Advancing Airport Security: Leveraging Cameras and AI to Detect Drone Threats

Integrating unmanned aerial vehicles, commonly known as drones, into civilian airspace presents a complex challenge for airport security. Recent incidents, such as drone sightings at Gatwick Airport in 2018, show the importance of countermeasures against unauthorised drone activity. In response, the British Government presented a strategy aimed at deterring, detecting, and disrupting drone misuse, signalling an effort to safeguard public infrastructure.

Reliable counter-drone systems typically fuse multiple types of sensors – from radar and radiofrequency to optical cameras. Fusing data from multiple modalities of sensors typically increases the accuracy and reliability of the system. However, each of these requires reliable data processing methods, that take the raw data from the sensors and process it to understand if a drone exists in the area. In this project, we investigate how the use of cameras coupled with AI trained on synthetic data could be used to improve drone detection capabilities.

A challenge with using AI systems is the scarcity of accurately labelled drone images for training. Here, the project takes a novel approach by exploring synthetic data—3D-rendered drone images—for the training of machine learning models. Synthetic data not only mitigates the challenges of data scarcity but also allows flexibility in simulating diverse scenarios, such as drone-aircraft interactions that may pose challenges in the real world. Synthetic data also allows better accuracy – as it does not rely on human-generated labels, and instead allows for pixel-perfect labelling – important for creating accurate and reliable machine learning models.

However, a key challenge with this approach is sim-to-real – training on synthetic data and testing on real data. Most of the research in this area relies on mixing a small amount of real-world data into the training dataset. Instead, we set out to create models trained on purely synthetic data – something that as far as we know has not been successful in the drone detection space – effectively achieving sim-to-real. Furthermore, we set out to prove that the models that we trained were generalizable by testing on multiple real datasets. We also investigate the control of pan-tilt-zoom cameras using reinforcement learning – effectively creating end-to-end fully autonomous agents, that can surveil an area based on the input image only. This is a step towards fully autonomising the surveillance around airports.

While drone disruptions need to be addressed, the adoption of drone technologies poses many potential benefits – from lowering the costs and improving delivery times of everyday items, to immediate emergency response or drug delivery. PwC reports that the adoption of drones could contribute £45bn to the UK economy[1]. But, for drone use to be accepted by the wider society and regulators, it needs to be proven to be safe. Any associated risks must be addressed by the regulators. One of those risks is the detection and monitoring of drone traffic – something that could potentially be achieved using the technologies described for airport security. Hence, improvements in drone detection and tracking capabilities may lead to drone corridors by enhancing the capabilities of UTM systems.

[1] https://www.pwc.co.uk/issues/technology/drones/the-impact-of-drones-on-the-uk-economy.html

We have published papers on drone classification[2], and drone tracking[3]. These publications represent the culmination of research and collaboration with our partners, including Dr Stephen Harman (previously CTO of Aveillant – a holographic radar company – now Thales) and Alan Holt from the Department for Transport. Their expertise and contributions have been key in advancing our understanding of drone detection technology and its potential applications in airport security.

We hope that this research will on one hand advance the technology of airport security – but on the other, drive the development of UTM infrastructure – enabling the widespread use of drones, from delivery to healthcare applications, presenting huge potential benefits to our society. Because these developments are still at a low TRL level, further research is required to bring these technologies to more practical applications. We hope that stakeholders across academia, industry, and government, bring this research towards more practical applications by furthering investment into this area.

[2] https://www.mdpi.com/2313-433X/8/8/218

[3] https://arc.aiaa.org/doi/abs/10.2514/6.2023-0194