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A Power Management System for Indoor Micro-Drones in GPS-Denied Environments

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Abstract : GPS-Denied drones open the possibility of indoor applications, including dynamic arial surveillance, inspection, safety enforcement, and discovery. Indoor swarming further enhances these applications in accuracy, robustness, operational time, and coverage. For micro-drones, power management becomes a critical issue, given the battery payload restriction. This paper proposes an application enabling battery replacement solution that extends the micro-drone active phase without human intervention. First, a framework to quantify the effectiveness of a power management solution for a drone fleet is proposed. The operation-to-non-operation ratio, ONR, gives one a quantitative benchmark to measure the effectiveness of a power management solution. Second, a survey was carried out to evaluate the ONR performance for the various solutions. Third, through analysis, this paper proposes a solution tailored to the indoor micro-drone, suitable for swarming applications. The proposed automated battery replacement solution, along with a modified micro-drone architecture, was implemented along with the associated micro-drone. Fourth, the system was tested and compared with the various solutions within the industry. Results show that the proposed solution achieves an ONR value of 31, which is a 1-fold improvement of the best alternative option. The cost analysis shows a manufacturing cost of $25, which makes this approach viable for cost-sensitive markets (e.g., consumer). Further challenges remain in the area of drone design for automated battery replacement, landing pad/drone production, high-precision landing control, and ONR improvements.

Keywords : micro-drone, battery swap, battery replacement, battery recharge, landing pad, power management
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