Thesis subject:

Reactive navigation of a fleet of drones in interaction

PhD Advisor:

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Context of the thesis :

The thesis is part of the project activities of the Laboratory of Excellence (LABEX) at the Université de Technologie de Compiègne (UTC) in France on the Control of Technological Systems of Systems (MS2T) (www.utc.fr/labexms2t).

The thesis is part of the project activities of the Laboratory of Excellence (LABEX) at the University of Technology of Compiègne in France on the Control of Technological Systems of-Systems (MS2T). It is also integrated into the Project of Excellence Equipment ROBOTEX in Heudiasyc laboratory in the "mobile robotics" theme and in particular within the works to be carried on the flight of a fleet of drones. The thesis project will be financed by the ANR program MS2T LABEX.

PhD thesis description:

Autonomous aerial vehicles or drones are mainly used or dedicated to surveillance missions and collection of information. Their area of employment is changing, particularly in the civilian domain. Possible applications such as traffic monitoring, surveillance of rail lines or high voltage, vehicle tracking to improve safety, inspection of buildings are made to grow, especially in urban and / or semi-urban environments. Since the surveillance zones are numerous, it can be interesting to deploy multiple UAVs which can communicate with each other, exploring and monitoring a large area to increase the range of inspection and also the safety of the area being monitored. In this context, the vehicles must be able to communicate with each other, be able to not collide with each other, that is to say to keep a minimum safe distance from their peers or other obstacles. Moreover, if the communication between vehicles would cease by default, it is important to ensure that each UAV is able to prevent other peers or other obstacles (mobile or stationary), especially during flights in urban areas. Here, we are interested in drones like miniature multi-rotors helicopters flying over small areas, in urban areas, where obstacles can be numerous and in the proximity of multiple drones. This will provide navigation assistance for the drones do not come into collision, even if communication is lost between them. The aim is to allow multiple UAVs to navigate (and stabilize) jointly ensuring mutual avoidance and collision with other moving obstacles. In particular, we wish to start with the case of three drones, which by avoiding obstacles could keep a sufficient distance so as not to collide. The detection can be done by reactive vision (optical flow, detection of moving obstacles), but also by fusion with information from other sensors such as ultrasonic or infrared sensors, inertial sensors. Reactive avoidance approaches such as techniques based on the visual potential fields will be studied for the case of drones flying in 3D. The proposed methods should be suitable for embedded computing capacity. The project is therefore to propose sensor-based control strategies and plannification to bring the UAV in desired flight configurations while ensuring non-mutual collision. We can also explore bio-inspired approaches, related to the behavior of birds and insects where their exteroceptive sensors allow them to fly together without coming into collision. The thesis project is to design, integrate and validate experimentally developments allowing the collision and formation flight (quadrotors). It will explore rapid and appropriate methods for implementation on board aerial vehicles. Constraints of computing time and real time are important and are taken into account for this type of application. The thesis also includes an experimental aspect of integrating the techniques developed on existing experimental platforms (helicopters with four rotors) equipped with core capacities and within the French Project of Excellence Equipement Robotex.