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Cooperative Navigation of UAVs in GPS-denied area using an extended Kalman filter with colored RSSI measurements

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In this paper, we focus on UAVs (Unmanned Aerial Vehicles) positioning in GPS-denied environments and proposes a navigation mode of "track reckoning + relative ranging + heading constraint". Internal sensors (gyros, accelerometer, barometer, etc.) measure the self-motion to obtain the flight path and attitude, and the external sensors identify and measure the relative ranging to achieve peer-to-peer constraint for UAVs. In order to guide the swarm to the intended destination when GPS is denied, the ground anchor nodes are set to provide relative heading constraints to the UAVs for target and trajectory guidance. We propose a hybrid centralized-distributed scheme including 20 UAVs, as well as its dynamic motion model and measurement model. To improve the ranging accuracy in the actual RSSI measurement, we analyze the influence of antenna pattern inhomogeneity and channel variation, respectively. The former mainly determines an antenna radiation function related to the yaw angle and relative position between the two measuring UAVs. The latter uses overlapping Allan variance to analyze and identify the measurement noises from outfield tests, that is, quantization noise, flicker noise, random walk noise and Gaussian white noise, which to some extent bridges the difference between the theoretical model and the practical measurement of RSSI. In this way, an improved extended Kalman filter is to predict and correct the colored noise by adaptively integrating the current peer-to-peer radio ranging performance and its Allan variance. To prove the effectiveness of this approach, simulation results base on practical noise modeling are demonstrated.