Worldwide Pose Estimation Using 3D Point Clouds Supplementary Material

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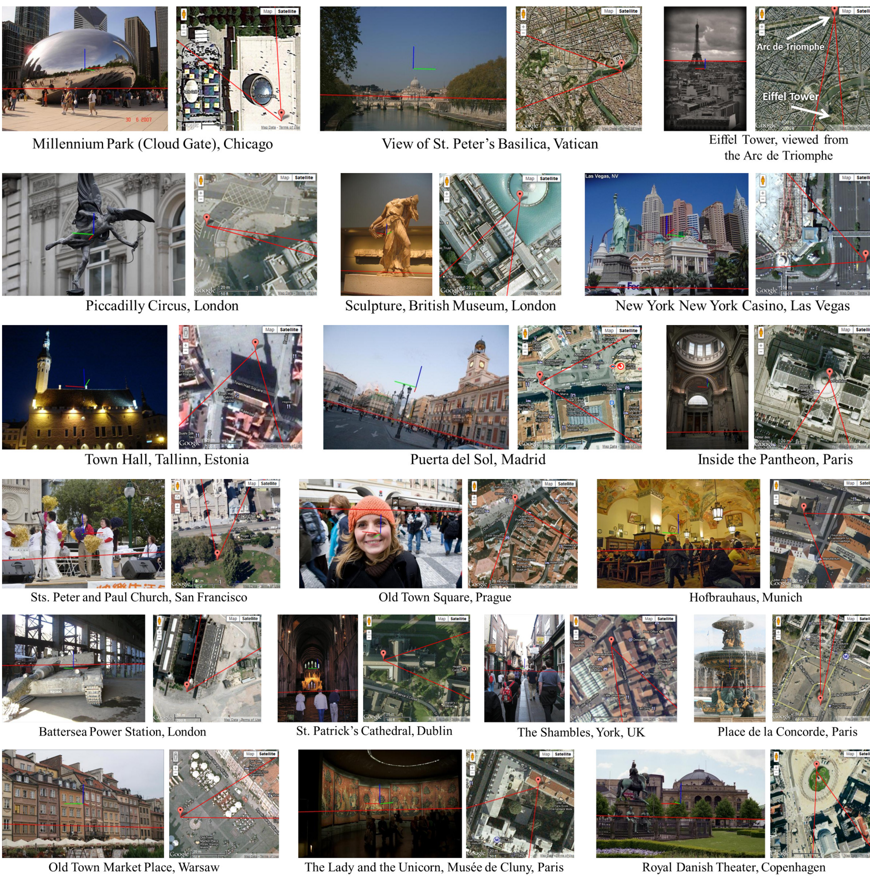


Fig. 1: *Sample estimated poses for the* **Landmarks** *dataset.* This figure shows a few images that were successfully registered, along with their estimate pose overlaid on a map. Each map has been annotated to indicate the estimated position, orientation, and field of view of the photo, and the image itself is drawn with a red line showing the horizon estimated from the pose, as well as axes showing the estimated up (blue), north (green), and east (red) directions. (Best viewed zoomed in.)

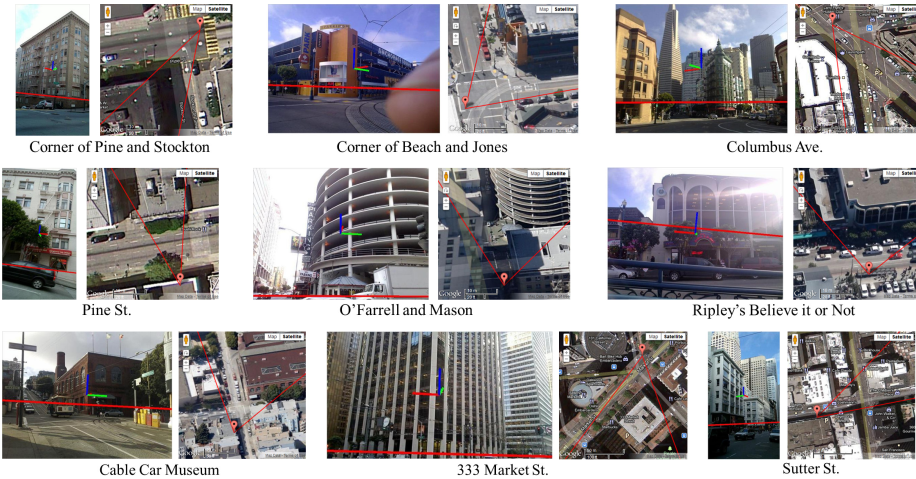


Fig. 2: *Sample estimated poses for the* **San Francisco** *dataset.* This figure shows a few images that were successfully registered, along with their estimate pose overlaid on a map. The annotations have the same meaning as in Figure 1. (Best viewed zoomed in.)

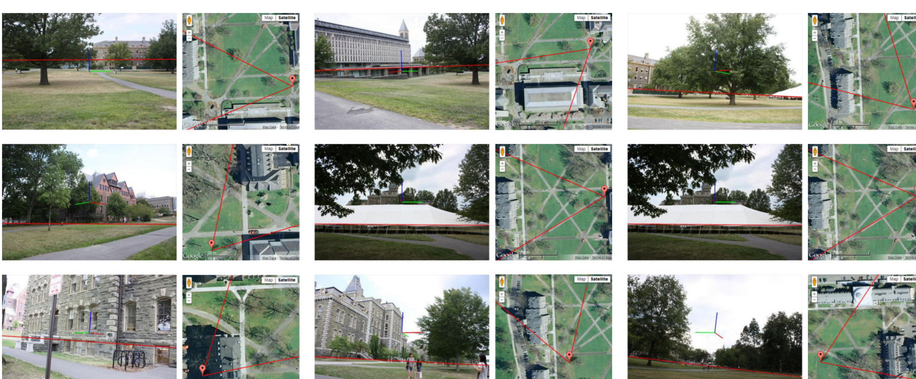


Fig. 3: *Sample estimated poses for the* **Quad** *dataset.* This figure shows a few images that were successfully registered, along with their estimate pose overlaid on a map. The annotations have the same meaning as in Figure 1. (Best viewed zoomed in.)

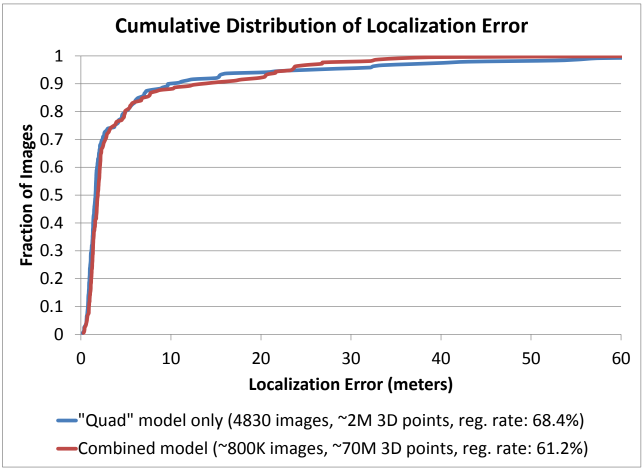


Fig. 4: *Localization accuracy for the registered query images for the* **Quad** *dataset.* This plot shows a cumulative error histogram for estimated locations for query images in the **Quad** dataset (which comes with accurate ground truth from differential GPS). Each plot shows the result for using average point descriptors (the trend when using all descriptors is nearly identical). Two plots are shown, one for an experiment localizing to the Quad dataset alone, and another for the more difficult task of localization to a combined model (i.e., Quad plus Landmarks and SF, which are much larger datasets). The localization errors are very similar between these two experiments (though the recall is lower for the combined experiment, as shown in the legend).

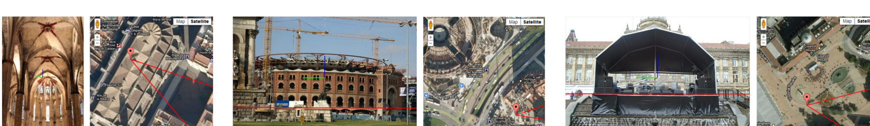
Fig. 5: Two visually overlapping landmarks in Salzburg, Austria. The Hohensalzburg Castle (left image, center) is also visible in the background of the Mirabell Palace (right image, top). These images are from separate landmarks in our dataset, so some true registrations may be misclassified as false.

Fig. 6: Example of a correct registration penalized as incorrect by the ground truth provided for the San Francisco dataset. Left: the query image. Right: the database image most closely matching the query image, as found by counting number of common 3D points after registration. The ground truth for this dataset doesn't always list a comprehensive set of visible building IDs for each image.

Fig. 7: Some examples of **Landmarks** test images that failed to be registered to the 3D model by our algorithm. These are often unusual viewpoints or buildings with few features.

Fig. 8: Some examples of **San Francisco** test images that failed to be registered to the 3D model by our algorithm.

Fig. 9: Some examples of **Quad** test images that failed to be registered to the 3D model by our algorithm.



Santa Maria del Mar, Barcelona   Plaça d'Espanya, Barcelona   Birmingham, Victoria Square

Fig. 10: *Inaccurate orientations for the* **Landmarks** *dataset.*. While the recovered positions of these images are roughly correct, the orientations are inaccurate, due to misregistration of the corresponding database 3D point cloud to the geo-registered coordinate system. This can be alleviated through better methods for geo-registering point clouds, as mentioned in the paper. (Best viewed zoomed in.)