Chapter 8
Integrating UAV–IoT Networks for Proactive Wildfire Detection:
Innovations and Future Directions

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ABSTRACT

The most effective solutions brought to all industries, especially for environmental monitoring and disaster management with this integration is the Unmanned Aerial Vehicles (UAVs) combined with Internet of Things (IoT) technologies. The aim of this paper is to investigate the architecture, applications and challenges of UAV-IoT networks that have potential to support real-time data collection capabilities along with communication range. First, we develop a new concept of passive monitoring using UAVs as mobile platforms fitted with advanced sensors to sense data from ground-based IoT devices in various environments efficiently. Through teamwork between researchers, industry professionals and policy makers to address the current challenges of these technologies, they can be leveraged (if successfully applied) for sustainable development with more safety.

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INTRODUCTION

Wildfires have become one of the greatest environmental threats, intensified by our changing climate, continued urbanization and a move away from former land use efforts. Wildfires have increased in frequency and intensity over the last decade, resulting in severe damage to ecosystems as well as human lives and properties. The U.S. continues to experience larger and more damaging wildfires compared with historical averages, as reported by the National Interagency Fire Centre, in just the first half of a recent year alone there were 50 major incidents that have burned tens or hundreds-of-thousand acres (squared kilometres). This is a serious crisis, underscored by the unyielding fact that wildfires have impacted around four million square kilometres of land worldwide Compliance with several regulations to ensure that UAVs comply within the regions they are being operated. The program still has to grapple with the environmental concerns associated with wildlife and concerning issues cast by weather conditions for it to be implemented in a responsible fashion. Realizing UAV-IoT networks to reach its full potential will require investments in research and development, normative actions based on standardization that enable diverse functionalities achieved through interoperable means for broader market uptake as well as adaptive regulatory support which favour innovation with public safety. Sum up, UAV-IoT network is a milestone of monitoring (Kaur & Kumar, 2024).

Some of the major findings highlight that concepts like MQQQ and CoAP also play a crucial role to have detailed communication protocols for potential data transmissions as in IoT applications latency, signal interference can be on higher side. The problem, however, is that the technology also presents technical difficulties such as policing reliable communication links between all devices and complying with physical limitation in energy requirements alongside data security. Wildfires are a multifaceted, intertwined issue with many causative agents. Lightning strikes in arid conditions and human activities including cigarette butts, poor management of campfires or sparks from equipment are to blame for most wildfires (Zhang et al., 2019). This past summer in California, the Zaca Fire is a striking example: it ignited by some sparks from machinery and went on to char over 240 thousand acres5. These incidents show why we need to take wildfire management seriously (Zhao et al., 2020).

These areas are commonly remote and rugged, making them difficult for traditional detection methods. However, because we cannot see or reach them in these locations, and they can burn unnoticed for many days undetected often times too large by the time detected to be controlled. Traditional detection generally depended on human senses or antiquated technologies that may not have been able to react quickly enough to new types of threats (Alzubaidi & Yaqoob, 2021).

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