Towards hierarchical place recognition for long-term autonomy

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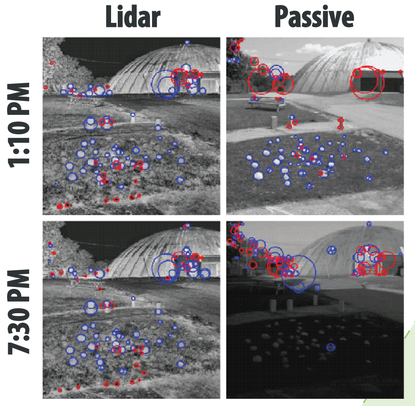
Lidar sensors provide a continuous stream of **lighting-invariant** measurements

Traditional place-recognition algorithms are at least **linear in computational complexity**

Hierarchical place groupings do not depend on an image-based **place discretization**, and are an enabling factor for **logarithmic computational complexity**

Motivation

Lighting invariance is extremely important for place recognition – we are trying to recognize places after significant time has passed. Lidar measurements provide lighting-invariant appearance information, but introduce additional challenges.



Camera images provide a convenient discretization of a 'place'. Lidar measurements are continuous, so a place discretization must be chosen. We propose using a hierarchical discretization, since it covers a wide range of possible discretizations and allows for search speed-ups.

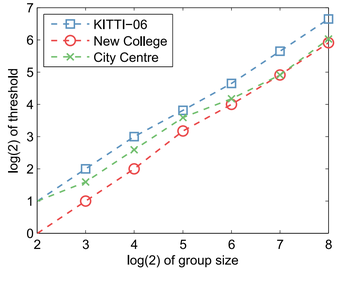
Method

We use the OpenFABMAP implementation [1] based on FABMAP [2]. We describe all of the images within a group with a single Bag-Of-Words descriptor, grouping up to 256 images. The map to the right shows the physical distance covered by group sizes of 128 images.

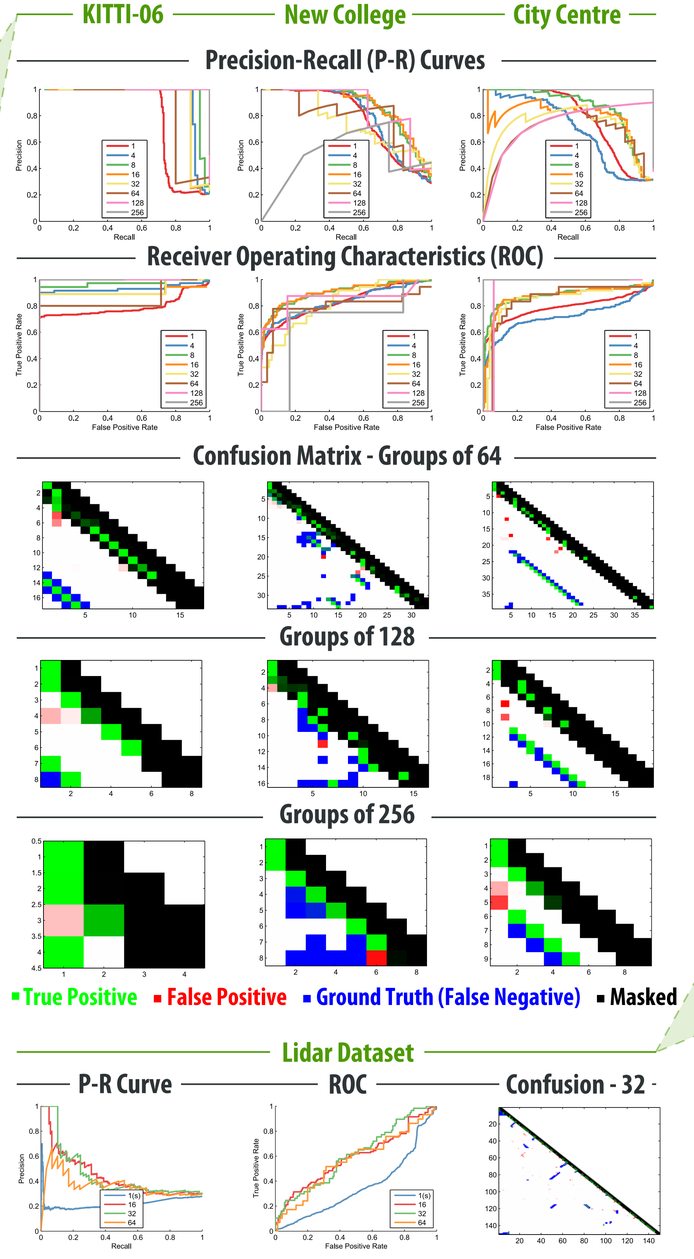
Word counts from groups of images are added and thresholded. To maintain descriptor sparsity, the threshold on word occurence grows with group size (shown to the right).

City Centre - Groups of 128

Word Count Threshold



Results



Conclusions

Comparing places at a group level is not only possible, but improves recall in many cases. Image groups were required for any reasonable performance on the lidar dataset. This allows more seamless integration with continuous sensors such as lidar.

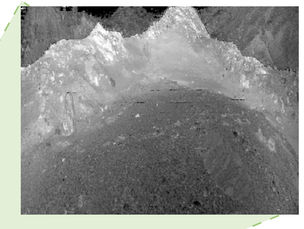
Future Work

We plan to use this place-recognition algorithm with unstructured lidar that does not provide discrete images.

We are pursuing a hierarchical search scheme that will drastically reduce computational complexity.

A deeper place description may also be necessary to maintain descriptiveness at much larger place sizes. The Grizzly platform (below) will be used for data collection in the future.

Lidar Intensity Image



Grizzly Platform

Acknowledgments

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Citations

[1] A. Glover, W. Maddern, M. Warren, S. Reid, M. Milford, and G. Wyeth. OpenFABMAP: An open source toolbox for appearance-based loop closure detection. In *2012 IEEE International Conference on Robotics and Automation*, pages 4730–4735. IEEE, May 2012.

[2] M. Cummins and P. Newman. FAB-MAP: Probabilistic Localization and Mapping in the Space of Appearance. *The International Journal of Robotics Research*, 27(6): 647–665, June 2008.