Group 16 - The Ionic Drone

In recent years, the aviation industry has witnessed a growing interest in the utilisation of plasma actuation for active flow control. This surge in attention has resulted in significant advancements in understanding the potential of plasma actuation methods and the opportunities they offer. By using plasma actuators instead of moving control surfaces, a wide range of benefits can be attained, including enhanced operational efficiency, reduced noise emissions, and improved maintenance procedures, while simultaneously maintaining overall performance standards. As a result, there is an increasing focus on exploring potential applications that capitalise on the advantages provided by plasma actuators. A new market was created for the product to fit in. Silent noise monitoring and wildlife surveillance was identified as suitable field for showcasing these advantages. For simplicity, it has been decided that the drone shall be in the open category of EASA to neglect all the certification requirements. This results in some restrictions which must be kept in mind during the design process. The mission profile entails a climbing flight to a height of 120m, followed by a thrust idle silent (under 30dB) glide for 1km while descending to a height of 55m. Subsequently, another climbing turning flight is performed to return to a height of 120m.

System Design

The selected design features a battery-powered fixed-wing drone with a catapult launch system and parachute landing mechanism. It incorporates a single-engine pusher with 12-inch folding propellers that reduce drag during gliding. The wing is divided into two sections: the lifting region and the plasma region. 3.6 billion possible planform configurations were iterated to design the wing. The lifting region spans 2.8m and is optimized for lift, with 10cm extensions on each side for the plasma actuators. Circular trailing edges on these extensions facilitate control over roll by modifying the Kutta condition using plasma actuators. Similar control surfaces are employed on the horizontal and vertical tails for yaw and pitch control. It must also be noted that the drone is more than 80% recyclable, directly contributing to TU Delft's goal of a sustainable future.

Plasma Design

The plasma actuator is strategically positioned at the trailing edge of the extensions, where the airfoil features a smoothly curved trailing edge. This design enables the plasma to effectively disrupt the airflow in that region, influencing the Kutta condition downstream of the wing. By doing this, circulation over the airfoil is increased. As a result, a change in Cl is induced, offering precise control over the aircraft. The sleek design was refined through detailed analysis performed using various software such as XFLR 5, Ansys Fluent and Open VSP. Plasma flow is simulated on Ansys Fluent using moving wall boundary conditions for further detailed CFD simulations. This design is further validated using wind tunnel testing in the Wind Tunnel by Group 16. This concept is also supported by multiple research papers.