10 - FLOWS

Rising temperatures around the world have been observed to dramatically affect the global water cycle, increasing both the likelihood and severity of extreme flooding. When compared to the two previous decades, the rate of occurrence of flood-related extreme weather events has increased by more than 130% since the year 2000. To adapt to these often catastrophic events, humanity has developed complex flood monitoring and forecasting systems, relying on fixed stream stage sensors to obtain data about water levels. Although they reliably provide real-time information, these systems require significant investments in the manufacturing and mounting of a large number of sensors, and only cover fixed geographical areas.

Mission Objective

The objective of the FLOWS system is to provide a versatile, cost-effective airborne platform for the monitoring of water levels, riverbed topography, and waterborne debris during flood events. This data can then be used by flood modelers to improve predictive models, but also by decision-makers to initiate warning and response procedures in an informed manner. A further objective for the system is to directly intervene, supporting first responders in their efforts by delivering humanitarian aid to civilians in need. To fulfill these objectives, the system should demonstrate at least ten hours of endurance, as well as resistance to inclement weather conditions, while the ground segment should allow for remote operations around the world.

System Design

The system is divided into an airborne segment, represented by a hybrid fixed wing-VTOL unmanned aerial vehicle (UAV), and a ground segment design based on a standard 12-meter sea container.

To guarantee the real-world feasibility of the design, it was decided to rely on commercial off-the-shelf components for as many capabilities as possible, minimizing development effort and costs. Propulsion, power management, and communications among others are fulfilled by industry-supported hardware. This design methodology has allowed the team to increase the level of design and focus on integration.

The UAV features one horizontal pusher propeller and four VTOL propellers in a quadcopter configuration, positioned on two longitudinal booms that also support the tandem tail. With a wingspan of 9.8 meters, the UAV can take off and land vertically, but also perform a glide landing in case of propulsion system failure.

Four 16kW internal combustion engines provide power to the propulsion system, as well as to the payload and avionics. Equipped with two high-performance multispectral cameras and a bathymetric LiDAR, the system can monitor water levels and riverbed topography day and night. Also available is an open payload bay, from which humanitarian aid supplies can be deployed to support first responders.

The ground station allows for bidirectional communication with the airborne segment, guaranteed through both direct link and satellite, with an effective operational range of over 200 kilometers. After operations conclude, the UAV can be disassembled and stored in the ground station for transport.

Several simulation models were developed to analyze aerodynamic, structural, and stability properties of the airborne segment. In the following two weeks, the design team will focus on the verification and validation of these models, together with evaluating sustainability metrics, producing cost estimates, and studying the market for the system.