UAV Multilevel Swarms for Situation Management

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Abstract

The development and usage of Unmanned Aerial Vehicles (UAVs) quickly increased in the last decades, mainly for military purposes. Now, this type of technology is also used in non-military contexts: mainly for civil and environment protection: search & rescue teams, fire fighters, police officers, environmental scientific studies, etc. Although the technology for operating a single UAV is now mature, additional efforts are still necessary for using UAVs in fleets (or swarms). Therefore the ASIMUT project (Aid to Situation Management based on Multimodal, Multivel and Multimission acquisition Techniques) is needed to address several key challenges in the context of swarms, including networking, communication, monitoring and positioning aspects. This motivates the development of novel multilevel cooperation algorithms which have not been widely explored, especially when autonomy is an additional challenge. Techniques to optimize communications for multilevel swarms are also required. Finally, distributed and localized mobility management algorithms that cope with conflicting objectives such as connectivity maintenance and geographical area coverage must be provided.

1 ASIMUT Project

The main goal of the ASIMUT project is to address scenarios where a mission is to be achieved based on data fusion coming from different sensors in a number of UAVs that constitute a swarm.

2 Swarm decisional autonomy and mobility management

- Swarm decisional autonomy: The CARUS project [1] went a step further than the state-of-the-art on autonomous swarms of UAVs. The authors achieved a theoretical and experimental study of a swarm of UAVs with autonomous decision, which purpose was to monitor and solve issues on specified interest points.

- Mobility management: Some promising approaches are inspired by nature, and more precisely by ant colonies. Ant Colony Optimization (ACO) is a set of probabilistic techniques for solving computational problems, which can be reduced to finding good paths through graphs. Initially proposed by Marco Dorigo in 1992 in his PhD thesis [2], ACO has found applications in many domains. The main idea is that ants use the environment to exchange information via pheromone deposit which concentration influences their behavior. This process is called stigmergy. UAVs deposit repulsive pheromones in visited geographical areas so as to prevent other UAVs from revisiting the same places too early [3].

Additional objectives are considered such as network connectivity as recently proposed by Schleicher et al. for surveillance scenarios [4].

References


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The ASIMUT project requires:
- Intra-level and inter-level cooperation the latter being without doubt an area that has not been widely explored, especially when autonomy is also a challenge
- Management and the optimization of the interactions between the swarms that participate in the mission and how their local decisions and work impact the behavior of the other swarms
- Development of distributed and online mobility management algorithms. The latter deal with potentially conflicting objectives such as coverage, connectivity preservation and bandwidth efficiency

These innovations will be combined as a global framework for the ASIMUT project and evaluated via state-of-the-art simulations; a preliminary step before its real-world deployment.

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