Instrumentation and Sensor Fusion Implementation for Automated Takeoff and Landing Sequence of a Single-Rotor RC Helicopter

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Abstract: The Autonomous Takeoff and Landing Sequences of an RC Helicopter (ATLaS) aims to develop a control system that can automate the takeoff and landing sequence, as well as maintain a low-altitude hover, of a Radio-controlled (RC) helicopter. These three areas of helicopter flight commonly involve vehicle operation in so-called "Ground-effect" region. The ground-effect region, which occurs up to an altitude of approximately the rotor diameter, is caused by rotor tip vortices being unable to form properly due to interference, and the rotor downwash being interrupted by the ground. This results in extra lift and speed, which, whilst being possibly seen as positive attributes, requires control system parameter retuning. Without such compensation, the increased control sensitivity results in helicopter instability. It is therefore important that sufficiently accurate estimates of vehicle state (primarily: attitude and altitude) be available to the control system.

In this paper a rudimentary fusing of Inertial Measurement Unit (IMU) and ultrasonic ranging for proximity (altitude) measurement is discussed and presented. These sensors are incorporated intoa TREX600-ESC scale RC helicopter (rotor diameter 1.6m). Raw performance of the Ardupilot's (an ATMEGA-based, low-cost autopilot) IMU is characterized, showing significant noise is present in the accelerometer output. The ultrasonic sensors on the other hand are shown to be accurate to within 1cm up to a distance of 2m. Results show that a simple fusion algorithm consisting of correcting the initial accelerometer integral based on measured altitude keeps errors from propagating and within 30cm of actual height at all times. Although not particularly accurate, the approach is merited by very low computation requirements (i.e. versus Kalman fusion), and should be sufficient to determine when the helicopter control system should switch into and out of ground-effect operating parameters.

Key Words: IMU; Proximity Sensor; Sensor Fusion; Unmanned Aerial Vehicle