Master 2 internship: Study of the limits of a centralized control of a fleet of UAVs

Fleets of unmanned aerial vehicles (UAVs) are of great interest for industrial applications such as site surveillance, leisure activities and military applications. Indeed, UAVs operating in fleets offer many advantages over a single drone (wider coverage, autonomy, heterogeneous sensors, robustness).

To orchestrate the movements of the fleet, a drone control algorithm is required. This algorithm is used to determine, for each drone, which direction to take and at what speed. There are several ways of thinking about this control: either in a centralized way, where an omniscient entity makes decisions, or in a decentralized way, where each entity (drone) makes decisions based solely on its local environment. Decentralized management is the most widespread because it's easier to implement, but more and more interest is being shown in centralized management through the development of architectures using Software Defined Networking (SDN). In particular, this centralization is intended to optimize decision-making, thanks to the controller's overview.

However, controlling a fleet of drones in a centralized manner brings with it a whole set of problems. There are different strategies for placing the controller: either it's a fixed station on the ground (which benefits from high computing power but a limited communication range), or the controller is a UAV that navigates (in which case it can adjust its range thanks to its mobility, but it will have lower computing power). The choice of a centralized or decentralized approach is also motivated by the different applications (forest surveillance or radio transmission, for example) possible for the fleet, since each case brings different constraints.

The aim of this internship is to identify when a centralized approach is more interesting than a decentralized one. The aim is to determine which parameters influence the performance of a centralized control, and then to evaluate the influence of these parameters on the "quality" of the control. These parameters could be, for example, the frequency with which the information required for control is sent, the distance between the drones and between the drones and the controller, or the packet loss rate. This quality is yet to be defined, and could correspond to the quality of service.

Firstly, the study will focus on a leader-follower control algorithm with one leader and two followers seeking to keep each other in formation. The study will involve a single controller that will be tested in different communication environments, allowing us to see the influence of parameters. A decentralized approach will also be studied under different communication environments. The ns-3 simulator will be used for this study.

Place of the internship: LIP, ENS de Lyon

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Skills required: network skills (TCP/IP stack, network performance). Wi-Fi and ns-3 skills are a plus. Fluency in English.

Starting date: between the beginning of February and the end of March 2024