



# A general approach to hand-eye calibration through the optimization of atomic transformations

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Uma abordagem geral para calibração olho-mão através da otimização de transformações atômicas



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Intelligent Systems for Human Assistance



# Intelligent Robotics and Systems

## IRIS LAB

A showcase of our projects

### Multi-robot Systems



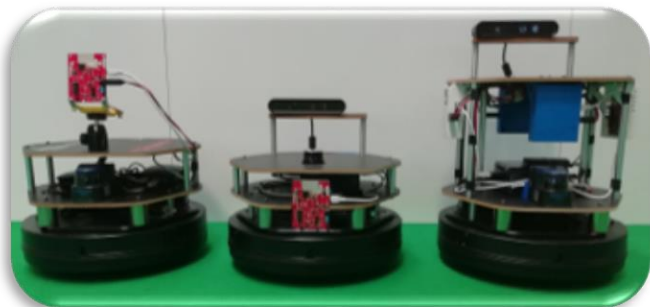
### Autonomous Driving



### Collaborative Robotic Arm



### Intelligent Perception



### Industrial Logistics

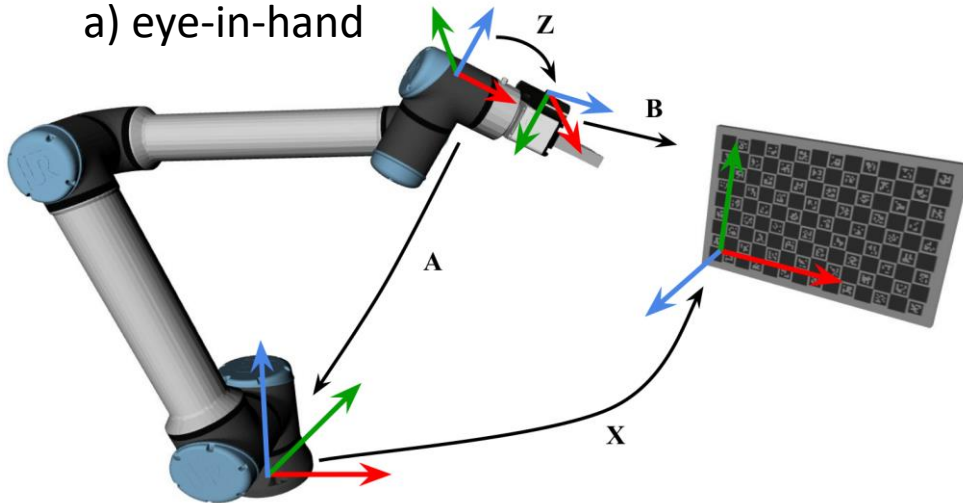




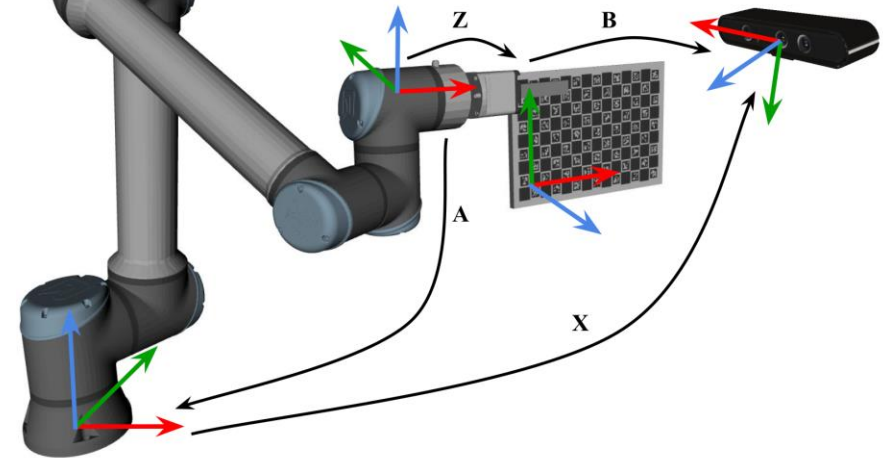
# The Hand-eye Calibration Problem

## A sensor pose estimation problem

a) eye-in-hand



b) eye-to-base



- Problem is stated as  $AX = ZB$
- **A** and **B** are **known**
- **X** and **Z** are **unknown**

- Early Solution Tsai and Lenz (1988)
- Only supports a single sensor
- **A, B, X, Z** hide complexity



# Optimization of Atomic Transformations

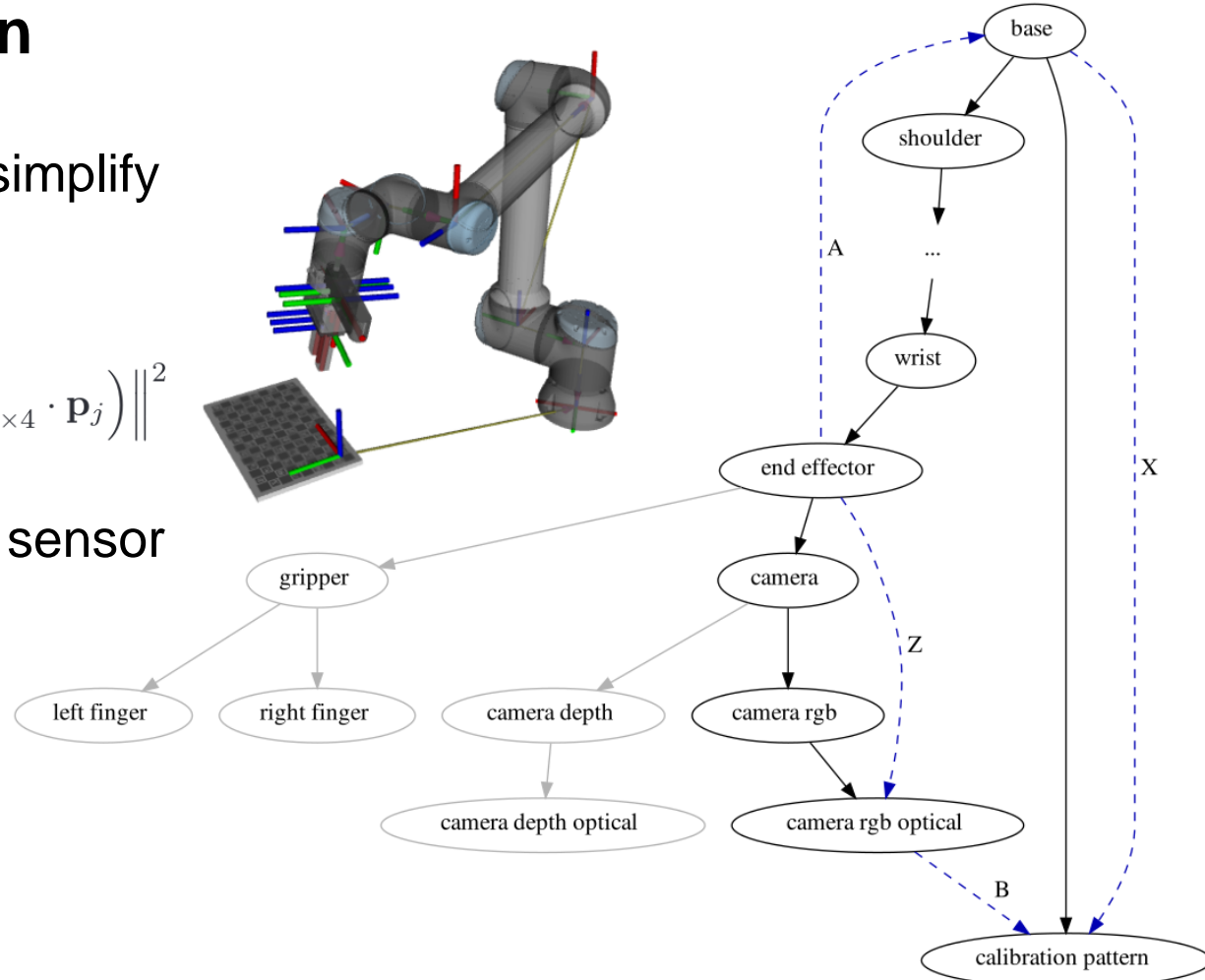
## A general solution

- Use the complexity to simplify

$$\operatorname{argmin}_{\{\hat{T}_k\}, \hat{k}_m, \hat{d}_m} \sum_m \sum_i \sum_j$$

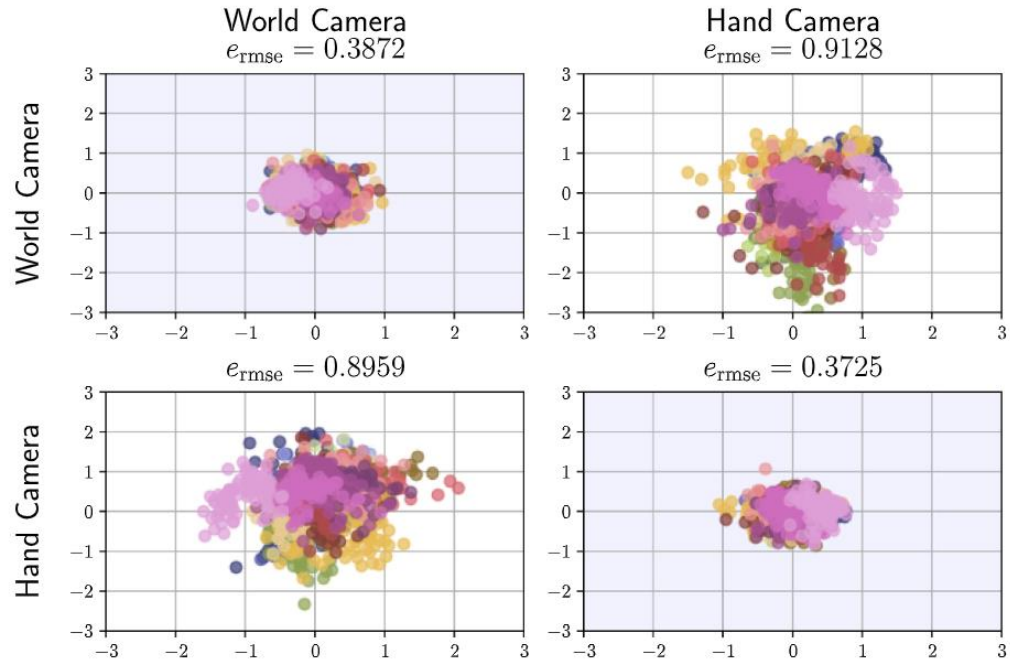
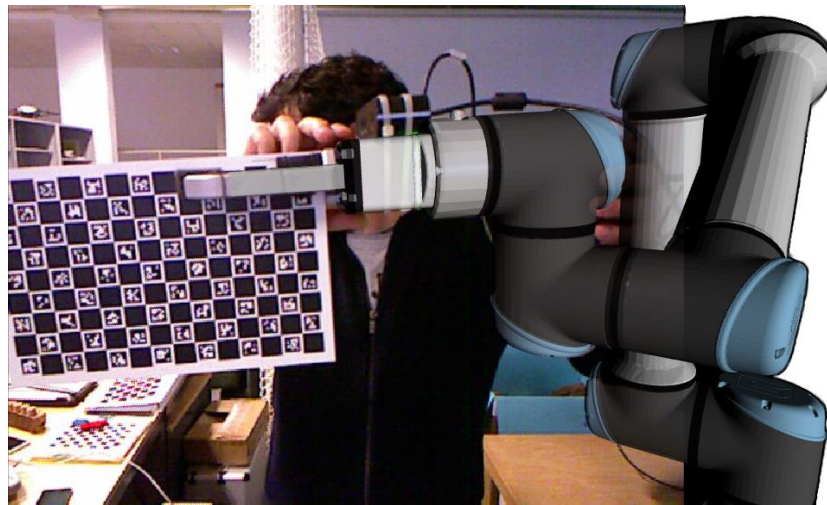
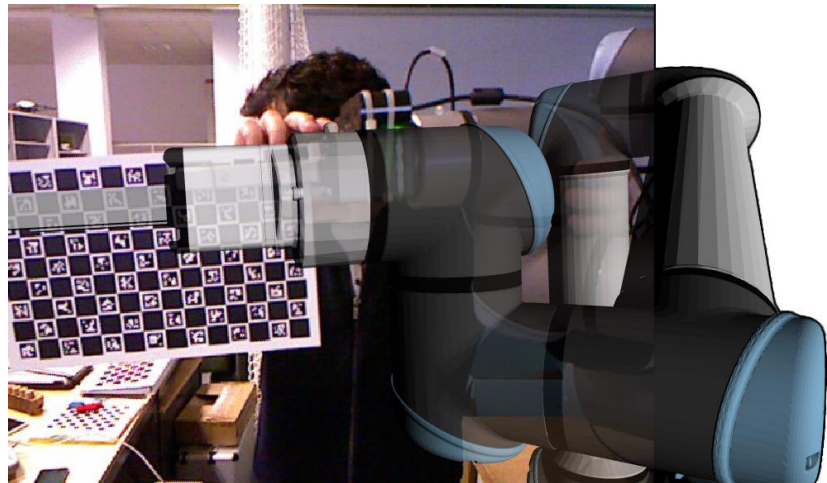
$$\left\| \mathbf{q}_{m,i,j} - \mathcal{P} \left( \hat{\mathbf{k}}_m, \hat{\mathbf{d}}_m, [\mathbf{C}_{m,i}]_{3 \times 4} \cdot \mathbf{p}_j \right) \right\|^2$$

- Accepts any number of sensor
- One single calibration





# Results & Conclusion



ROS GitHub

<https://github.com/lardemua/atom>