University of Bordeaux 1 - Science and Technology

Mobility Models for UAV Group Reconnaissance Applications

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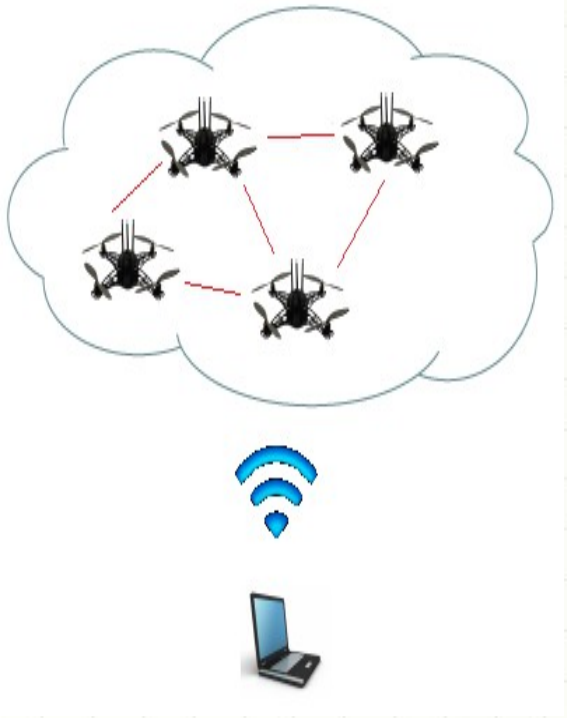
Problematic

Use mobility model that most closely matches the results of real-world scenario.

Introduction

- MANET
  - Mobile Ad Hoc Network
  - Networks of mobile entities
  - Collect, process and transmit data
- UAV
  - Application of mobility models with U
- 2 differents mobility models
  - Random Waypoint
  - Distributed Pheromone Repel



Scenarios

- Objectives
  - Scan area in a limited time
  - Scan the entire area regularly, but at least once every hour
- Characteristics
  - Square with a side length of 30 Km
  - 10 UAVs per run
  - Fixed wing aircraft
  - UAVs start at the middle of south edge

Scenarios

- Requirements
  - UAVs are autonomous
  - Regularly scans
  - Randomness element in mobility models
  - Data must be returned to the C&C
  - Lost or unaivalable UAVs is not important
  - Communication bandwidth is limited

Models

- Properties
  - Min an Max air speed and can’t changed direction in an instant
  - No collisions thanks to altitude adjustements
  - Flight altitude: 3500 meters (11 000 feet)
  - Flight speed: 150 km/h (41.7 m/s, 81.0 knots)
  - Turn radius: 500 meters
  - Infinite bandwidth between 2 UAV’s within 8000m
  - Scan zone 2000x1000 m

Models

- Random Mobility Model

Table 1. UAV random action table.

	Probability of action		
Last action	**Turn left**	**Straight ahead**	**Turn right**
Straight ahead	10%	80%	10%
Turn left	70%	30%	0%
Turn right	0%	30%	70%

Models

- Pheromone models
  - One pheromone map per UAV
  - Marks the areas when they have been scanned
  - Broadcast regularly a local area pheromone map

Models

- Pheromone models

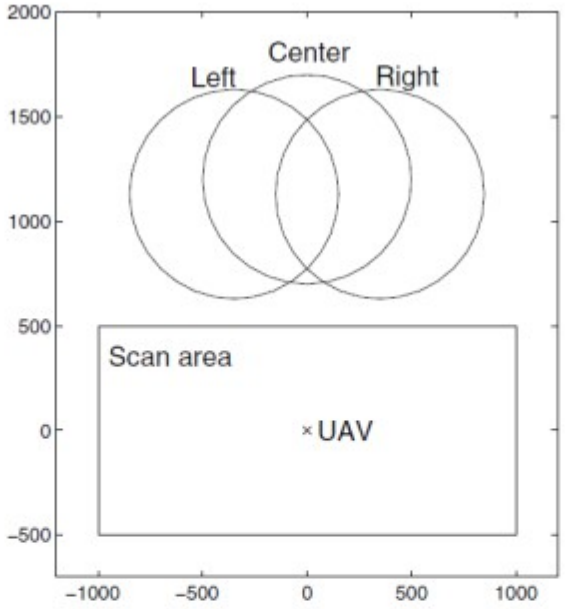


Figure 2. Pheromone search pattern

Table 2. UAV pheromone action table.

Probability of action		
Turn left	**Straight ahead**	**Turn right**
(Total – Left) / (2 * Total)	(Total – Center) / (2 * Total)	(Total – Right) / (2 * Total)

Evaluations

- Scan coverage
- Scan charateristic
- Communication

Evaluations

Scan Coverage

- Theory : 900km² in 18 min
- Prevision : 40 min because of several turnings
- Rapidity of scanning : 0,083 km²/s per UAV

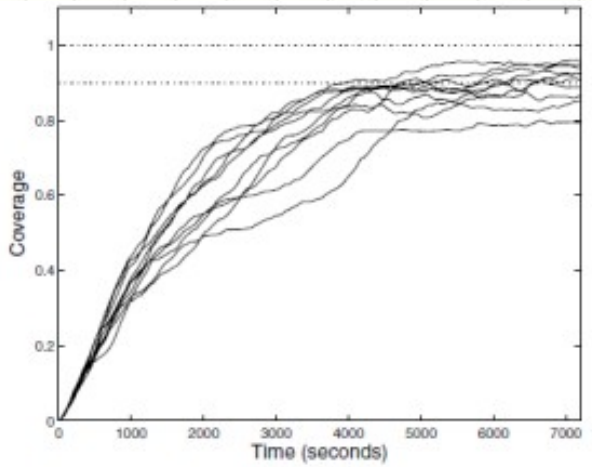


Figure 3. Random mobility coverage

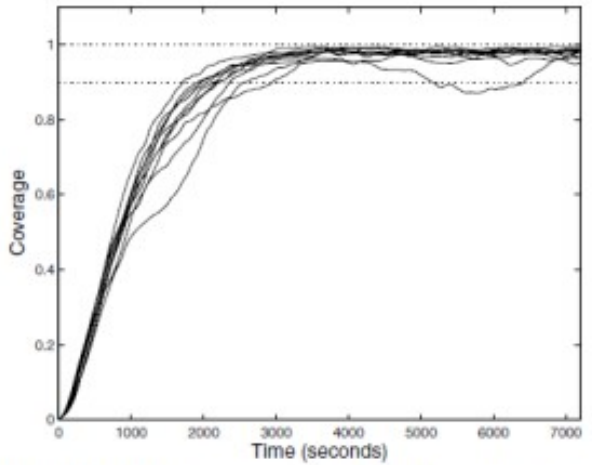


Figure 4. Pheromone mobility coverage.

Evaluations

Scan characteristic

Both models manage quite well to avoid rescanning a recently scanned area

Table 3. Never scanned area

	Max	Median	Min
Random	16.2%	3.2%	0.5%
Pheromone	0.21%	0.03%	0.01%

Pheromone > Random

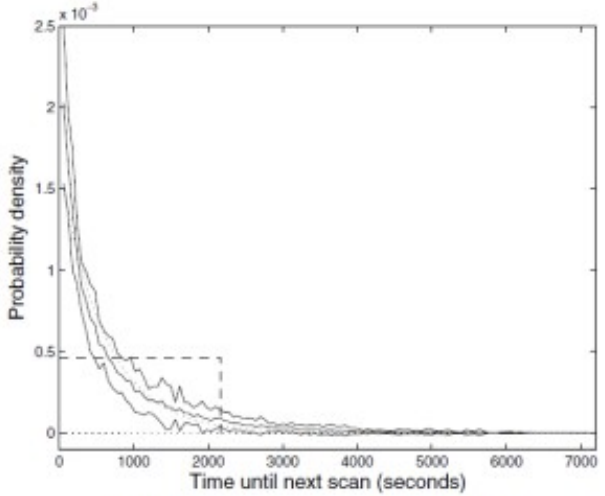


Figure 5. Random mobility

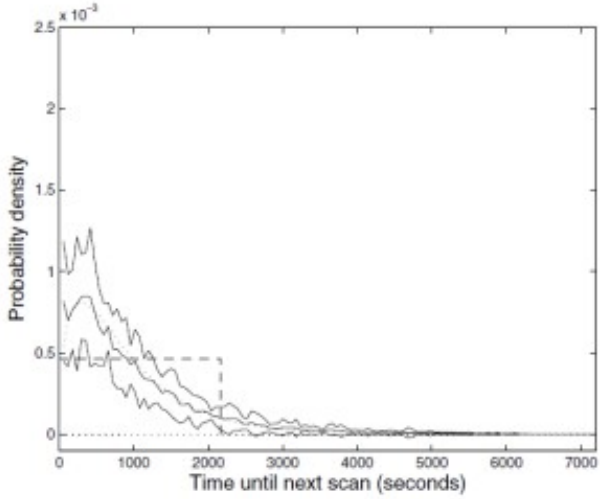


Figure 6. Pheromone mobility

Evaluations

Communication

- Low constant connectivity
  - ➢ More UAVs for a fully network connected

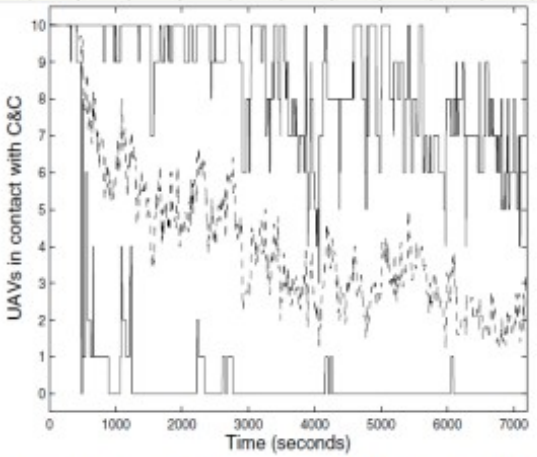


Figure 7. Random. Number of UAVs in contact with C&C (max, average, min).

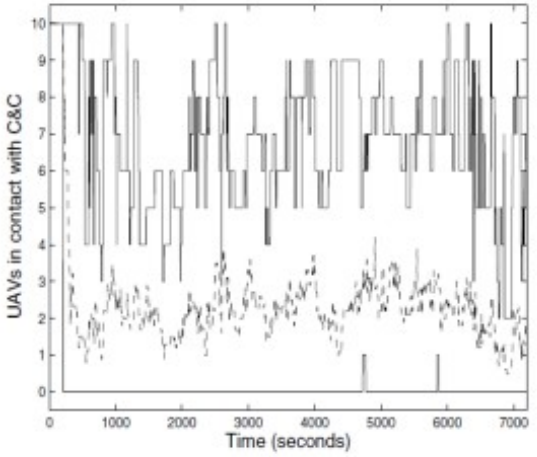
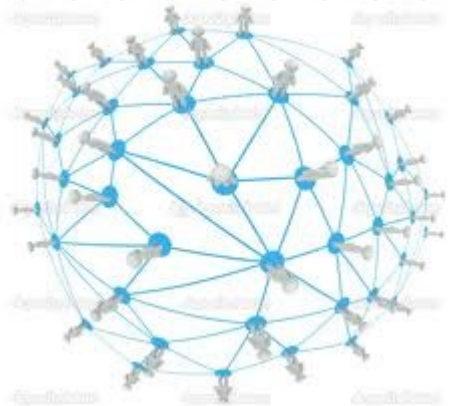


Figure 8. Pheromone. Number of UAVs in contact with C&C (max, average, min).

Conclusion

- Good model for scan coverage and reconnaissance scenario …
- … But coverage and connectivity of communications are two conflicting objectives.
- Possiblity amelioration is to temporary storage data and relax the limited bandwidth.



Do you have any questions ?

Nouveau travail

Ressources

- <Texte du site intranet ici>
  <lien hypertexte ici>
- <Texte de support de lecture supplémentaire ici>
  <lien hypertexte ici>
- Cet ensemble de diapositives et ressources connexes :
  <lien hypertexte ici>

Annexe