Defense of a Doctoral Dissertation

# Optimization Framework for Drone Operations under Constrained Battery Duration

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## Abstract

Drones, known as unmanned aerial vehicles, receive a tremendous amount of attention from civilian, commercial, and military sectors across the globe as means of monitoring situations in real time and delivering demands. There has been an increasing interest and active research in drones recent years because they are cheaper and easier to operate. However, one of the major obstacles of these drones is that they are operated by batteries, which severely limit on flight duration for drones to be practically useful in many applications. Hence, the primary goal of this dissertation is to develop an optimization framework for operating drones under constrained battery duration.

First, a framework has been developed for routine healthcare service and emergency damage assessment service, in which optimal flight paths of drones and locations of ground control centers are optimized under limited battery duration. Additionally, a two-phase optimization framework has been also developed to reduce the amount of battery consumption that drones spend to reach the damaged area.

Second, a robust optimization framework is proposed to handle the uncertainty in temperature-induced battery capacity reduction. Furthermore, new battery recharging methods are developed to extend the flight duration per charge from the initial launching point. A dynamic wireless battery charging concept is developed to prolong the flight duration of drones for routine monitoring service such as border surveillance. In addition, a hybrid mode consisting of a dynamic wireless battery charging system and a stationary wireless battery charging system is developed to compensate the major drawback of each of the charging systems.

Third, a rerouting process for drones is developed to find an alternative flight path when drones counter an insufficient remaining battery duration to ensure safe recovery. Undesired flight environments such as strong winds can trigger excessive battery consumption of drones. Such an environment can also cause an uncertainty in the flight time between the waypoints. Hence, a chance constrained programming method is developed as an optimization framework to find an optimal alternative flight path under uncertain flight time.