Wildlife Strike Prevention in the Context of Innovative Air Mobility

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Innovative Air Mobility (IAM) Operations are envisioned to perform their flights at low altitudes and as such in areas which are most abundant with wildlife [1]. Given the performance and structural characteristics of electric Vertical Takeoff and Landing (eVTOL) aircraft, high numbers of damaging collisions with animals are expected [2], [3]. To prevent such wildlife strikes, a system for collision avoidance between eVTOL and birds/bats was developed. The set-up of envelopes around the aircraft, where entering of opponents initiate different responses, was inspired by the concept of the Airborne Collision Avoidance System [4] used in conventional fixed-wing aviation and the "Well Clear" concept for Unmanned Aerial Vehicles (UAV) [5] (Figure 1). By addressing collisions between eVTOLs and animals, the focus of novel concepts for collision avoidance with non-collaborative airspace users [6] was extended to consider non-anthropogenic intruders.

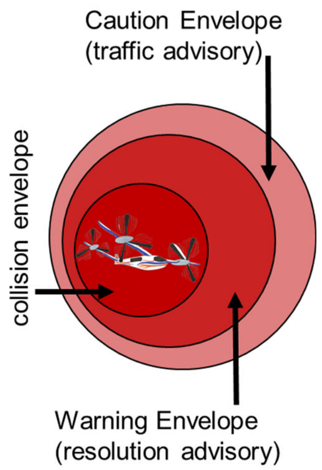

Figure 1: Envelopes around the eVTOL. Source: [7], used with permission

Using real-time information about wildlife movement, for example obtained by avian radar, a three-phase decision-tree to avoid collisions with animals was developed [7] (Figure 2). In the first, i.e. the strategic phase, the abundance of critical wildlife is evaluated and, if required, departure is rescheduled. During the flight, wildlife approaches towards the eVTOL trigger avoidance maneuvers. Depending on the intruded envelope, an automated tactical or manual emergency avoidance (sometimes referred to as "safety-net" or "collision avoidance") maneuver is executed.

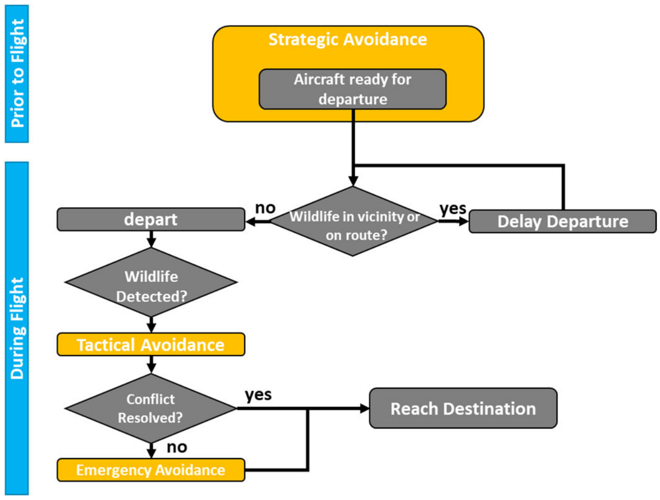

Figure 2: Phases of Collision Avoidance. Adapted from [7], with permission

Initial evaluations were performed with simulations for a sample route between the airport and the main railway station of Munich, Germany, for 13 variants of wildlife occurring prior or during the flight [8]. It was found that the proposed maneuvers could be successfully executed by the four representative eVTOL configurations considered (Multicopter, Lift to Cruise, Tilt Rotor and Vectored Thrust). On average, the Closest Point of Approach (CPA) with intruding wildlife was increased by 72%. The average airborne delay, when maneuvers were initiated, amounted to 107 seconds, corresponding to 15% of the assumed regular flight time of 692 seconds, which is considered reasonable to avoid potentially damaging strikes. Delays imposed in the strategic phase were higher, due to a conservative threshold of five minutes before re-evaluating departure.

In a second study [9], the simulation model of the system was enhanced to be applicable independent of location. It was validated for an airtaxi trajectory with continuous eVTOL traffic and real wildlife movements from all seasons of one calendar year collected at the location of Leeuwaarden airbase, the Netherlands. To reduce departure delays, a strategic envelope around the initial flight segment as well as a strategic avoidance parameter were introduced. The in-flight maneuvers and the geometric dimensions of the envelopes were optimized for performance and further reduction of delays. Finally, the manual emergency avoidance, which was performed by a human operator in the initial study, was modelled by assuming a successful conflict resolution to facilitate the execution of large-scale fast-time simulations. eVTOL traffic was simulated alongside 84 days of wildlife movements for the same four eVTOL configurations used for the initial study. The resulting 336 combinations were simulated twice, once with unimpeded air traffic and once with the UAM-CAS system activated. The simulations revealed that the UAM-CAS reduced the number of collisions per

10,000 flights by 62%. The average CPA was increased by 20%. With the incursions into the warning envelope being reduced by 61%, the need for human intervention to resolve conflict was substantially reduced. The adjustment of the strategic phase resulted in a substantial reduction in ground delays, with an average remaining delay of 14.4 seconds. In-flight delays amounted to 1.25 seconds on average. The total average delay corresponds to approximately 7.5% of the overall flight time. A small number of flights experienced delays of above 100 seconds. These consistently took place during peak wildlife activity during dawn and dusk.

Summarizing the findings of the two studies, it can be concluded that the implementation of a UAM-CAS system can substantially contribute to reducing wildlife strikes for eVTOL aircraft at the cost of reasonable delays. During peak activities, where delays are higher, a rescheduling of flights to avoid energy-intense avoidance maneuvers during the flight, is recommended. Since these periods are coupled to dawn and dusk, they are predictable and relatively short, which facilitates a timely rescheduling.
The wildlife strikes still experienced with an active UAM-CAS are most likely caused by missing reaction of the simulated animal targets, as already found in [10]. It is proposed that future studies implement wildlife behavior to evaluate the consequences on wildlife strike occurrences.

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Biography

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Dr. Isabel C. Metz received her M.Sc. degree in Mobility and Transportation (cum laude) from the University of Technology in Braunschweig, Germany and her PhD degree from Delft University of Technology in the Netherlands. In her current position at the German Aerospace Center's Institute of Flight Guidance, she heads the institute's tower simulation facilities and investigates options to involve air traffic controllers and pilots in the process of operational wildlife strike prevention.