Unsupervised Calibration of Wheeled Mobile Platforms (Proc. ICRA 2016)

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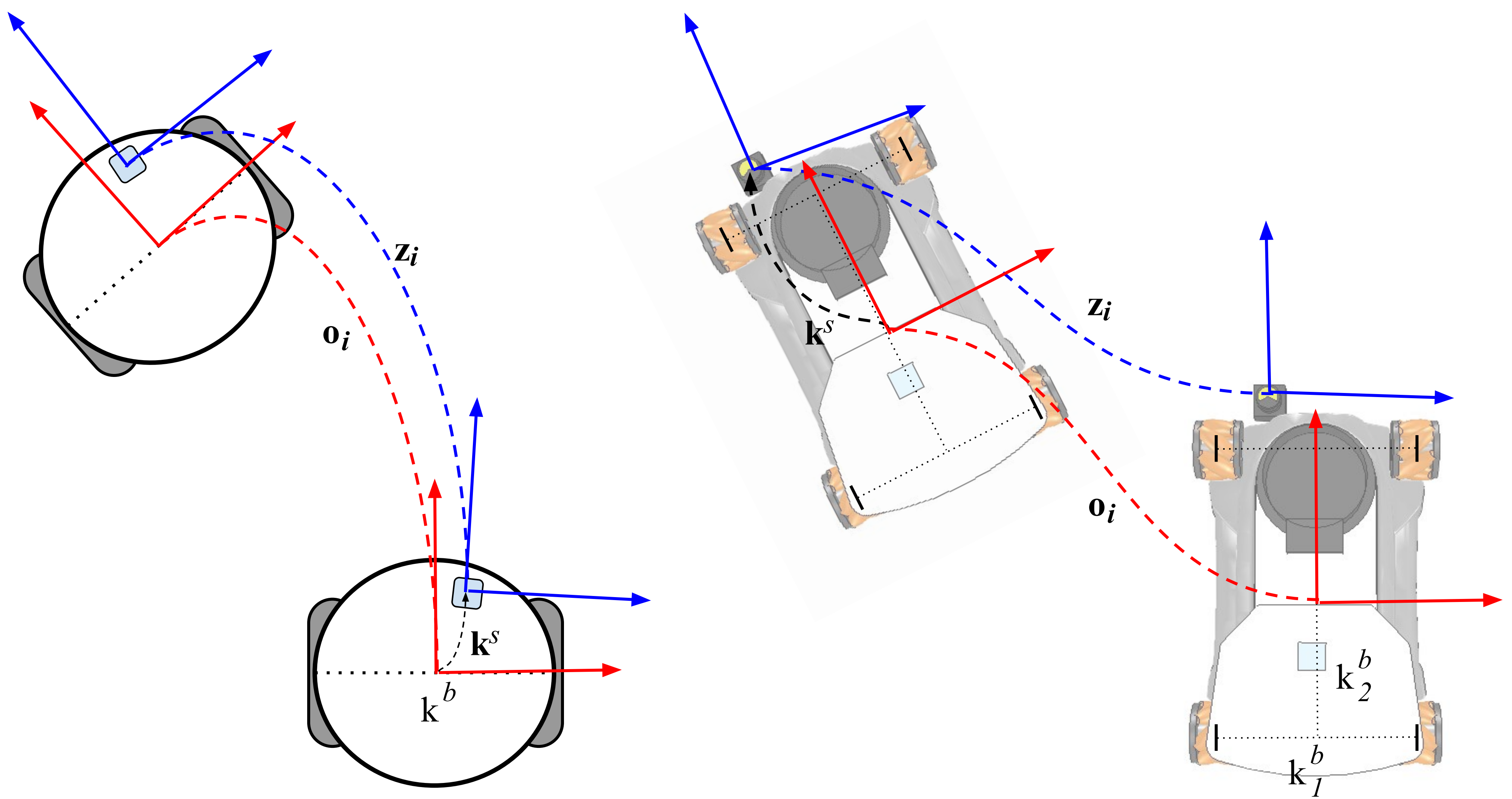
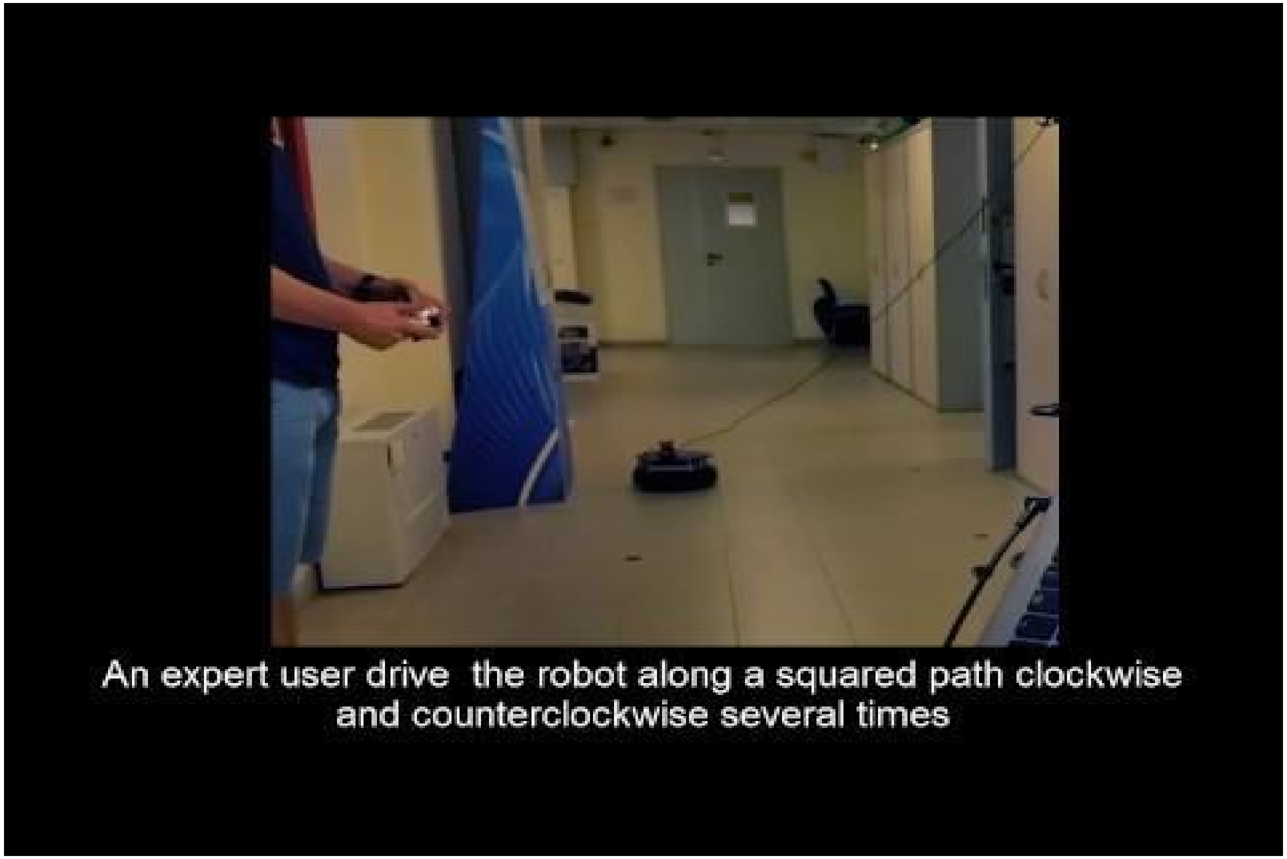
Pdf: 10.1109/ICRA.2016.7487631
Code Available: https://gitlab.com/srrg-software/srrg_nw_calibration

** : Dr. Di Cicco is currently at Nutonomy*

Intrinsics and Extrinsics Parameters



State of the Art



- G. Oriolo A. Censi, L. Marchionni. Simultaneous maximum-likelihood calibration of robot and sensor parameters. In Proc. of the IEEE Int. Conf. on Robotics & Automation (ICRA), 2008.
- A. Tapus A. Martinelli, N. Tomatis and R. Siegwart. Simultaneous localization and odometry calibration for mobile robot. In Intelligent Robots and Systems, 2003. (IROS 2003). Proceedings. 2003 IEEE/RSJ International Conference on, volume 2, pages 1499–1504 vol.2, 2003.
- A. Martinelli and R. Siegwart. Estimating the odometry error of a mobile robot during navigation. In Proc. of the European Conf. on Mobile Robots (ECMR), 2003.

Issues

Do I cover the space enough?

Which path to take?

Let the robot solve the task!

Provide the robot with a set of elementary motions, expressed as required motor velocities, *e.g.*

- Apply same velocity to each motor, a.k.a **go forward**
- Apply opposite velocities to motors, a.k.a **rotate**
- **...**

The robot will

First **explore** the **effect** of actions on the parameter estimate

Then **exploit** the acquired knowledge to effectively self-calibrate

How to evaluate these **effects**?

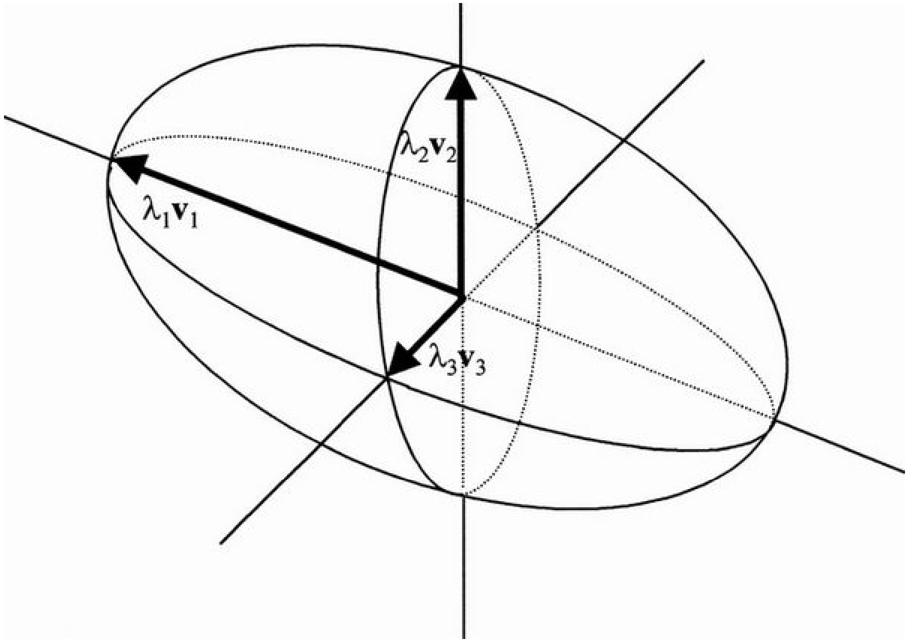
Hessian Matrix Analysis

In our least squares formulation, **H** is build as an approximation of the Hessian matrix:

$$\mathbf{H} \quad = \quad \sum_i \mathbf{J}_i^T \mathbf{\Omega}_i \mathbf{J}_i$$

it may be used to measure the **amount** of information that an observable random variable ***x*** carries about an unknown parameter ***a*** of a distribution that models ***x*** *

In practice: by extracting *eigenvalues and eigenvectors* of **H** we can figure out which parameters have been better estimates

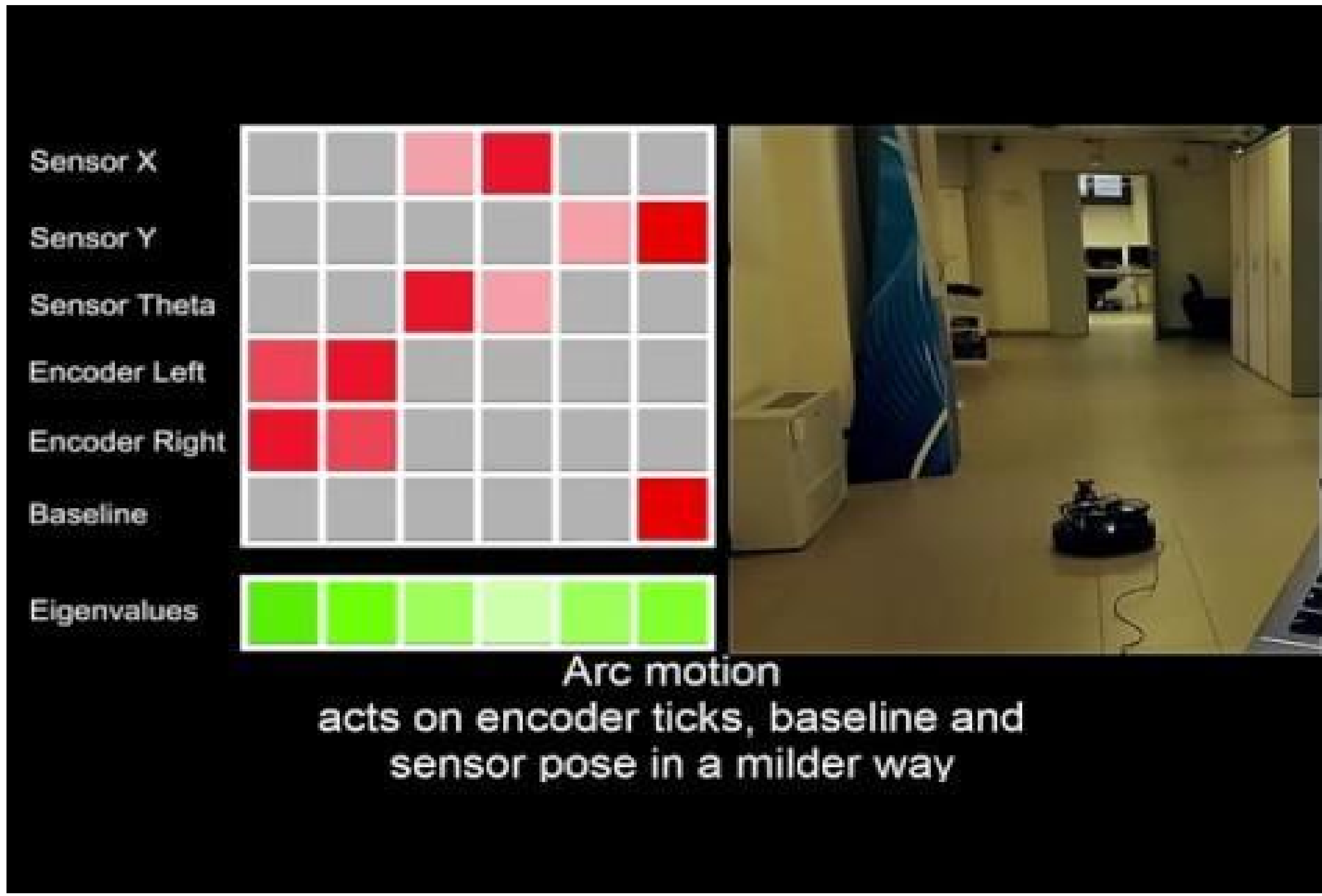


**: see Fisher Information*

Exploration Phase

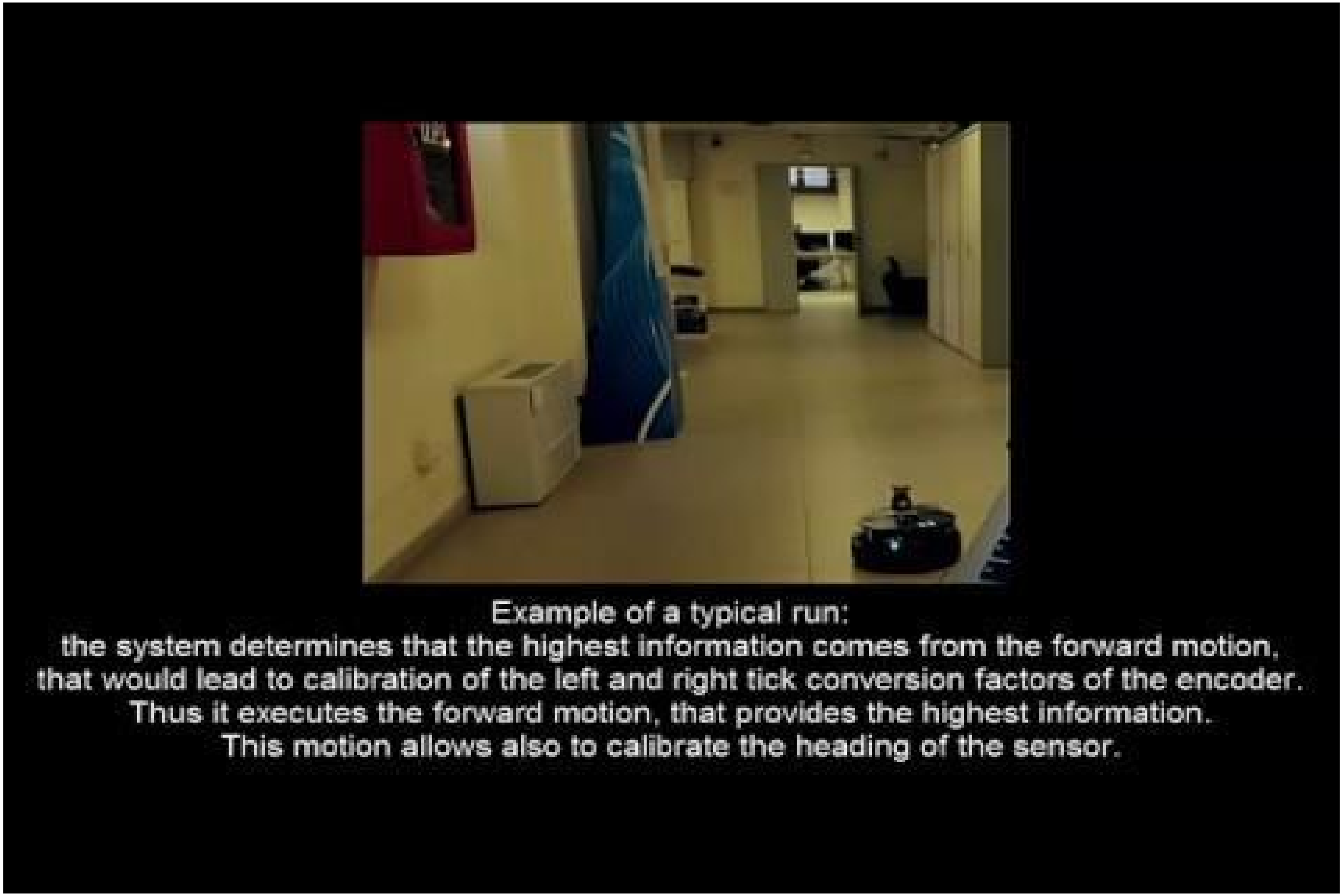
We provide our Differential Drive platform with these three motions, storing the **H** matrices computed :

- Forward / Backward
- Rotate in place
- Arc Motion



Exploitation Phase

Next motion chosen accordingly to $l = \underset{j}{\operatorname{argmax}} \det(\mathbf{H}_t + \mathbf{H}_j)$



Results


Unsupervised calibration paramaters led to more robust odometry computation.
Ground truth
Unsupervised calibration
Supervised calibration

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