

# #26 - Air-Guard: A Bio-Inspired Morphing UAV

Over the years, recreational drones have made large advances in terms of technology and the proliferation of these recreational drones means that they are now more accessible than ever. The increase in drone use and the inability to effectively counter drones that enter restricted/private airspace have resulted in large financial losses for airports, breaches in privacy and in some cases have facilitated the transport of drugs. A notable incident that caused the delays of close to 1,000 flights affecting approximately 140,000 passengers took place in 2018 at London Gatwick airport where 2 drones caused the shut down of the airport for over 24 hours. Additionally, it has been reported by Dubai international airport that the estimated costs of halting airport operations due to drones result in losses close to \$100,000 per minute of downtime.

## Mission Objective

The Air-Guard system provides a counter-drone system with an autonomous, agile, reliable, affordable and sustainable aerial vehicle in order to efficiently protect sensitive airspace against the threat of unlicensed drones. The Air-Guard system aims to be implemented at Schiphol airport monitoring an area of  $28 \text{ km}^2$  with the main design focus of the system for this project being the drone. Current anti-drone methods on the market include drone guns, quad-copter net catching systems and radio jamming systems, however, these methods involve human interaction, have high operational costs, lack robustness and most importantly they lack the agility to chase and counter fast-moving drones leaving a large gap in the market for an efficient anti-drone system.

## System Design

The Air-Guard drone is a fixed-wing drone capable of autonomous visual tracking and catching of unlicensed drones via a shooting net mechanism integrated with a parachute. Compared to multi-rotor drones, the Air-Guard drone concept has a longer range, higher efficiency and is more agile. This is a result of the inspiration for the drone design being derived from bird morphology. Birds are able to actively morph their wing and tail surfaces to actively alter their aspect ratio, wing loading and stability to achieve the most efficient flight configuration over a wide variety of flight profiles. Similarly, the Air-Guard drone morphs its wing and tail such that the drone can be stable in loiter and transition into performing multiple high g maneuvers seconds apart. This allows the drone to more closely follow unlicensed drones in restricted areas and immobilize these drones in a matter of a couple of minutes completely autonomously. The morphing concept of the drone uses multiple actuators and carefully tuned elastic tendons in combination with specially designed artificial feathers to emulate bird morphology, the design also includes previously neglected areas

of bird wing anatomy to incorporate multiple bio-inspired aerodynamic surfaces to delay stall and increase the maneuverability of the drone. The increased performance and abilities of the drone are completely powered by dual electric motors with 75% of the structural mass of the entire drone coming from sustainable circular materials. The drone works in tandem with the ground station where communications and housekeeping data are routed and maintenance/charging of the drone is carried out. To summarise, with Air-Guard we aim to fill the gap in the market with an ingenious, high-performance, bio-inspired design to neutralize the threat of unlicensed drones.

