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Title: Examining the role of IMU health characterization and monitoring in UAS safety

Abstract

Inertial measurement units (IMUs) can be vital for vehicle attitude and position estimation in unmanned aerial vehicles (UAVs). Degradation in these units could result in incorrect position estimates that are utilized in vehicle control, trajectory prediction, and other critical systems; however, the modes and effects of degradation in these IMUs are not well understood. In order to quantify the risk posed by degradation in these sensors, a study was conducted on the types of IMUs prevalent in the commercial market, their known failure modes, and the applicability to health monitoring methods for risk reduction and increased safety in an increasingly autonomous airspace. First, use cases and failure modes of the various types and reliability of commercially available IMUs were reviewed, and knowledge gaps and issues in the field were identified. Noting that inexpensive and lightweight MEMS (Microelectromechanical Systems) IMUs are some of the most commonly used but least reliable sensors in sUAS (small Unmanned Aerial Systems), five inexpensive MEMS IMUs were chosen for a performance evaluation study, selected from the Pixhawk autopilot systems, hobby sUAS, and prior NASA experimental studies. For each of these IMUs, a 10-minute bias test and a 12-hour drift test were performed for the accelerometers in a benchtop setting, using a BeagleBone Black for data collection. Using these results, the sensors' performance is compared to their reported specifications, and the utility of implementing diagnostic methods for MEMS IMUs for research and commercial applications is evaluated. The paper concludes with a planned study for the evaluation of vibration-induced degradation for the selected sensors.