Framework for Natural Landmark-based Robot Localization

Andrés S. Montero, Hicham Sekkati, Jochen Lang and Robert Laganière
School of Electrical Engineering and Computer Science, University of Ottawa

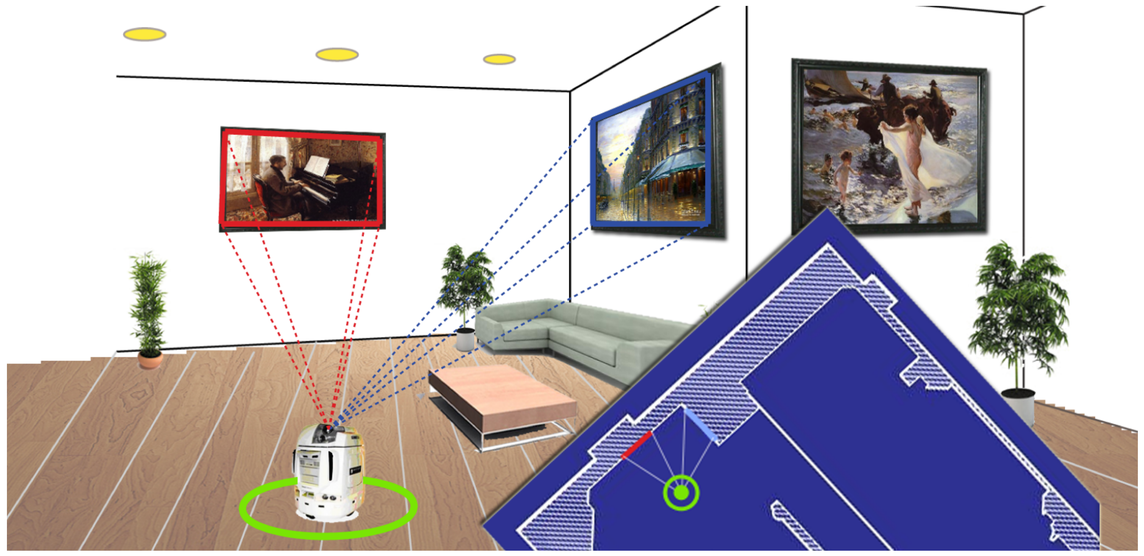
Jeremy James
Cohort Systems Inc.

Abstract

Framework developed for vision- based robot localization using natural planar landmarks. Specifically, we demonstrate our framework accuracy with planar targets using Fern classifiers that have been shown to be robust against illumination changes, perspective distortion, motion blur, and occlusions. We add stratified sampling in the image plane to increase robustness of the localization scheme in cluttered environments and on-line checking for false detection of targets to decrease false positives. We use all matching points to improve pose estimation and an off-line target evaluation strategy to improve a priori map building. We report experiments demonstrating the accuracy and speed of localization. Our experiments entail synthetic and real data. Our framework and our improvements are however more general and the Fern classifier could be replaced by other techniques.

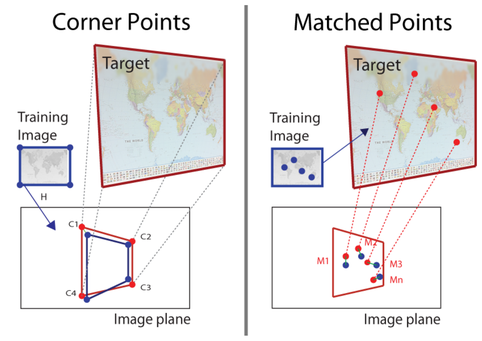
Objective

1. **Evaluate natural landmarks to be used as targets in the system for robot localization.**
2. **Aid the process of robot localization using natural landmarks using feature matching algorithms and the selected targets for indoor applications.**



Robot uses the detected targets to compute and correct its location.

Pose Estimation

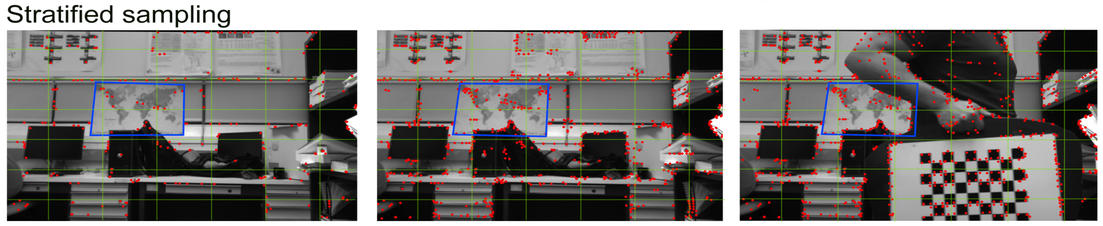


Using matching feature points instead of corners improves pose estimation.

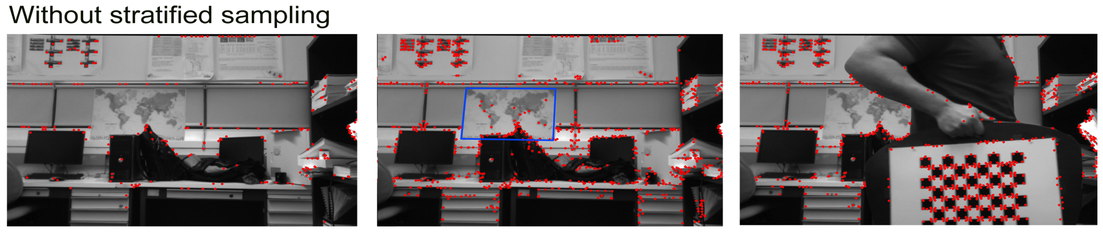
Larger number of point correspondences increases robot localization.

Stratified Sampling

Stratified sampling

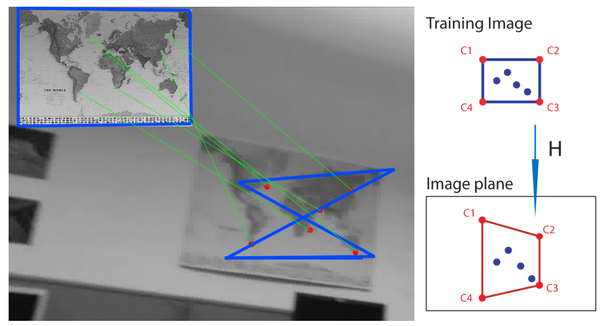


Without stratified sampling



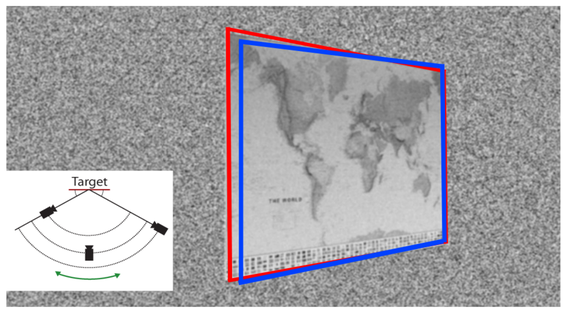
The feature detector is applied to subsets of features instead of the whole image and the strongest features are selected.

Planarity Check



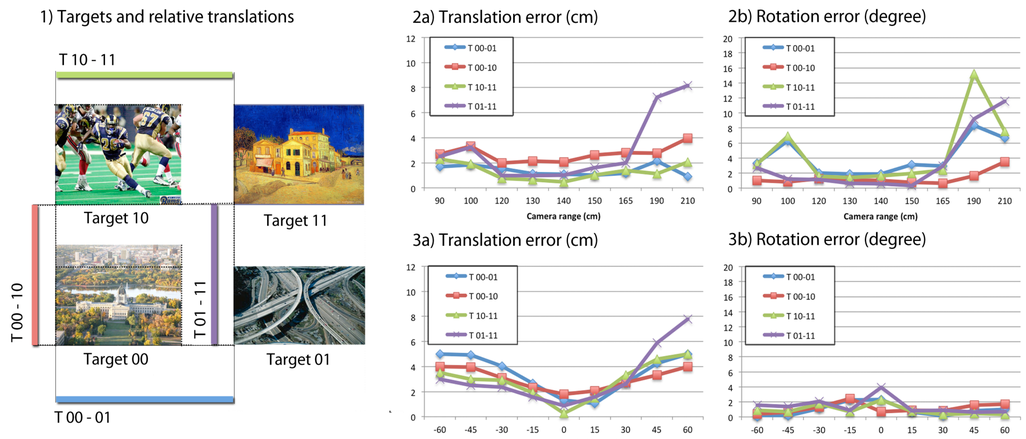
The projection of all matching points must be contained inside the convex hull of the corner points {C1,C2,C3,C4}.

Target Evaluation

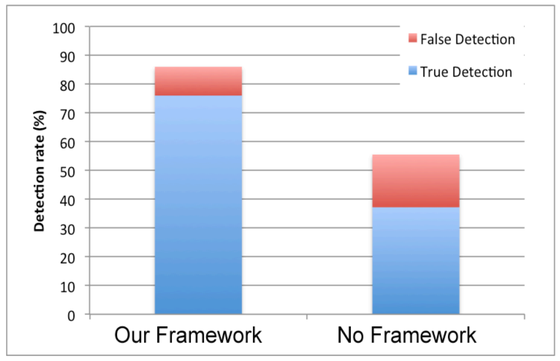


We use the camera information to project the target from different views, adding random noise and blur.

Experimental Results with Real Data



Detection Results



Target detection rates using real data and synthetic experiments.

Acknowledgement

We gratefully acknowledge the financial support from the Natural Sciences and Engineering Research Council of Canada (NSERC) and from Cohort Systems Inc.

Conclusion

1. **We developed a framework for robot localization and target evaluation using natural landmarks independent of the classifier.**
2. **Experimental evaluation using Fern classifier resulted in an average translation and rotation error of 2.7cm and 2.5 degrees in ranges from 1 to 3 meters.**
3. **Stratified sampling and planarity check double the true rate of detection without affecting execution time and reduce false detection rates.**
4. **The use of matching points improved the accuracy of localization up to 50%.**