World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:16, No:10, 2022

Image-Based UAV Vertical Distance and Velocity Estimation Algorithm during the Vertical Landing Phase Using Low-Resolution Images

Authors : Seyed-Yaser Nabavi-Chashmi, Davood Asadi, Karim Ahmadi, Eren Demir

Abstract : The landing phase of a UAV is very critical as there are many uncertainties in this phase, which can easily entail a hard landing or even a crash. In this paper, the estimation of relative distance and velocity to the ground, as one of the most important processes during the landing phase, is studied. Using accurate measurement sensors as an alternative approach can be very expensive for sensors like LIDAR, or with a limited operational range, for sensors like ultrasonic sensors. Additionally, absolute positioning systems like GPS or IMU cannot provide distance to the ground independently. The focus of this paper is to determine whether we can measure the relative distance and velocity of UAV and ground in the landing phase using just low-resolution images taken by a monocular camera. The Lucas-Konda feature detection technique is employed to extract the most suitable feature in a series of images taken during the UAV landing. Two different approaches based on Extended Kalman Filters (EKF) have been proposed, and their performance in estimation of the relative distance and velocity are compared. The first approach uses the kinematics of the UAV as the process and the calculated optical flow as the measurement; On the other hand, the second approach uses the feature's projection on the camera plane (pixel position) as the measurement while employing both the kinematics of the UAV and the dynamics of variation of projected point as the process to estimate both relative distance and relative velocity. To verify the results, a sequence of low-quality images taken by a camera that is moving on a specifically developed testbed has been used to compare the performance of the proposed algorithm. The case studies show that the quality of images results in considerable noise, which reduces the performance of the first approach. On the other hand, using the projected feature position is much less sensitive to the noise and estimates the distance and velocity with relatively high accuracy. This approach also can be used to predict the future projected feature position, which can drastically decrease the computational workload, as an important criterion for real-time applications.

Keywords : altitude estimation, drone, image processing, trajectory planning
Conference Title : ICAFD 2022 : International Conference on Aerodynamics and Flight Dynamics
Conference Location : Dubrovnik, Croatia
Conference Dates : October 06-07, 2022