

Mobility Models for UAV Group Reconnaissance Applications

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Problematic

A decorative blue wavy line that starts from the top right, curves downwards and to the left, and then curves back up and to the right, ending near the top right corner of the slide.

- 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 UAVs
- 2 different 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 unaivable 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 adjustments
- 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.

Last action	Probability of 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

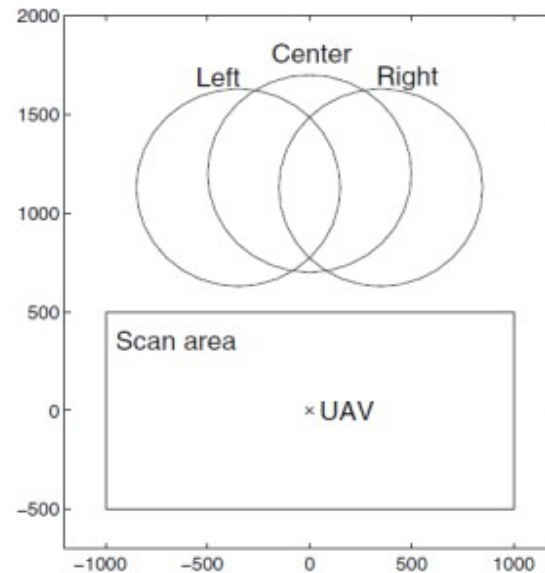


Figure 2. Pheromone search pattern

Table 2. UAV pheromone action table.

Probability of action		
Turn left	Straight ahead	Turn right
$(\text{Total} - \text{Left}) / (2 * \text{Total})$	$(\text{Total} - \text{Center}) / (2 * \text{Total})$	$(\text{Total} - \text{Right}) / (2 * \text{Total})$



Evaluations

- Scan coverage
- Scan characteristic
- Communication

Evaluations

Scan Coverage

- Theory : 900km^2 in 18 min
- Prevision : 40 min because of several turnings
- Rapidity of scanning : $0,083\text{ km}^2/\text{s}$ per UAV

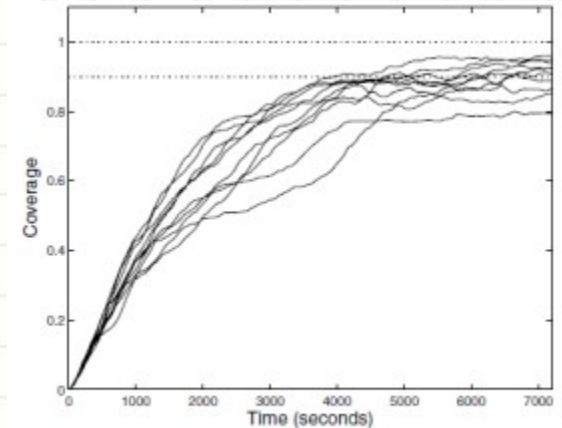


Figure 3. Random mobility coverage

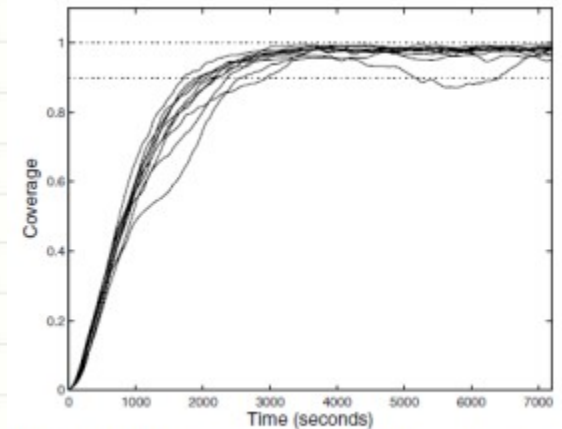


Figure 4. Pheromone mobility coverage.

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

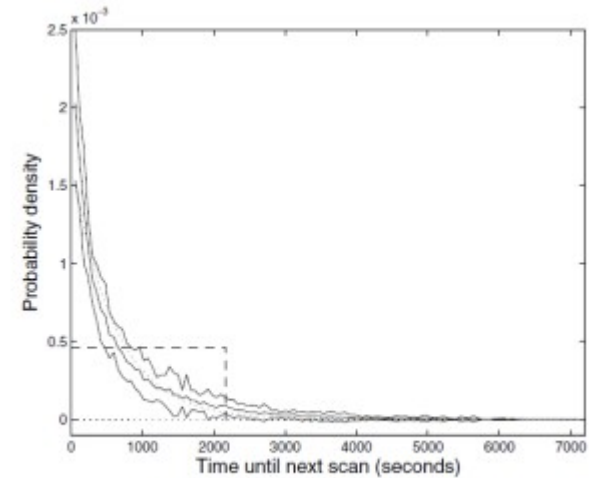


Figure 5. Random mobility

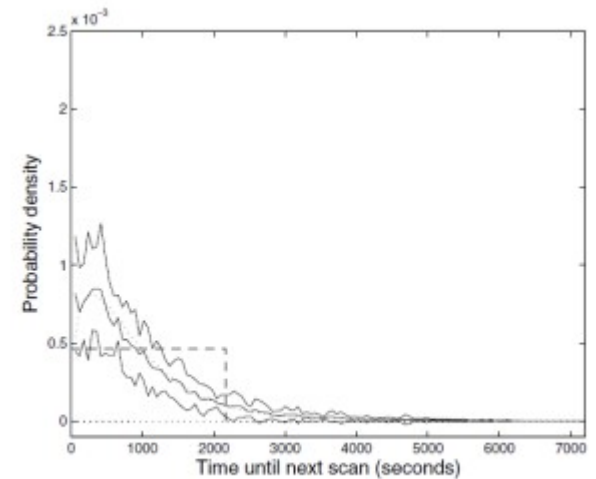


Figure 6. Pheromone mobility

Evaluations

Communication

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

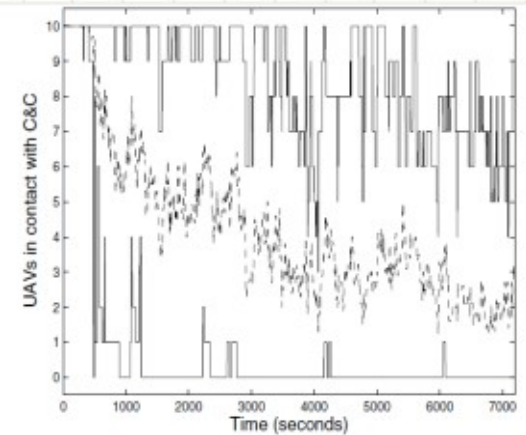


Figure 7. Random. Number of UAVs in contact with C&C (max, average, min).

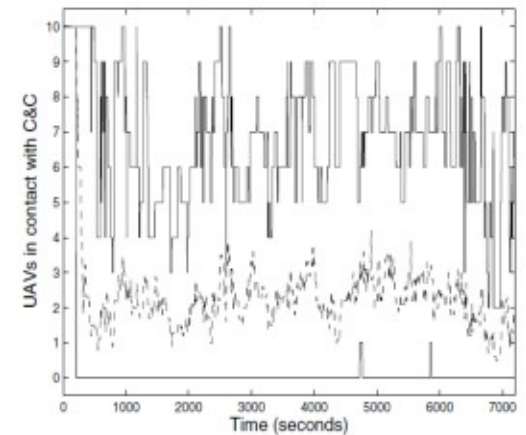


Figure 8. Pheromone. Number of UAVs in contact with C&C (max, average, min).



Conclusion

- Pheromone model good scan bad connectivity