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

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Context
Mission: detect suspicious events and Suspicious Behaviour Detection
- Without human intervention
- In unknown areas
- Quickly

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

Objectives

Purpose 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.

Each UAV has a mission represented by its own objective map, evolving 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.

Principle of Artificial Potential Fields (APF)
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

Common Constraints
- Collision Avoidance
- Embedded Sensors Parameters
- Information Sharing
- UAVs Kinematics

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

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

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Some path planning methods
- Artificial Potential Fields
- Virtual Forces
- Genetic Algorithms
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Publication & Patent

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