Prognostics Based Decision Making for UAV Operations

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***Abstract*—Within the last decade, progress toward developing a practical electrically-powered transport aircraft has accelerated with improvements in battery technologies and advanced algorithms to control and monitor safety critical processes. In addition, the focus has been placed on developing autonomous vehicles for intra-city short haul flights using vertical takeoff and landing (VTOL) aircraft in effort to facilitate NASAs new Urban Air Mobility (UAM) program. This requires precise knowledge of the current health state of the entire vehicle, and how its current and future state of health impacts its overall performance. The urban air landscape is far less forgiving than the open sky at 30,000ft, and trajectory differences of even a few meters can have devastating consequences. Online prediction and decision making methodologies are critical to the safety of the aircraft, its occupants, and the success of its mission. This approach has been studied over the last 5 years but the majority of the work has only focused on single component prognostics, and simple decisions such as which waypoint to discard. We apply our recent work on system level prognostics with multiple components degrading/failing simultaneously during operation to a more complex decision making process such as payload weighing and route selection. This framework is more applicable to the needs of the public than previous approaches because it directly applies to delivery and transportation, the two most common use cases for VTOL aircraft. By utilizing a prognostics based decision making scheme and given its payload and destination information, the aircraft can determine (1) maximum safe flying distance with the payload, and (2) the optimal and safe route it should fly. In this work we do not focus on recovering from a fault in mid-flight, but rather the vehicles state of health from flight to flight and how the vehicles decisions change over time as its state of health does. The implementation of the methodology is validated using a DJI Mavic Pro quad-copter with simple delivery missions and subject multiple components to degradation over time.**

***Index Terms*—VTOL, quadcopter, prognostics, health management, decision making, autonomy**