Improving Aviation Safety Using Low-Cost Low-Fidelity Sensors Augmented with Extended Kalman Filters to Develop an Accurate 3D Dynamic Sense-and-Track System

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In recent years, congestion in the global airspace has escalated at an exponential rate, increasing the probability of an air collision. Furthermore, many companies plan to deploy autonomous aerial vehicles (drones) in the near future, which will exacerbate congestion at low altitudes. Currently, transponder based collision avoidance systems are required on commercial aircraft, but not on smaller aircraft due to their prohibitive cost, and can fail when other aerial vehicles do not have compatible systems installed. I developed an on-board low-cost transponder-independent system that enables all aerial vehicles to sense-and-track any flying object to predict and avoid collisions. The innovation in my method lies in replacing expensive high-fidelity sensors with lower quality sensors augmented with complex filters to improve accuracy. My sense-and-track system consists of three components: 1) object localization method (using memory efficient cluster identification algorithms to identify objects), 2) state estimation equations using Euler approximations to initiate tracking, and 3) Extended Kalman Filters for aircraft position and velocity estimation for tracking. My Sense-and-Track method was implemented in two applications: 1) A drone-tracking application was tested using inputs from a series of stereo cameras (for omnidirectional R3 tracking); 2) An aircraft tracking application was tested using a marine radar to track aircraft taking off at Boston Logan airport. The system accurately tracked aircraft in the local airspace demonstrating its feasibility. The proposed system has the potential to be implemented on all aerial vehicles due to its low cost and, hence, significantly improve aviation safety while enabling commercial drone flight.

Awards Won:

Third Award of $1,000

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