Chapter 16
Navigating Complexity: Unraveling the IVHM Requirements Puzzle in Unmanned Aerial Systems Through Innovative IVHM-RD Method

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ABSTRACT

This chapter aims to establish an approach for IVHM requirements elucidation. A meticulous literature study served as the bedrock of this research, offering critical insights into existing methodologies and challenges in IVHM for UAS. Leveraging this knowledge, the study innovatively introduced the IVHM-RD method, a culmination of extensive data analysis. This approach not only grounded the study in established theories but also pushed the boundaries of understanding in IVHM, ushering in transformative possibilities for UAS design. This method consolidates diverse stakeholder demands through extensive data analysis, resulting in a prioritized set of IVHM requirements. The study's innovative approach, bridging the gap between theory and practice, promises transformative implications for UAS design processes.

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INTRODUCTION

In the vast expanse of a rugged mountain range, a fleet of unmanned aerial systems (UAS) embarks on a critical reconnaissance mission. Their objective: to survey inaccessible terrain for potential hazards and gather vital intelligence for disaster response teams. As the UAS navigate through unpredictable weather conditions and harsh environments, they encounter unforeseen technical glitches and mechanical failures. Without immediate intervention, these malfunctions could jeopardize the success of the mission and compromise the safety of personnel on the ground. The UAS market has experienced significant growth due to technological advancements and increasing demand in various fields, including logistics and delivery (Fan et al., 2020). The incorporation of Integrated Vehicle Health Management (IVHM) is becoming increasingly important to ensure the efficiency, safety, and dependability of UAS (Ranasinghe et al., 2022). The global IVHM market is predicted to grow at a CAGR of 7.7% from 2018 to 2023, reflecting the importance of IVHM in UAS, as it represents the growing realization of the advantages of preventive maintenance and real-time health monitoring (Ezhilarasu et al., 2019). The increasing complexity of UAS operations makes the need for advanced health management systems evident. Autonomy and automation describe the degree to which unmanned aerial systems (UAS) can make decisions without human intervention, thanks to complex computer programs (Montazeri et al., 2021). The Department of Defence sets ten levels of autonomy, including remote guidance, real-time health and diagnosis, adapting to flight conditions and failures, re-planning the group's route on the fly, distributed control, group strategic goals, group tactical objectives, and fully autonomous swarms. Regulatory bodies are placing greater emphasis on safety in the UAS sector, such as the Federal Aviation Administration (FAA), which emphasizes the importance of incorporating effective IVHM practices to meet safety standards. This research has the potential to benefit various individuals, groups, and entities involved in the UAS industry and related fields. The research results may help regulatory agencies like the FAA and other aviation authorities understand what works regarding IVHM, improve safety and regulatory compliance by informing the creation of standards and guidelines for the use of IVHM in UAS operations. UAS operators and service providers may apply the prioritised IVHM requirements to maximize the efficiency of their fleets' operations and maintenance, leading to more effective mission execution, less downtime, and better dependability. IVHM technology companies and entrepreneurs may use the study's findings to improve solutions or create new ones that meet the prioritised needs. Innovation in the sector may flourish due to new possibilities for UAS-specific health monitoring systems. This study helps advance the UAS industry and allied disciplines by outlining a systematic and evidence-based method for determining IVHM needs.