Global Structure-from-Motion by Similarity Averaging

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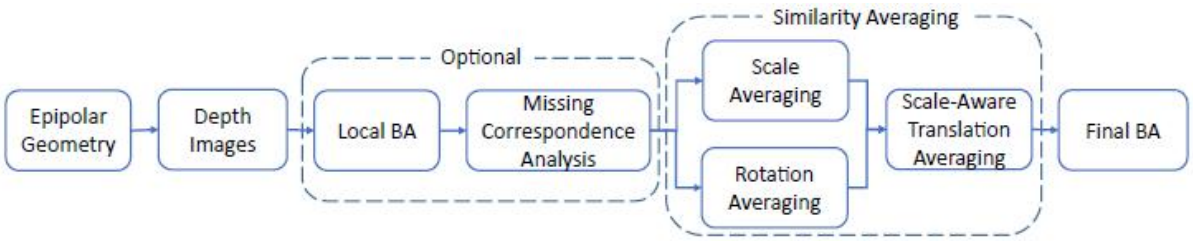
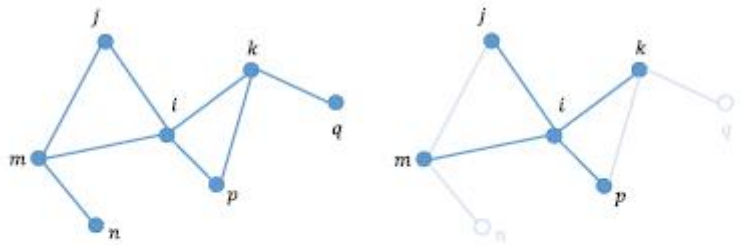
Goal: To solve all camera positions and orientations in a global coordinate system.

Pipeline of the proposed approach



(Figure from the paper)

[Epipolar Geometry] Input is a set of images with known essential matrices. That is inputs are represented by an Epipolar Graph (see the figure (a) below), where each camera is a vertex and the two cameras are connected if the essential matrix between them is known.



(a) (b)

Figure 1. Left: an EG graph where each camera is a vertex and two cameras are connected if the essential matrix between them is known. Right: a stellate graph includes all vertices and edges directly linked to a center vertex i.

[Depth Images] Compute a sparse 'depth image' for each camera from a stellate graph (see the figure (b) above). For a depth image for camera *i*, the stellate graph includes all vertices and edges **directly** linked to *i*. A depth image contains the depth values at sparse features.

* With these depth images, we can transform an essential matrix to a similarity transformation. Because similarity transformation encodes rotation, translation and *scale*, we can determine the **baseline lengths** between the two cameras from these scale ratio.

[Local BA/Optional] is applied to *images in each stellate graph* to improve pairwise relative motion and excludes some poor essential matrices.

[Missing correspondences/Optional] is applied between image pairs to exclude outlier essential matrices due to repetitive scene structures. (The approach is presented in "What can missing correspondences tell us about 3d structure and motion?" CVPR 2008)

[Rotation Averaging] solves all camera orientations simultaneously from input pairwise relative rotations.

[Scale Averaging] solves global scale of each depth image.

[Multiple View Triangulation] computes the scene structure.

[Final BA] optimises the camera parameters and 3D points together.