

29 - Unmanned fire-fighting multi vehicle

Nowadays high-rise buildings have become indispensable in Dutch cities. Due to the current housing shortage, the number of high-rise buildings will only continue to grow. Recently, the Dutch fire brigade has voiced concerns over their fire safety as the height of these buildings poses a problem, risking the lives of many residents. Extinguishing fires from the outside is only possible up to 30 meters, meaning that high-rise fires can only be attacked from the inside. Whilst ascending to the top floors, firefighters face significant challenges, not only due to the heavy equipment they carry but also the dangerous situations they must deal with due to smoke and extreme temperatures. To support firefighters in combating fires in high-rise buildings, an Unmanned Aerial Vehicle (UAV) has been designed, which will provide extinguishing capabilities for top-level floors.

Mission Objective

Time is crucial in reducing the effects of fire in a high-rise building. The UAV is therefore designed for rapid deployment and after arriving at the scene, it is ready for take-off in 480 seconds. Due to high controllability and manoeuvrability, the drone pilot can target fires without difficulty. Due to pressure and heat, windows in burning buildings often burst, enabling oxygen to fuel the fire. The UAV will be able to swiftly reach these windows and will spray water inside to extinguish the fire. In addition, the UAV can cool intact windows with water to prevent them from bursting. With an operational time of roughly 25 minutes at maximum payload, the UAV is able to provide continuous support for a significant amount of time. After each run, the payload can be easily refilled and new batteries can be placed in the UAV.

System Design

To extinguish the fire, the UAV will be equipped with a water tank with a pressure pump, which is able to spray water over a range of more than 10 meters. On each trip, the UAV will carry a substantial payload of 20 kg. Through carefully selected electrical components, the UAV will be able to accurately target the fire, manoeuvre around the building, and provide the firefighters with awareness on the status of the fire. Whenever necessary, the electrical components will be protected by thermal insulation against the heat. During the design phase, a limitation was put on the size of the drone to ensure it is easily transportable and can fit inside a fire brigade van. The most optimal configuration was found to be a three-layered hexagon, resulting in a UAV with a minimum width of 1.4 meters. The UAV will be powered by two lithium polymer batteries and features six 32-inch propellers. With a thrust-to-weight ratio of 2, the UAV boasts great hovering capabilities. The control and stability of the UAV are analysed and a control system is chosen. During the design of the

UAV, sustainability played an important role. The UAV makes use of a non-toxic, biodegradable extinguishing agent and a clean energy source. Additionally, part of the components and materials used can be recycled, reducing its carbon footprint. Above all, there will be a significant improvement in the safety of the firefighters and residents of high-rise buildings, through accurate detection of dangerous areas and active suppression of fire.

