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Acceleration-Based Motion Model for Visual Simultaneous Localization and Mapping

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Abstract : Visual Simultaneous Localization and Mapping (VSLAM) is a technology that obtains information in the environment for self-positioning and mapping. It is widely used in computer vision, robotics and other fields. Many visual SLAM systems, such as OBSLAM3, employ a constant-speed motion model that provides the initial pose of the current frame to improve the speed and accuracy of feature matching. However, in actual situations, the constant velocity motion model is often difficult to be satisfied, which may lead to a large deviation between the obtained initial pose and the real value, and may lead to errors in nonlinear optimization results. Therefore, this paper proposed a motion model based on acceleration, which can be applied on most SLAM systems. In order to better describe the acceleration of the camera pose, we decoupled the pose transformation matrix, and calculated the rotation matrix and the translation vector respectively, where the rotation matrix is represented by rotation vector. We assume that, in a short period of time, the changes of rotating angular velocity and translation vector remain the same. Based on this assumption, the initial pose of the current frame is estimated. In addition, the error of constant velocity model was analyzed theoretically. Finally, we applied our proposed approach to the ORBSLAM3 system and evaluated two sets of sequences on the TUM dataset. The results showed that our proposed method had a more accurate initial pose estimation and the accuracy of ORBSLAM3 system is improved by 6.61% and 6.46% respectively on the two test sequences.

Keywords : error estimation, constant acceleration motion model, pose estimation, visual SLAM
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