28 - GoAERO: Emergency Response Flyer

Natural disasters profoundly impact millions of lives around the globe each year, causing serious damage to both people and infrastructure. Ground response, especially in developing countries with insufficient public framework, has restricted accessibility for all first responders. Natural disasters can obstruct ground infrastructure, further decreasing the feasibility of this approach. Aerial response, led by rescue helicopters, presents a solution but comes with financial constraints for large-scale use, dependence on trained personnel, and limited maneuverability in confined areas. To overcome these limitations and tackle the challenge of rapid emergency response, this DSE project presents an autonomous, low-cost, agile, electric Vertical Take-off and Landing (VTOL) vehicle able to carry a single passenger.

Mission Objective

The objective of this project is to develop a sustainable VTOL flyer that can autonomously rescue a single passenger. It features advanced maneuverability with on-the-fly path planning for a range of 30 kilometers, at an altitude of 400 meters, targeting a unit cost below €120,000. The design complies with US and EU street legal transport regulations, allowing deployment on the nearest accessible road to the incident location. Ensuring safety is a paramount goal in the design process, with a specific focus on integrating redundancy principles.

System Design

Through evaluation of the vehicle's functions during its missions, design options concerning the VTOL capability are established. After conducting an extensive trade-off analysis, the multicopter solution distinguishes itself with impressive maneuverability, the lowest unit cost, and rapid response time, all while satisfying the safety requirements.

The final design incorporates six motors mounted on top of the fuselage using boom extensions. The motors drive the ducted rotors, each equipped with two custom-designed rotor blades. A Li-ion battery supplies the energy to the motors, designed with modular architecture to guarantee battery redundancy and safety-critical design. To ensure controllability in the event of one-engine failure, the rotors are mounted at an angle optimized using the Attainable Moment Set concept, introducing over-actuation and ensuring safe landing. The multicopter is controlled using a cascaded control loop for attitude, and a PID controller for position and velocity. The onboard sensors and flight computers are selected to enable autonomous mission completion and ensure continuous communication with both the ground station and air traffic control. The payload is accommodated in a laying-down orientation for passenger safety, with an extending bed that moves out from the front door of the fuselage nose cone.

With a cruise speed of 162 kilometers per hour, 94.5-kilogram payload capacity, fully electric power-train, high maneuverability characteristics, and estimated unit cost below €120,000 marks a significant advancement in aerial rescue capabilities. This design of the vehicle promises its customer a 33-minute mission time for the 30 km range mission including 10 minutes reserved for loiter.

It can also successfully rescue up to 12 passengers within a 2.4-kilometer radius of the moving ground station. Additionally, it is capable of landing on sand, in up to 0.5 meters of water, and on inclined surfaces, making it well-suited for the international GoAERO competition.

In the last weeks of the design process, the team concentrates on finalizing the proposed concept and analyzing its performance.