RWTH Aachen University
Chair and Institute for Flight System Dynamics

Master Thesis

# Distributed Data Fusion and Control over a Network of Unmanned Aerial Vehicles

presented by

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This thesis was submitted to the Institute of Flight System Dynamics on
April 3, 2024

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# Abstract

The utility of autonomous Unmanned Aerial Vehicle (UAV) swarms in scenarios like post-disaster search and rescue, mapping of inaccessible areas and defence is well known. At the same time the possibility of such swarms operating in GPS-denied environments is also quite high. In the context of the present thesis, a network based measurement model for a swarm of GPS-denied drones is presented. Inter-drone line-of-sight measurements are provided by Ultra-Wide Band (UWB) sensors on each drone, based on which localization of each drone within the swarm formation is done with the help of multi-lateration. The position computed by Multi-lateration is then fed to the Attitude Heading Reference System (AHRS) of each drone, where it is fused with the inertial solution. The maintainance of the swarm configuration over mission time is kept as the primary performance metric. An algebraic formulation of Multi-lateration is first presented, which performs decently for a GPS-disturbed swarm, wherein not all drones in the swarm are GPS-denied, but shows poor performance for a fully GPS-denied swarm. Alternatively, an iterative Multi-lateration scheme is presented, which has a comparitively lower accuracy for four drones but shows better performance than the algebraic Multi-lateration formulation for both GPS-disturbed and GPS-denied swarms. In order to test the multi-lateration formulations in simulation, a full-order simulation model of the integrated system of a single UAV is also developed. The integrated system contains the simulation models for the flight controller, UAV dynamics, accelerometer, gyroscope, magnetometer, GPS, barometer, and the AHRS. The closed loop performance of the integrated system model is also validated for a simple simulation flight.