# Outlier Rejection for Absolute Pose Estimation with Known Orientation

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In this paper we present an outlier rejection method for absolute pose estimation. We focus on the special case when the orientation of the camera is known. The problem is solved by projecting to a lower dimension where we are able to efficiently compute upper bounds on the maximum number of inliers. The method guarantees that only correspondences which cannot belong to an optimal pose are removed. Once the majority of the outliers have been removed the problem is greatly simplified and can be solved using standard methods (e.g. RANSAC [1]).

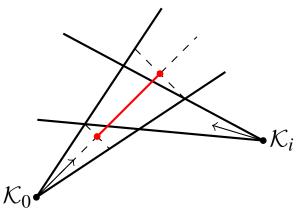
If the orientation is known we can w.l.o.g. assume that $R = I$, by rotating the image points. Each 2D-3D correspondence then constrains the translation $\mathbf{t}$ to a cone,

$$\mathcal{K} = \left\{ \mathbf{t} \in \mathbb{R}^3 \;\middle|\; \|\mathbf{X} - \mathbf{t}\| \leq \frac{1}{\cos(\varepsilon)} \langle \mathbf{x},\, \mathbf{X} - \mathbf{t} \rangle \right\}, \quad (1)$$

and we are interested in finding the translation which satisfies as many cones as possible.

To remove outliers we want to determine if a given cone $\mathcal{K}_0$ can be part of an optimal solution. If the answer is negative we can discard the correspondence safely.

In our outlier rejection scheme we first orthogonally project each intersection $\mathcal{K}_0 \cap \mathcal{K}_i$ to the center line in $\mathcal{K}_0$.




Each intersection gives an interval on the line and by finding the maximum number of overlapping intervals we get an upper bound for any solution which includes $\mathcal{K}_0$.

Finding the projection of the intersection between the cones is a convex problem and can be solved using standard solvers. For our application these are however too slow for practical use. Instead we form a polyhedral approximation of the cone $\mathcal{K}_0$. This allows us to find a closed form solution to the projection problem. In experiments we show that the errors introduced by the planar approximation are negligible and that the closed form solution gives significant speed-ups compared to using the standard solvers. For some instances the runtime went from 20-30 minutes to a couple of milliseconds.

We evaluate our method on a new dataset for metric localization from a single image for a car driving through a tunnel. The poor lightning conditions and repetitive textures makes matching difficult and there are a large number of outliers. See Figure 1 for an example image and localization result.

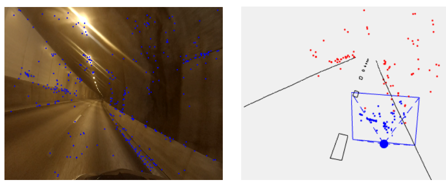


Figure 1: *Left:* Input image with SIFT features (blue points). *Right:* Camera pose in world coordinate frame.

We compare running our outlier rejection followed by a few iterations of RANSAC with performing RANSAC on original correspondences. Our approach gives improved performance, both in terms of localization accuracy and computation time.

[1] L. Kneip, D. Scaramuzza, and R. Siegwart. A novel parametrization of the perspective-three-point problem for a direct computation of absolute camera position and orientation. In *Computer Vision and Pattern Recognition (CVPR)*, Colorado Springs, US, 2011.