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► **To cite this version:**

Ema Falomir, Serge Chaumette, Gilles Guerrini. Mobility Strategies for Swarms of Unmanned Aerial Vehicles using Artificial Potential Fields and Global Path Planning . Séminaire des doctorants, Société Informatique de France, Jun 2018, Paris, France. hal-01828732

HAL Id: hal-01828732

<https://hal.science/hal-01828732>

Submitted on 3 Jul 2018

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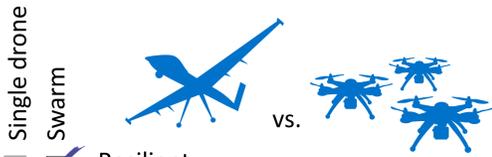
Mobility Strategies for Swarms of Unmanned Aerial Vehicles using Artificial Potential Fields and Global Path Planning

Ema Falomir, Serge Chaumette, Gilles Guerrini

Context

Mission: detect suspicious events and Suspicious Behaviour Detection

- Without human intervention
- In unknown areas
- Quickly



- Resilient
- Considered as a unique entity
- Quick intervention
- Precision due to low altitude

Objectives

Whole project

Allow autonomous Unmanned Aerial Vehicles (UAVs) to quickly perform collaborative tasks, such as wide area surveillance. The UAVs communicate between each other and have similar characteristics: they make a swarm. They are considered as a unique entity as seen by an operator permitting to decrease workload of the operator.

PhD goal

Develop & validate a distributed mobility model for a swarm of autonomous UAVs which takes into account the embedded sensors capacities to allow the realization of a mission.

Related Work

Some uses of swarms of UAVs

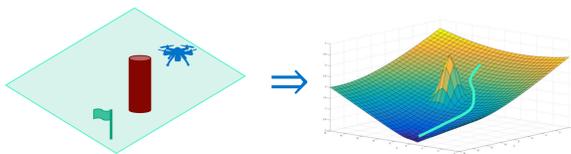
- Firemen Assistance
- Pesticides Spraying
- Park Cleaning
- Area Surveillance
- Search And Rescue

Some path planning methods

- **Artificial Potential Fields**
- Virtual Forces
- Genetic Algorithms
- Chaotic Processes
- Particle Swarm Optimization

Principle of Artificial Potential Fields (APF) from the perspective of each UAV

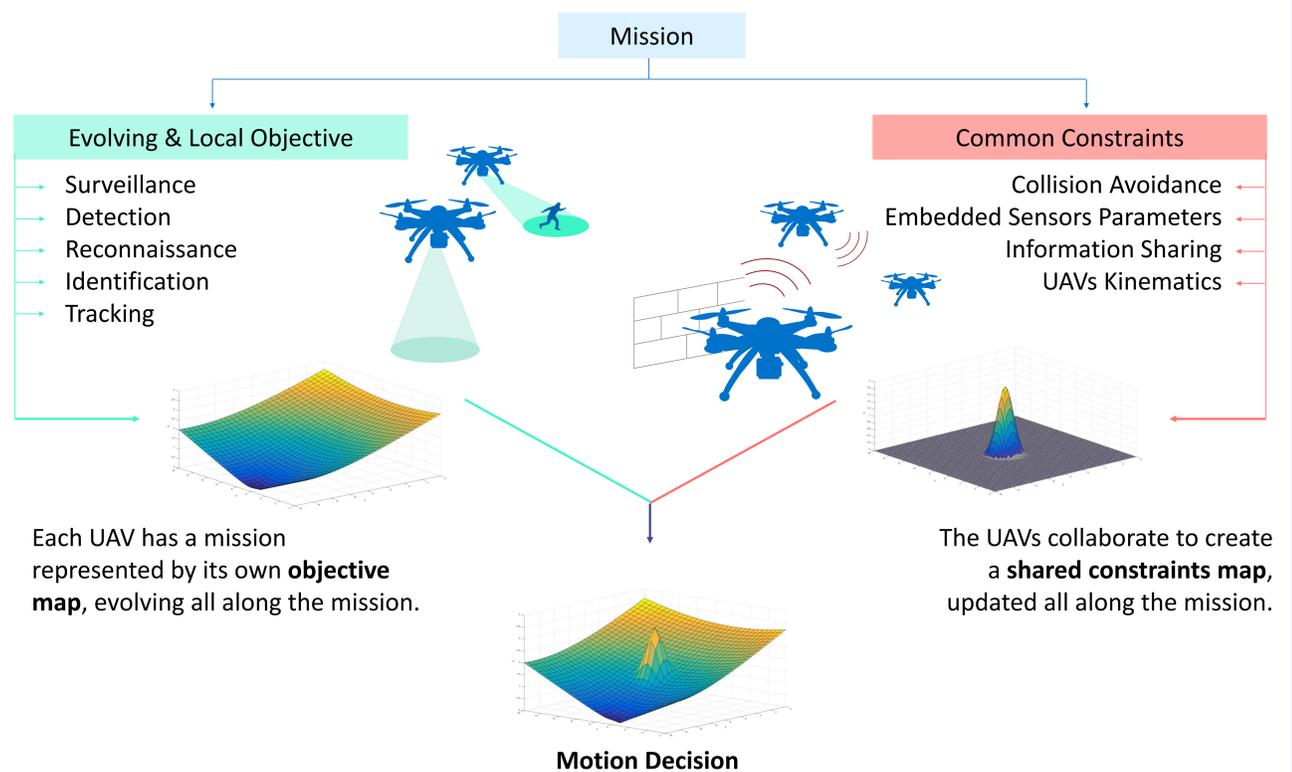
- The UAV moves within an APF and goes towards the lowest potential.
- The APF is a combination of an **attraction** towards a target and a **repulsion** from obstacles.



A UAV has to reach a target while avoiding the obstacle.

Calculation of the APF related to the target and to the obstacle. Deduction of the path.

Principle of Our Mobility Strategy



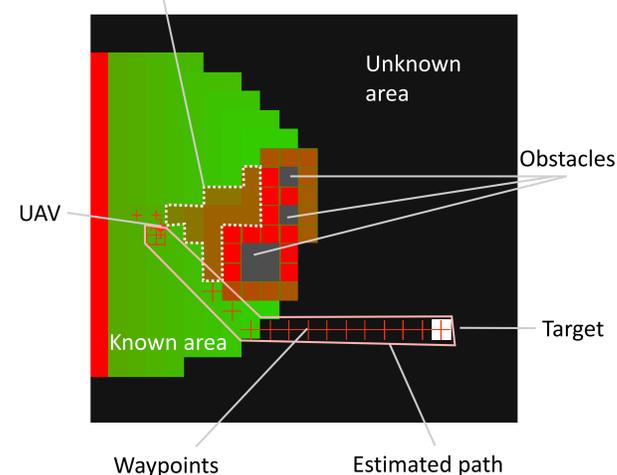
Each UAV has a mission represented by its own **objective map**, evolving all along the mission.

The UAVs collaborate to create a **shared constraints map**, updated all along the mission.

Our Approach

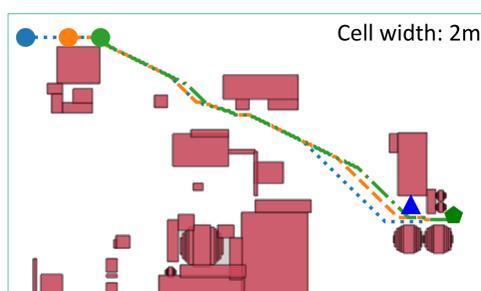
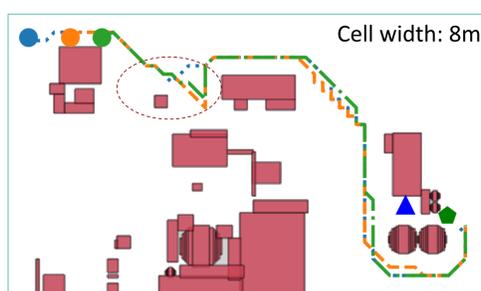
- The environment is discretized into square cells.
- The UAVs trajectories depend on the cells width.
- Addition of a potential field for the obstacle avoidance anticipation to the repulsive field around the obstacles (see figure below).
- Calculation of a global path for several iterations.
- Speed proportional to distance of next waypoint.

Avoidance anticipation area



Artificial potential field resulting from our proposal, showing an anticipation of collision avoidance.

Some Illustrative Results



Trajectories of 3 UAVs composing a swarm in an unknown environment.

Publication & Patent

E. Falomir, S. Chaumette and G. Guerrini. Mobility Strategies based on Virtual Forces for Swarms of Autonomous UAVs in Constrained Environments. 14th International Conference on Informatics in Control, Automation and Robotics, July 2017.

E. Falomir, G. Guerrini, P. Garrec, Essaim constitué d'une pluralité de drones volants légers.

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