

Integration of Advanced Altimetric Systems for UAV Vertical Navigation During Landing Manoeuvres

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This paper presents the results of a study on Altimetry Systems For Autonomous Landing and Take Off (ASFALTO) that has been performed in the framework of the technology studies for the Italian government research program PRORA-UAV owned by the Italian Aerospace Research Center (CIRA) and the research consortium CoRiSTA. ASFALTO is a joint project on the integration of advanced altimeters onboard Unmanned Aerial Vehicles (UAVs) to be used as vertical navigation sensors for autonomous take off and landing on runways that are not equipped with navigation aids. In order to demonstrate in flight the developed navigation and automatic flight control techniques, CIRA has build a small UAV that is called Flight Small Scale Demonstrator (FSSD). Landing is a very demanding phase in terms of vertical navigation for both manned and unmanned aircrafts. Indeed, the standalone GPS civil service is not capable to guarantee these performances. As a consequence, more accurate altimeters are investigated to be adopted onboard. All these sensors need to meet power and mass requirements for a small UAV. First of all, a laser and a radar altimeter model have been selected to be installed on the aircraft. The main difference between these instruments is that radar footprint dimension is larger than laser one. They have been chosen following requirements for the installation onboard FSSD. Subsequently, well-suited altimetry determination techniques have been investigated and an error budget analysis has been performed to determine the expected accuracy level. This analysis accounted for range, attitude, and mounting errors influence on altitude measurement. Finally, a specific sensor fusion algorithm has been developed in order to obtain the best state estimation taking advantage of measurements from standard navigation sensors such as GPS and inertial sensors. The developed altimetry techniques have been tested in flight. Flight test results are also reported

Nomenclature

c	= speed of light (299792458 m/s)
h_{GPS}	= altitude of the GPS receiver antenna when the aircraft is in the origin of the navigation system
h_{ALT}	= altitude measured by the altimeter
n	= refraction index

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