JOINT AEROSPACE/RÜZGEM SEMINARS

Integration of Inertial Navigation System with Consecutive Images of a Camera by Relative Position and Attitude Updating

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A new method for improving errors of the Inertial Navigation System (INS) using Unscented Kalman Filter (UKF) by integrating Inertial Measurement Unit (IMU) data with the information provided by the camera is presented. The constraints, in our approach, comprise of Epipolar geometry of two consecutive images with more than 65 percent coverage. Tracking down a known feature in two successive images results in the emergence of Stochastic Epipolar constraint. It emerges in the form of an implicit measurement equation of the Kalman Filter (KF). Correctly matching features of the two images is necessary for reducing the navigation system errors because they act as external information for the INS. A new method has been presented in this study based on covariance analysis of the matched feature rays' intersection points on the ground, which sieves the false matched features. INS navigates the vehicle between the two sequential images. When the camera captures an image, the features of the current and the past images are extracted by SIFT or SURF algorithms. After the sieving stage, feature constraints are used in the UKF measurement equation. Then, the INS and matched feature information is integrated through the UKF filter, and the states of the vehicle (attitude, position, and velocity) are corrected according to the last image. In this presentaion, the relative navigation parameters against the absolute one have been corrected. To avoid increasing dimensions of the covariance matrix, sequential updating procedure is used in the measurement equation. The simulation results show good performance of the introduced algorithm, which can be easily utilized for real flights.

Keywords: Inertial Navigation System, Visual Navigation, Image Processing, Feature Tracking, Epipolar Constraint, Integrated Navigation System