Group 19 - DroneCrane

June 8th, 2022

Moving payloads up high has been the key to human development through the ages, as building taller and reaching the inaccessible have been dreams of ours since the earliest times. To drive the quest for better technologies in our race against the current limits, the DroneCrane project entered the scene. It was conceived to introduce drone technologies as an affordable and flexible competitor in the payload-moving market, targeting a payload capacity of 500 kg and a vertical range of 200 m. The project aims at developing a swarm of cooperating drones that costs less than €100 000. DroneCrane's stance on the market is boosted by rapid set-up times and the fact that at least 80% of the system's weight will be recyclable or reusable.

The design began with a concept brainstorm after a thorough requirements identification process. DroneCrane's subsystems were assessed individually in a trade-off procedure that passed a robust sensitivity analysis. The development of the winner concept for each of the subsystems was pursued; to maximise the efficiency, reliability, and controllability of each drone, a 3D octocopter configuration was chosen for them, as shown in Figure 1. This layout allows for larger propellers, which increases the propulsive efficiency and thus reduces the amount of Li-ion batteries needed to be carried on the octocopter. Lower power requirements contribute to a system with an increased affordability, operability, and sustainability. The swarm is connected to the payload through a fibre-reinforced structure, the Lateral Force Relief System (LFRS), that allows the drone to carry mostly vertical loads, minimising the power losses that DroneCrane would have to suffer if all drones were connected directly to a payload. The LFRS has been designed so that its mass represents a lower additional load on the swarm than the one which would have derived from a one-point swarm-payload connection. DroneCrane is given a control system that works as follows: an operator on the ground will request the swarm to move in the air and the decentralised swarm algorithm will command the drones to adjust their attitude and thrust accordingly, with each drone being responsible for its own stability control.

DroneCrane has been designed to high reliability standards: the battery packs and power distribution boards are designed to be intrinsically redundant; the octocopter configuration allows to be controllable even in case any two rotors stop working, while the system will complete all missions even in case one of its drones is lost. Before the end of the design process, the number of the drones in the swarm will be fixed, as it stands now between 15 and 20, and the material properties will be defined, together with a manufacturing plan that can account for the requirements imposed on the recyclability and reusability of DroneCrane.

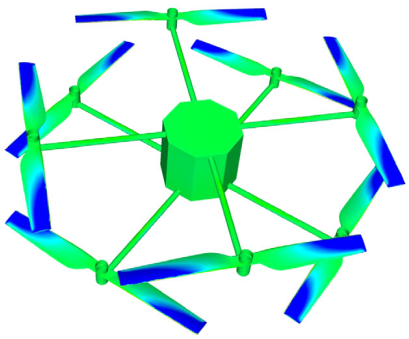

Figure 1: 3D octocopter configuration used[1]

[1] H. Zhu et al., Design and Assessment of Octocopter Drones with Improved Aerodynamic Efficiency and Performance (2020), https://doi.org/10.1016/j.ast.2020.106206.