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Mobility Strategies based on Artificial Potential Fields for Swarms of Unmanned Aerial Vehicles

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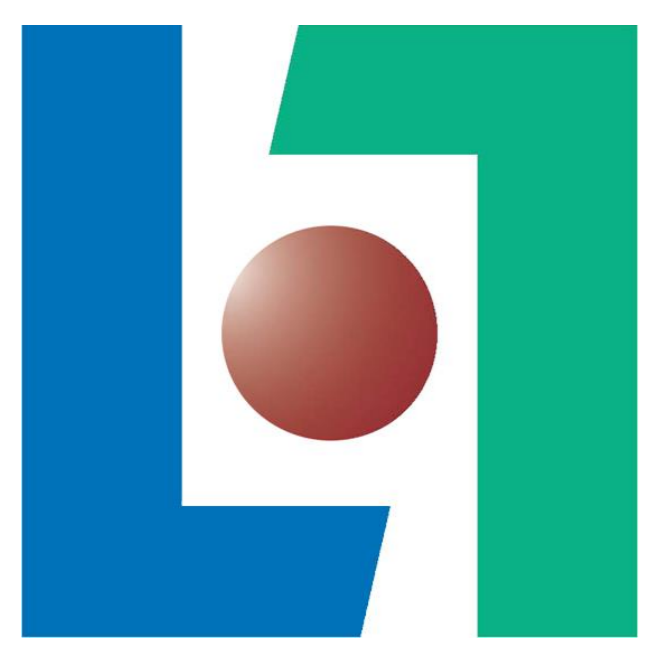
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Mobility Strategies based on Artificial Potential Fields for Swarms of Unmanned Aerial Vehicles

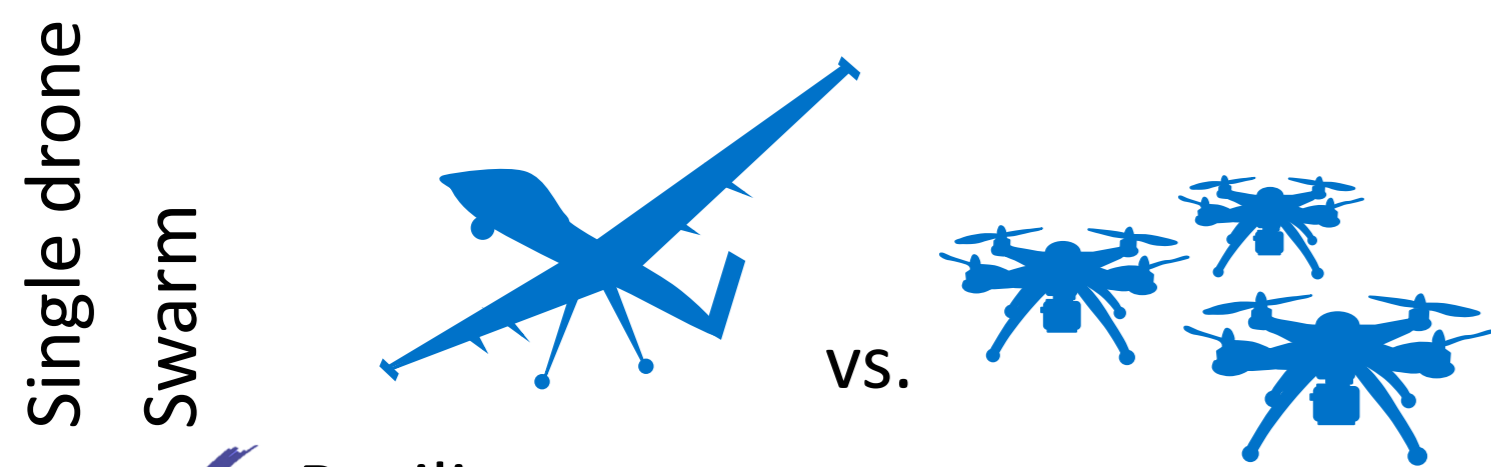
Ema Falomir

PROGRESS Team (PROGrammation, RÉSeaux et Systèmes)

Context

Mission: detect suspicious events

- Without human intervention
- In unknown areas
- Quickly



- | | | |
|--------------|-------------------------------------|-------------------------------|
| Single drone | <input type="checkbox"/> | Resilient |
| Swarm | <input checked="" type="checkbox"/> | Resilient |
| | <input checked="" type="checkbox"/> | Considered as a unique entity |
| | <input checked="" type="checkbox"/> | Quick intervention |
| | <input checked="" type="checkbox"/> | 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 them and have similar characteristics: they form a swarm. They are considered as a unique entity as seen by an operator.

PhD

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

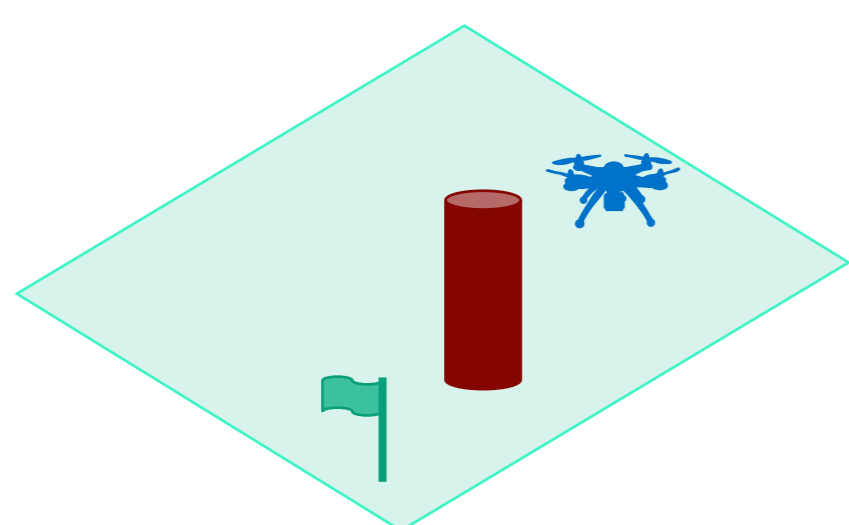
- **Artificial Potential Fields**
- Virtual Forces
- Genetic Algorithms
- Chaotic Processes
- Particle Swarm Optimization

Artificial Potential Fields (APF)

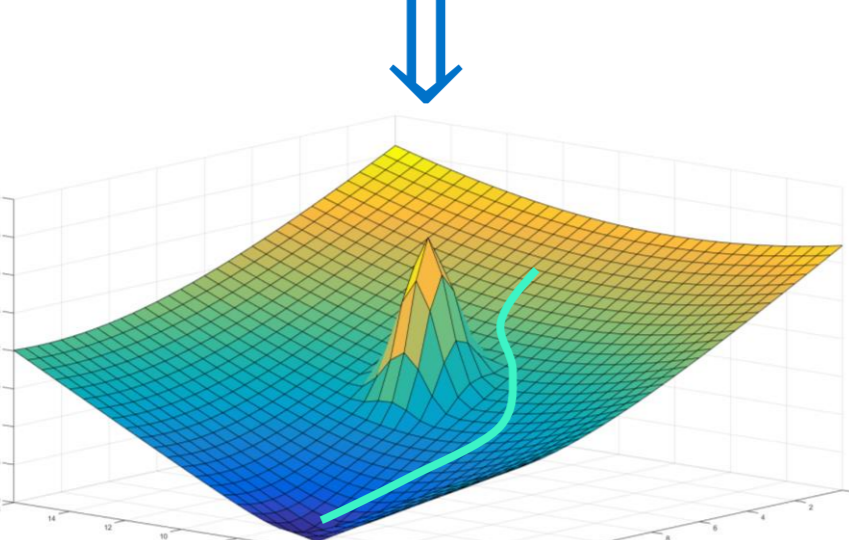
Principle

- 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.

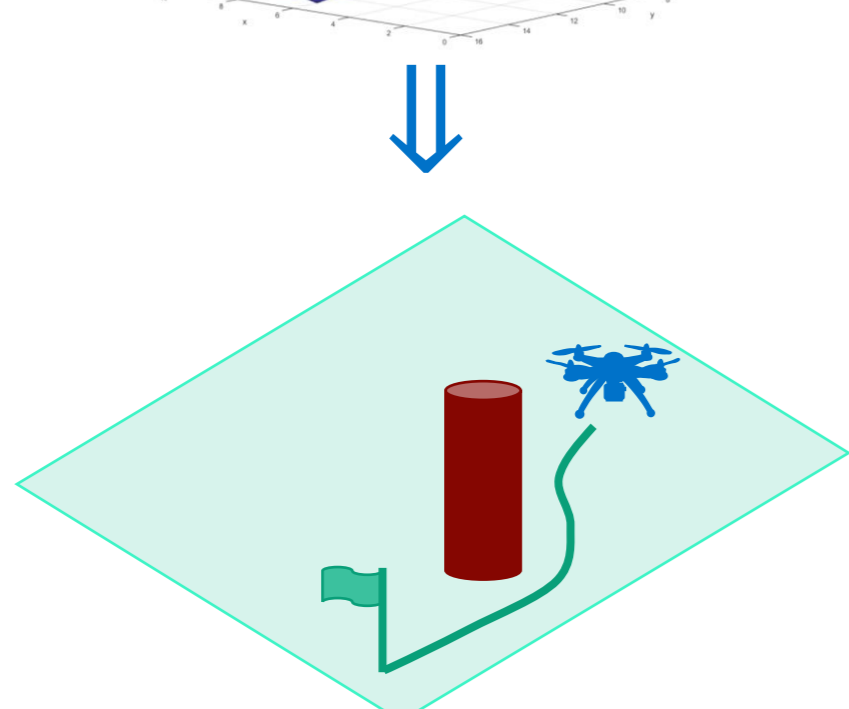
A UAV has to reach a target while avoiding the obstacle.



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

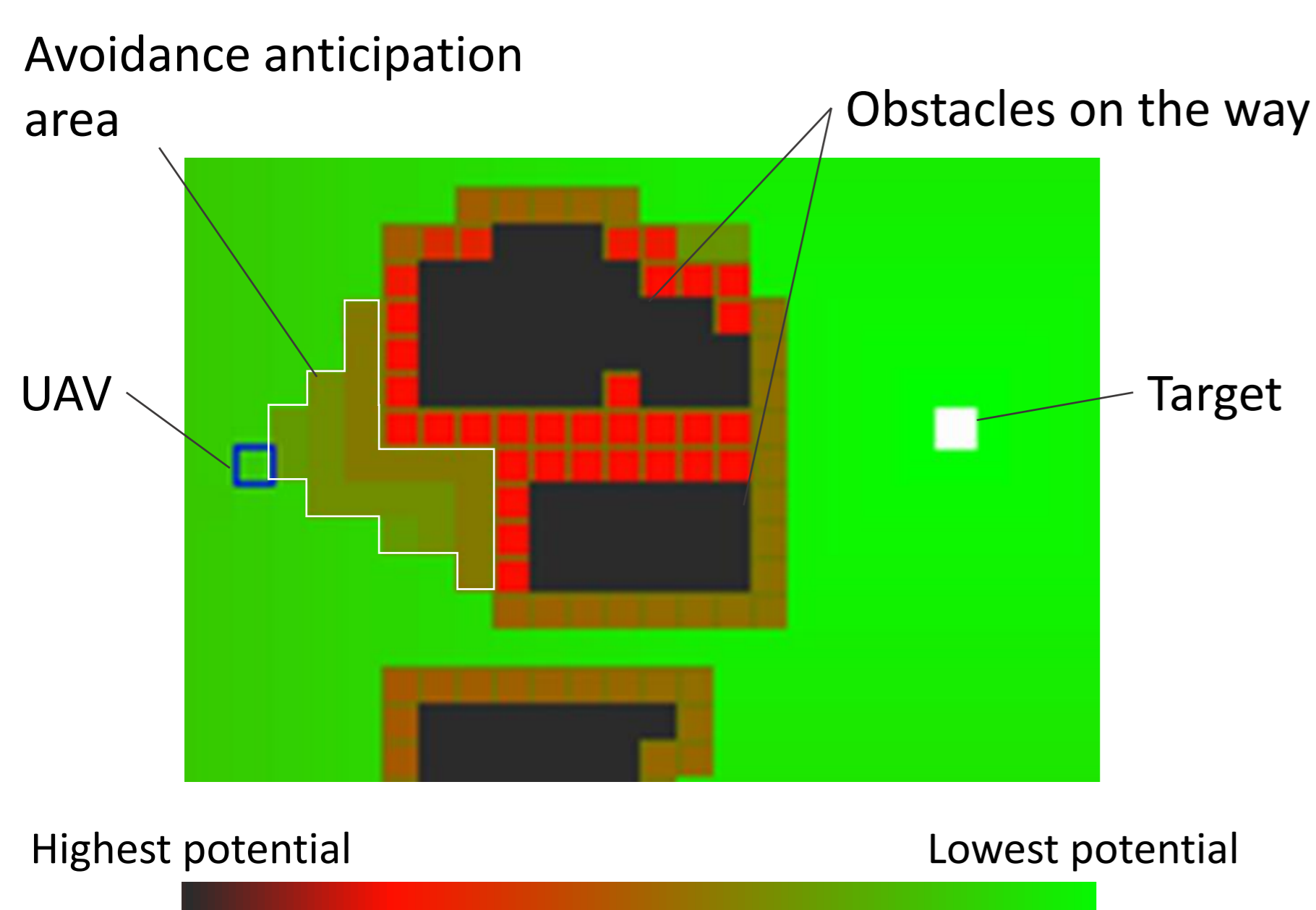


The drone follows the resulting path in the APF.



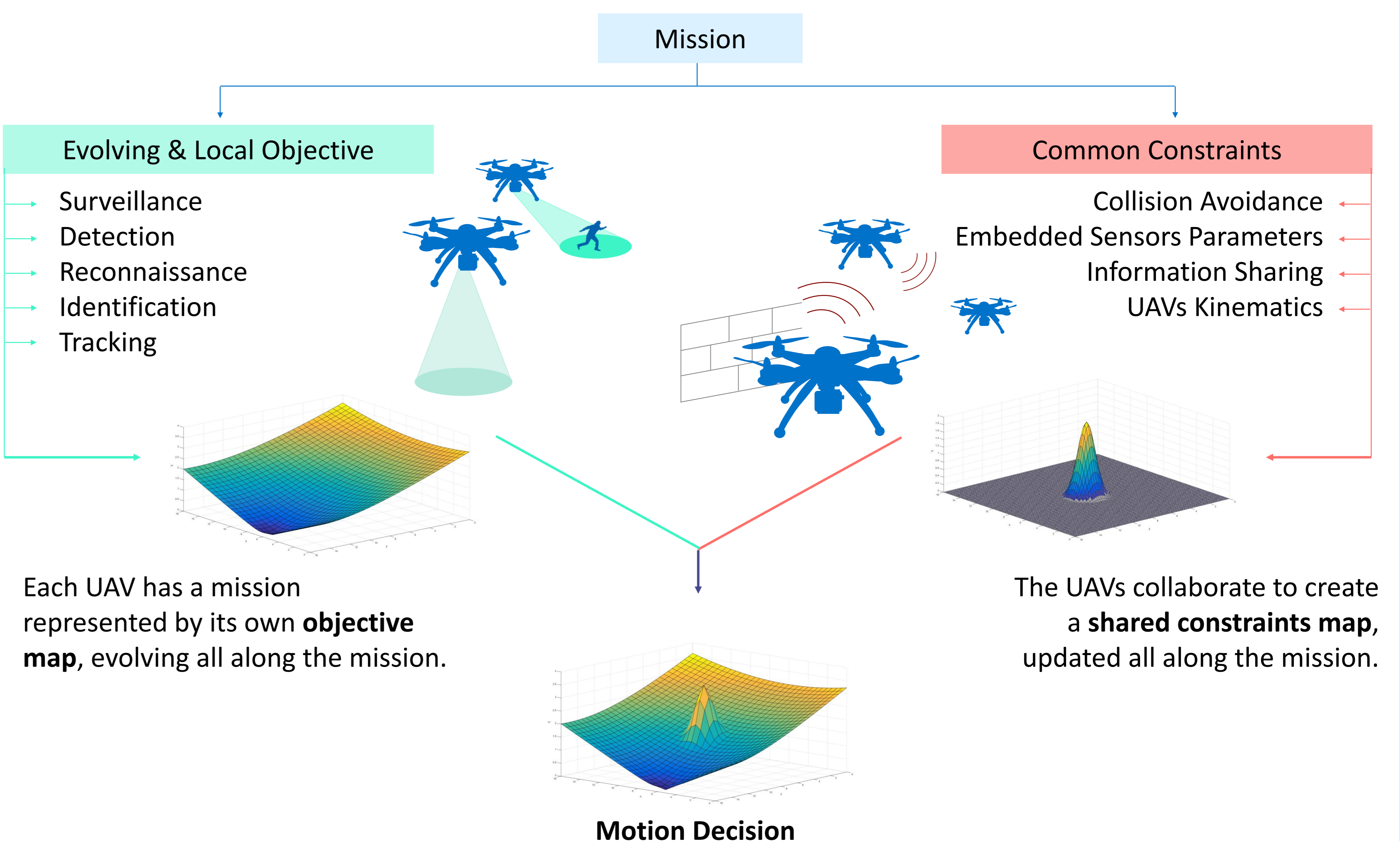
Our Approach

- The environment is discretized into square cells.
- The trajectories of the UAVs depend on the width of the cells.
- Addition of a potential field for the obstacle avoidance anticipation to the repulsive field around the obstacles (see figure below).

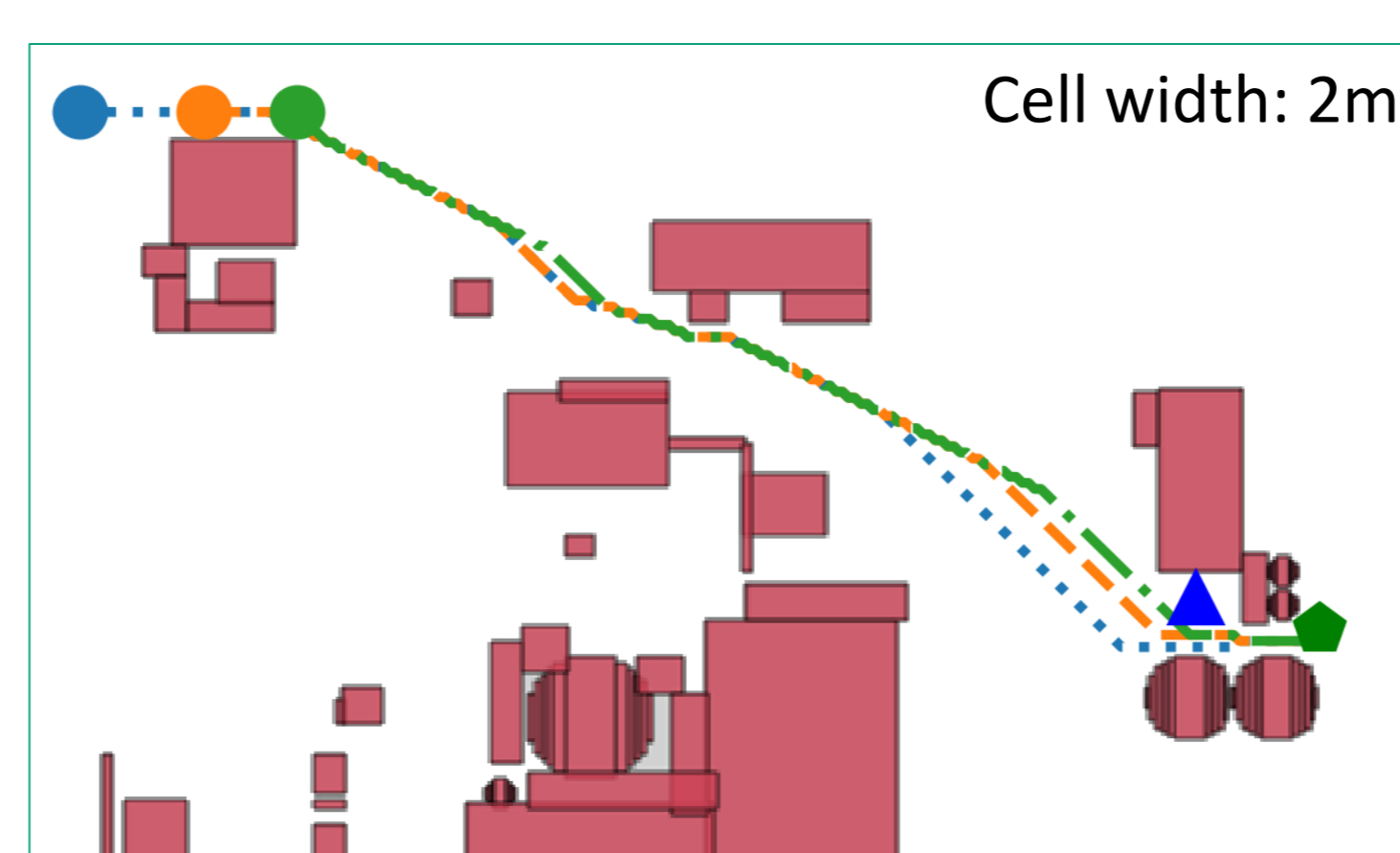
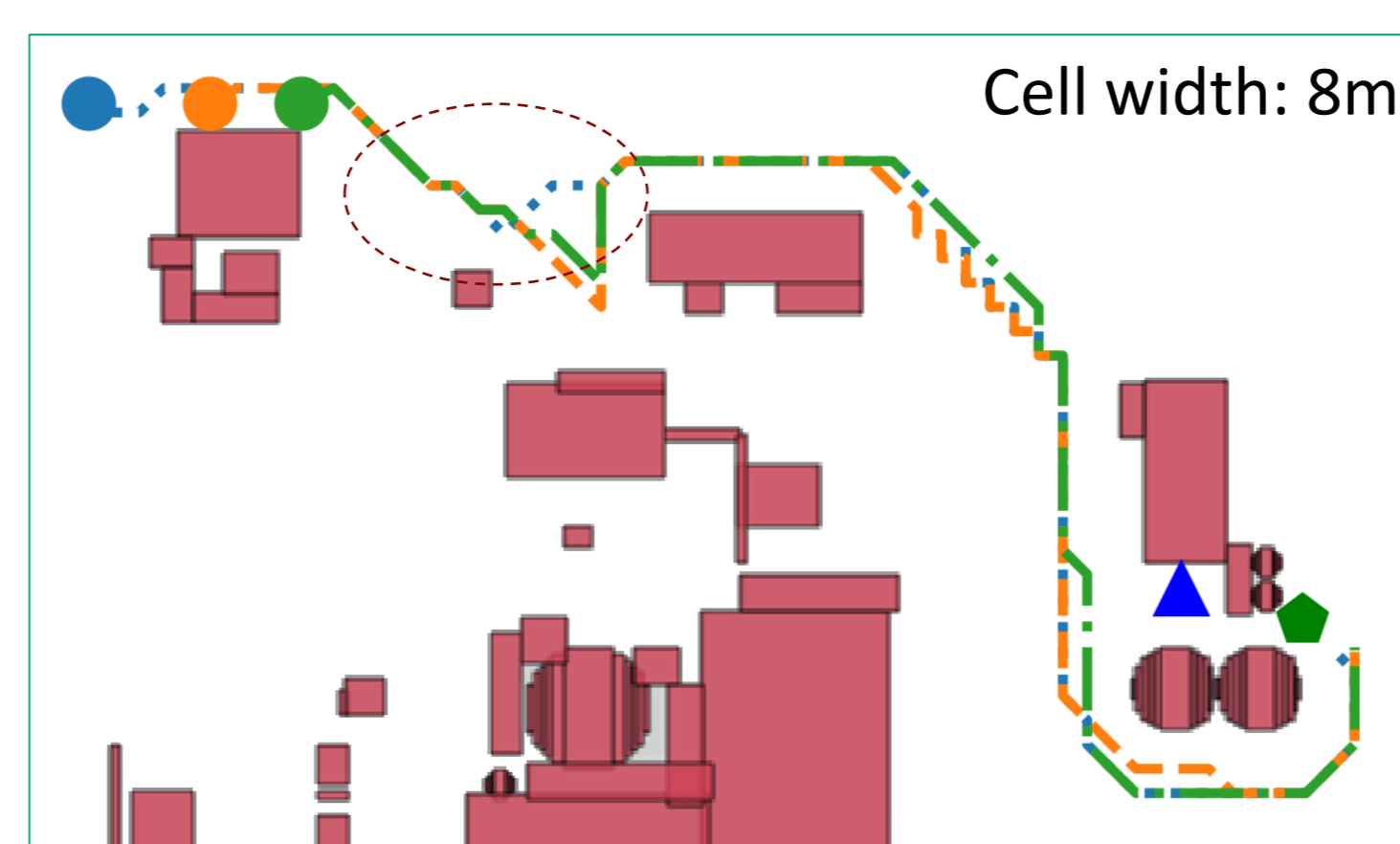


Artificial potential field resulting from our proposal, showing an anticipation of collision avoidance.

Principle of Our Mobility Strategy



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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