A Geoinformatics Framework for Spatiotemporal Drone Detection from Citizen-Collected Passive Signals for Airspace Awareness in Small Island States.

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Key words: Low cost technology; Young surveyor; Unmanned Aircraft Systems; Drone Detection; Remote Identification; Radio Frequency Signals; Small Island States

SUMMARY

Unmanned Aircraft Systems (UAS), commonly referred to as ‘drones’ have become ubiquitous in many industries ranging from surveying, live broadcasting, emergency response, infrastructure inspections and offshore monitoring to name a few. However, its seamless and inconspicuous integration into a country’s national airspace means that regardless of the nature of operations being conducted, privacy and security concerns will inevitably arise. The limited ability of civilian drone technology to collect non-voluntary identification and detection data while the aircraft is in flight leaves the operator’s actions unknown and unverified thus compounding these issues. While larger drone markets have introduced regulatory requirements such as the manufacturer’s implementation of Remote Identification (RID), many countries especially Small Island States (SIS) have not yet seen these capabilities activated for them. SIS are unique in that they have smaller market sizes, lower commercial profitability, inconsistent infrastructure and a lack of required expertise which can further delay or deter the implementation of these technologies. As a result, airspaces in SIS often remain vulnerable and under-monitored for drones.

This research, to an extent, addresses the gap in airspace monitoring capabilities and a SIS’s vulnerability to drone usage by proposing a scalable and low-cost national framework for drone detection that does not heavily rely on manufacturer cooperation, proprietary hardware or the activation of RID services. While these existing methods transmit useful identifiable information, they are often ties to infrastructure-intensive surveillance systems, voluntary data broadcasts or imposes additional costs to the operators. These approaches are typically impractical for an SIS due to financial, technical and regulatory constraints. This study develops a geoinformatics-based solution that leverages passive radio frequency (RF) signals captured from everyday devices such as laptops, mobile phones and low-cost antennae to detect drone emissions including Wi-Fi, Bluetooth and telemetry bursts during flight by anyone. The captured signals are timestamped, geotagged and

processed to extract key metadata parameters such as signal strength, channel patterns, and frequency-hopping characteristics which are then visualized on a geospatial dashboard to illustrate spatiotemporal activity patterns. Through the integration of participatory data collection, open-source software and spatial analytics, the framework demonstrates how near real-time airspace awareness can be achieved without retrofitting, specialized infrastructure or direct manufacturer involvement. The result is a practical and adaptable method that empowers SIS to implement data-driven drone governance using widely available technology. It also leaves fills a gap until RID technology becomes available to SIS.