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# Coordinated Search with a Swarm of UAVs

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## Objectives

▪ Enable multiple UAVs to autonomously search for a stationary target.

▪ Develop distributed coordination strategies for multiple UAVs.

## Search Tasks and Platforms Used
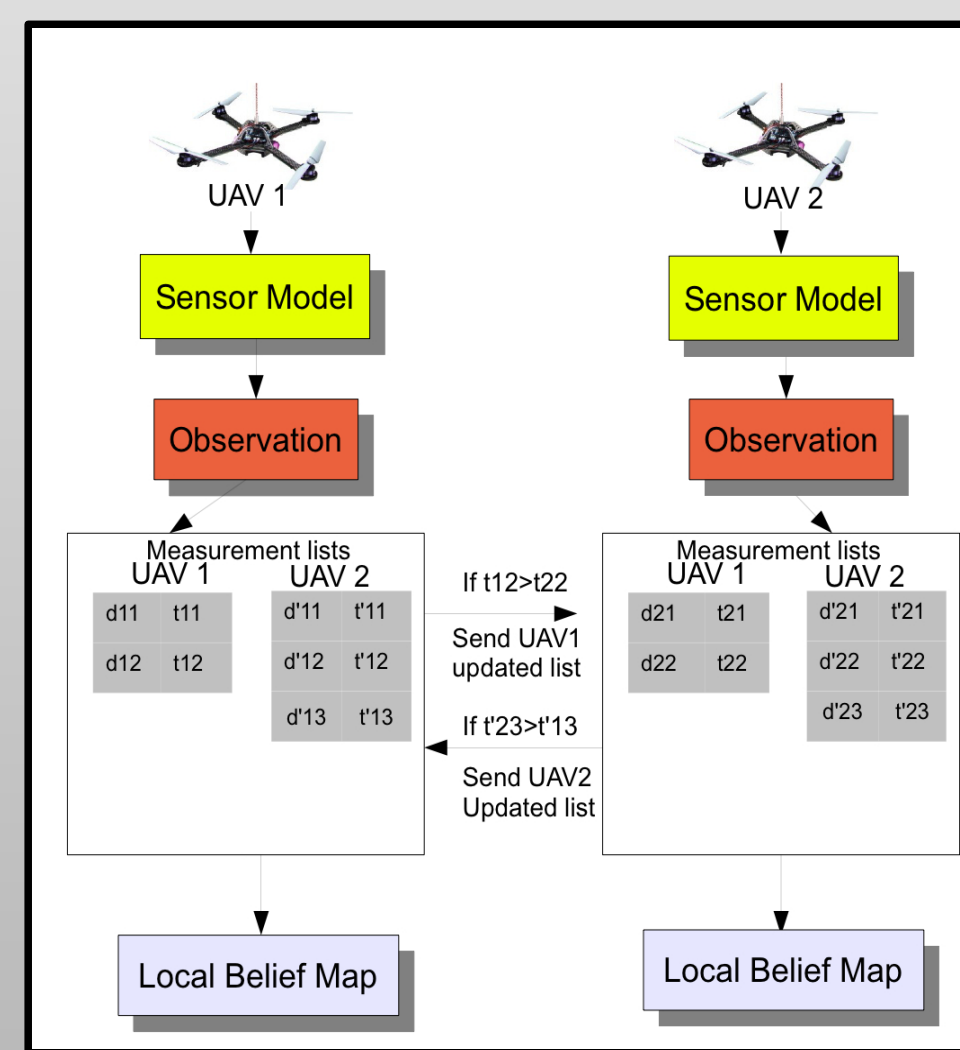
**AscTec Hummingbird quadrotor helicopter**

▪ Initial search task: Find at most one stationary object of interest (target)

▪ Requirement: UAVs should be small, lightweight, manoeuvrable

▪ Hardware choice: Ascending Technologies Hummingbird
  – 200g payload
  – 23 minutes flight time
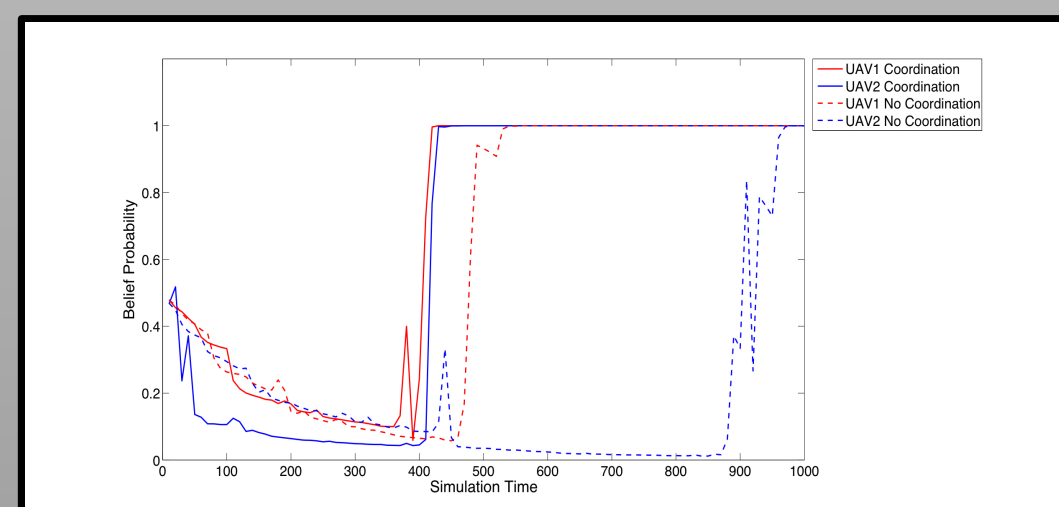  – Navigation and surveillance sensors

## Description of Search Task

1. We are searching for a single stationary target by deploying UAVs in area A.
2. The search area is decomposed into a set of |A| grid cells. The target (if present) occupies at most a single cell.
3. The UAV is equipped with navigation sensors (so that it knows its position within the resolution of a cell) and surveillance sensors (which provide a detect / no detect event for the cell the UAV is flying over).
4. Each UAV maintains a grid-based probabilistic map (belief map) composed of |A| cells. Each cell contains the probability that the target is located in that cell.
5. Each UAV decides on the next cell to visit using a steepest gradient ascent method applied to its belief map.

(a) 10m          (b) 20m
**Sample frames taken from a UAV**

## Data Fusion

▪ A UAV always maintains an up-to-date list of its own measurements.
▪ When two UAVs come within communication range, they synchronize their measurements and recompute their local belief maps.

UAV 1          UAV 2
Sensor Model          Sensor Model
Observation          Observation

Measurement lists          Measurement lists
UAV 1 | UAV 2          UAV 1 | UAV 2
d11 t11 | d'11 t'11          d21 t21 | d'21 t'21
d12 t12 | d'12 t'12          d22 t22 | d'22 t'22
d'13 t'13          d23 t23 | d'23 t'23

If t12>t22
Send UAV1 updated list

If t'23>t'13
Send UAV2 Updated list

Local Belief Map          Local Belief Map

## Preliminary Results

Simulation of two UAVs searching for a target in a 10x10 grid, in cooperative and non-cooperative modes. The initial probability of the presence of a target in the search area is set to 0.5. The figure shows the evolution of the belief probability of the target in the search area over time. Sharing measurement among UAVs leads to super-linear speed up time.

## Future Work

Investigate the impact of:
▪ UAV altitude (and thus sensing coverage and resolution)
▪ communication range
 on the performance of search strategies.

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