Abstract

In the simultaneous localization and mapping (SLAM) problem, a mobile robot must localize itself in an unknown environment using its sensors and at the same time construct a map of that environment. While SLAM utilizing costly (expensive, heavy and slow) laser range finders as a sensor has been very successful in both indoor and outdoor environments, large-scale SLAM with cost-effective vision-based sensors has yet to be realized. In this research, we evaluate the performance of one possible low-cost vision-based approach to SLAM. We use 3D points reconstructed from computationally lightweight Shi-Tomasi point features in trinocular camera images as the basic landmarks for SLAM. We provide a complete description of our vision-based 3D point sensor model and the method of integrating the sensor model into one of the most promising estimation algorithms: the Rao-Blackwellised particle filter (RBPF).

We empirically demonstrate the feasibility of our vision-based SLAM algorithm, ST-SLAM, in two different testbed environments: a simulated large-scale outdoor environment and a real indoor environment. The simulated outdoor experiment reveals that ST-SLAM algorithm is capable of scaling to large-scale environments with thousands of visual landmarks. The real indoor experiment proves ST-SLAM is robust to practical noise in the real world such as image noise, camera calibration error, and odometry error. Combining the experimental results, we conclude that ST-SLAM is feasible as a lightweight alternative to RBPF methods using sensors based on rich, computationally expensive feature descriptors. Finally, we propose future work required in order to make ST-SLAM a more feasible solution to large-scale outdoor online SLAM problems.