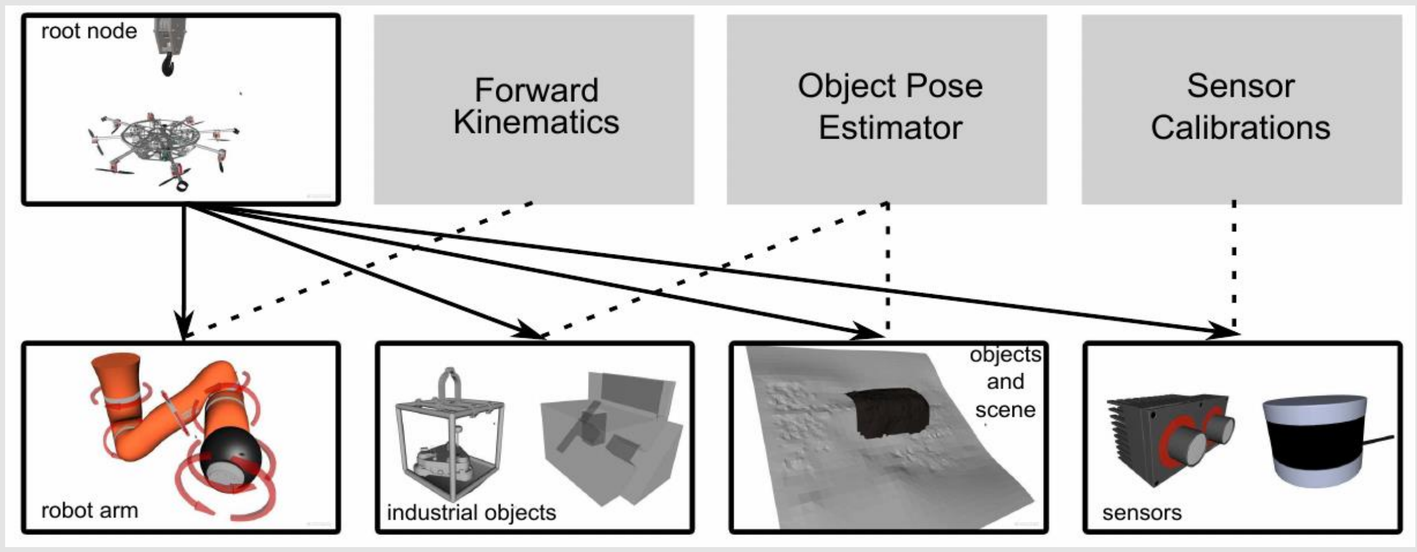
Problem: high costs of annotations!



Approach: Laplace Approximation.

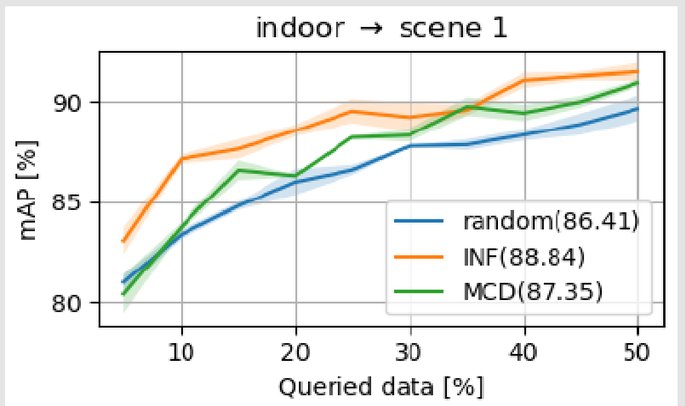



Uncertainty method based on:
'Estimating model uncertainty of neural networks in sparse information form', ICML 2020.

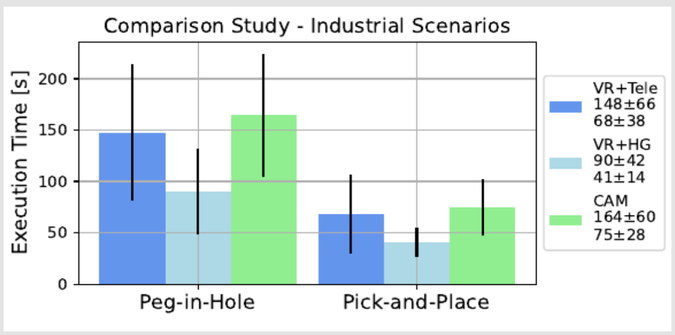



## E. Main Results

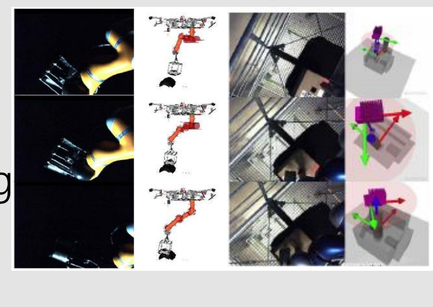
- Active learning in reducing the annotation efforts.




- Effectiveness of overall system in performing aerial manipulation tasks within industrial scenarios.




- Aerial manipulation at night; VR system also works under challenging situations!



Take away 1: ***The proposed telepresence system as a viable option for future industrial applications.***
Take away 2: ***Introspection improves the viability of learning-based perception for outdoor scenarios.***

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