Albert-Ludwigs-Universität Freiburg
Institut für Informatik
Lecture: Introduction to Mobile Robotics
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Sheet 12

Topic: Iterative Closest Point Algorithm

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Exercise 1: Data association

In the icp_framework tarball, you will find a complete implementation of the basic ICP algorithm. By commenting in one of the lines `icp(...)` in `main()` of `icp_framework.py` you can test it on four different datasets.

The algorithm already works well for datasets with known correspondences (i.e. P1 and P2), but it does not work for datasets with unknown correspondences (i.e. P3 and P4). If the correspondences between the points are unknown, they have to be estimated at first.

Implement closest-point matching (see `TODO` in `icp_framework.py`) and test it using the two data sets P3 and P4. The closest point matching should be implemented as reordering of the elements in the vector P to match those in X. Note that not all points in P can be matched to their closest partner in X, since this would require multiple matches of single points, which is not possible with simple reordering.

Exercise 2: ICP and SVD

Recall the formulas on the slides 5-7 of the ICP lecture and prove the following:

$$X' = P' \quad \Rightarrow \quad R = I \tag{1}$$

Hint: Find out, how singular value decomposition (SVD) and eigenvalue decomposition (EVD) are related to each other.

Exercise 3: ICP

Explain why the ICP algorithm is needed in robotics. In the context of SLAM, describe how you would approach each of the four stages of ICP (shown in the lecture on slide 12). You can choose from the variants presented in the slides or design new ones. Justify your choice. You can also choose a specific variant of SLAM and a specific sensor (e.g. 2D or 3D laser scanner) for your description.