# 12 - Wildfire Drone Swarm

With the global climate changing at an alarming rate, the threat of wildfires is increasing significantly. Currently, wildfires burn approximately 3.85% of the global land area each year.[1] These fires emit roughly 2 billion megatonnes of $CO_2$ to the atmosphere annually,[2], twice as much as the emissions produced by global aviation. Furthermore, projections for wildfire-prone regions such as California indicate that by the end of the century, wildfire emissions could increase by a median of 56%.[3] Beyond environmental damage, wildfires also pose a significant threat to human health and infrastructure. In the United States alone, an estimated 50 million houses are located in areas particularly vulnerable to wildfire damage.[4] Effective wildfire management is thus crucial in mitigating these risks and protecting both our environment and communities.

## Mission Objective

The project objective is to conceptualise a detailed design for a drone swarm that monitors forests in risk areas, with minimal workload for the firefighters. This can aid in wildfire management by assessing forest conditions and detecting fires faster. Moreover, the drone swarm will monitor ongoing fires and function as a communication relay for on-site firefighters. Designed for autonomous operation, the UAVs will generate their own flight sectors and trajectories. The system is intended to integrate seamlessly with existing wildfire management protocols.

## System Design

To implement the system across the world and cover even the most remote areas, the swarm was designed to operate without relying on pre-existing runways. Instead, the UAV units will take off from a launch rail and will be recovered with a hook and wire system. This rail and recovery system, together with the rest of the ground components of the swarm, will be transportable in standard shipping containers, allowing for the rapid deployment to the region of interest. Once in operation, each drone swarm will ensure that 25 units are airborne at all times, covering a total forested area of 1000 $km^2$. To overcome the low-visibility, smoke conditions surrounding wildfires, the swarm will include some relay units, which will establish clear telecommunication lines between the monitoring UAVs and the ground station.
Regarding the drone architecture, the UAV units adopt an inverted U-boom concept with a lithium-ion powered puller propeller, which allows for a flight endurance of up to six hours per sortie. The lightweight aluminium structure provides a safe shell for the extensive sensor package housed within the fuselage. This includes high-end infrared and visual cameras among the many key sensors, which ensure an accurate monitoring of the forest conditions at all times, and a near-immediate detection of any expanding wildfires.

With its advanced monitoring capabilities and autonomous operations, this drone swarm system can be rapidly and easily integrated into any fire department around the world and represents a pivotal innovation in the fight against severe wildfires and climate change.

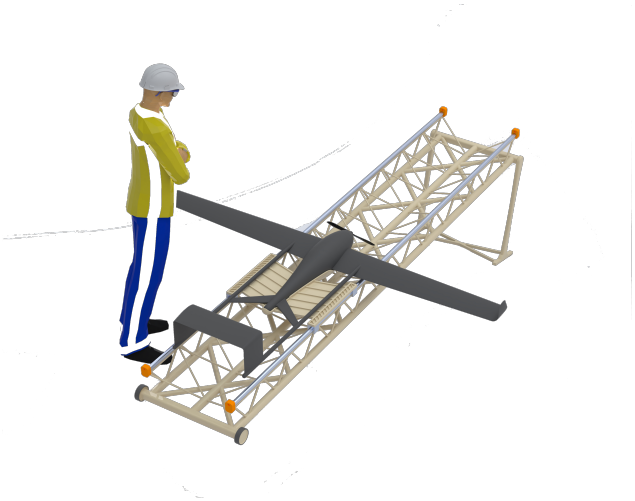

Figure 1: 3D Render of one of the UAV units and the launcher system

[1] Power, M. J., et al. (2013). Global Fire Emissions Database.
[2] CAMS (2023). Copernicus Atmosphere Monitoring Service.
[3] Hurteau, M. D., et al. (2014). Projected effects of climate and development on California wildfire emissions.
[4] Burke, M., et al. (2021). Changing landscapes in the wildland-urban interface.