Learning Deep Probabilistic Estimates of Elements of SO(3)

Introduction Accounting for position and orientation, or pose, is at the heart of computer vision. Many algorithms in image classification and feature tracking, for example, are explicitly concerned with output that is robust to camera orientation. Conversely, algorithms like visual odometry, structure from motion, and SLAM use visual sensors to estimate and track the pose of a camera as it moves through some environment. The algorithms in this latter category form the basis of visual localization pipelines in autonomous vehicles, aid in aerial vehicle navigation and mapping, and are often crucial to augmented reality applications.

Recent work Clark2017, Melekhov2017-dl, Kendall2015-kh has attempted to transfer the success of deep neural networks in many areas of computer vision to the task of camera pose estimation. These approaches, however, can produce arbitrarily poor pose estimates if sensor data differs from what is observed during training (i.e., it is 'out of training distribution') and their monolithic nature makes them difficult to debug. Further, despite much research effort, classical motion estimation algorithms, like stereo visual odometry, still achieve state-of-the-art performance in nominal conditionsBased on the KITTI odometry leaderboard Geiger2013-ky at the time of writing. Nevertheless, the representational power of deep regression algorithms makes them an attractive option to complement classical motion estimation when these latter methods perform poorly (e.g., under diverse lighting conditions or low scene texture). By endowing deep regression models with a useful notion of uncertainty, we can account for out-of-training-distribution errors and fuse these models with classical methods using probabilistic factor graphs. In this work, we choose to focus on rotation regression, since many motion algorithms are sensitive to rotation errors Peretroukhin2018, and good rotation initializations can be critical to robust optimization. Our novel contributions are figure [width=0.48]so3$_l earning/main_f igWeimproveclassicalposeestimationbyfusingitwithdeepprobabilisticmodels.fig : fus$

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