



Decentralized Rendezvous using Multiple Drones for Environmental Monitoring



Arael A. Anaya, George P. Kontoudis

Motion Planning, Active Learning, and Autonomy (MPALA) Lab, Colorado School of Mines, Golden CO

Background

- **Drone swarms** are more effective in environmental monitoring due to **divide-and-conquer** structure
- **Traditional** systems rely on **centralized topologies** or global communication
- **Decentralizing** increases **robustness**, allowing drones to **handle failure** and unexpected obstacles
- **Resilient consensus** algorithms ensure consensus despite decentralized communication

Research Objectives

- **Develop decentralized consensus** algorithm under robust network design
- Build and configure a **motion capture test bed**
- **Validate algorithm** on a **physical** drone swarm

Malicious Nodes

- Send **incorrect** or misleading **values**
- Represent faulty or **adversarial** agents
- Exploit topology **weaknesses**
- Must be mitigated to preserve **accurate measurements**

W-MSR Algorithm

The **Weighed-Mean Subsequence Reduced** (W-MSR) algorithm is a resilient consensus method

Inputs:

- Network topology
- F (Max number of adversarial agents tolerated)

Steps:

- Sort neighbors' positions
- Discard (up to F) largest and smallest values
- Average the remaining values

Output:

- Update positional estimate for drone

Overall Approach

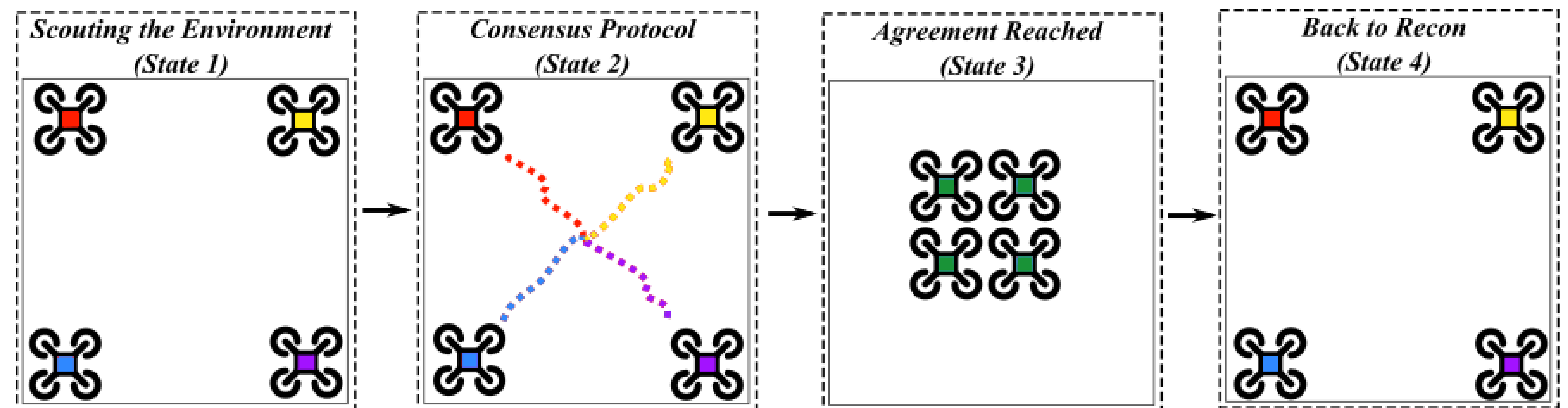


Figure 1: Rendezvous Example

W-MSR Positional Consensus

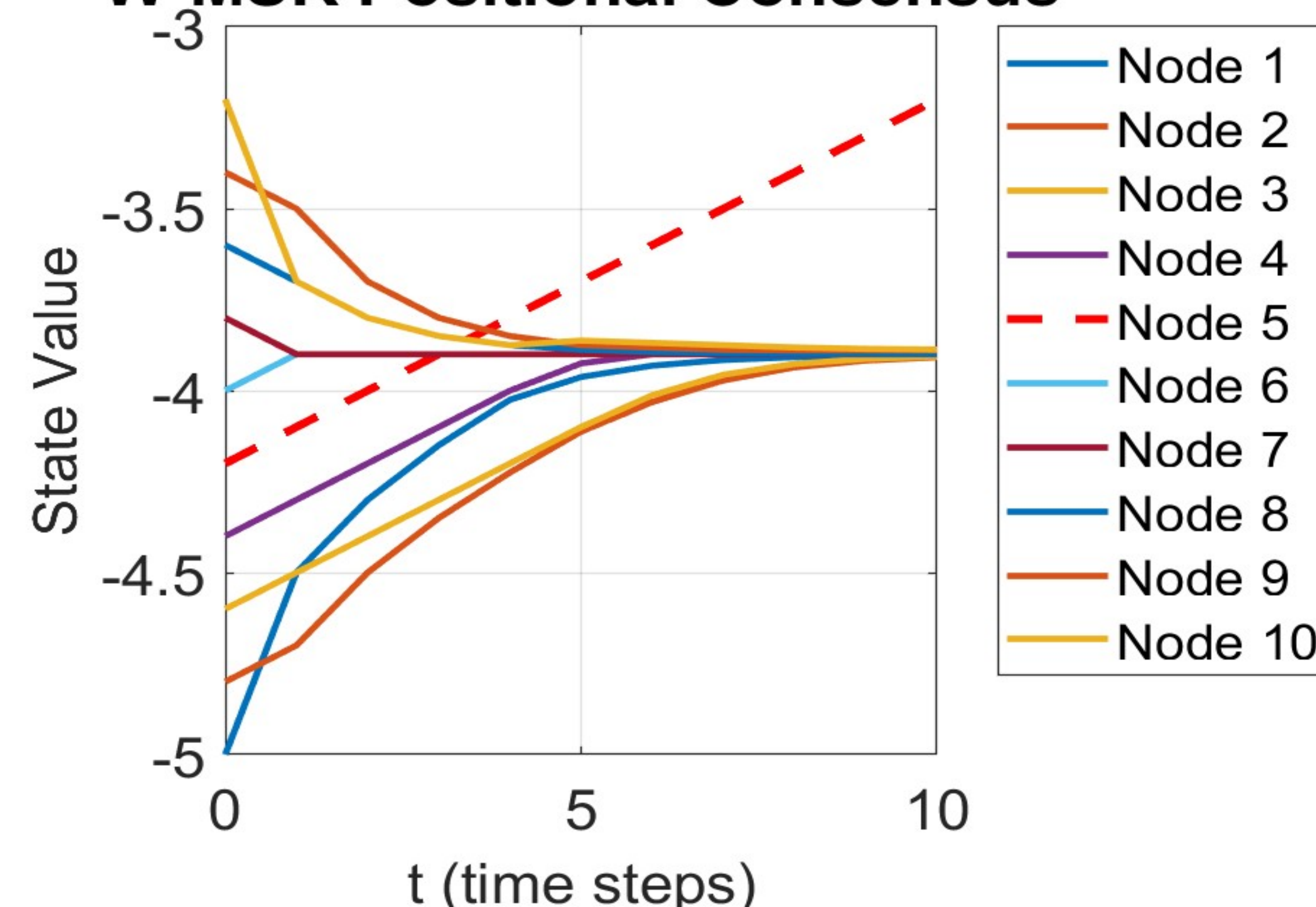
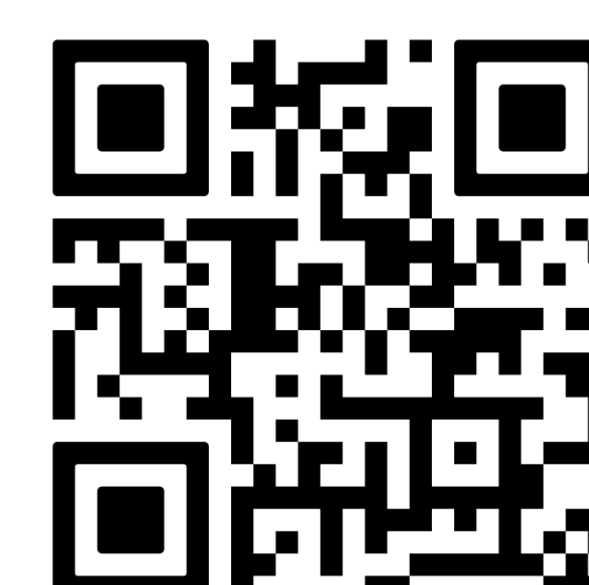
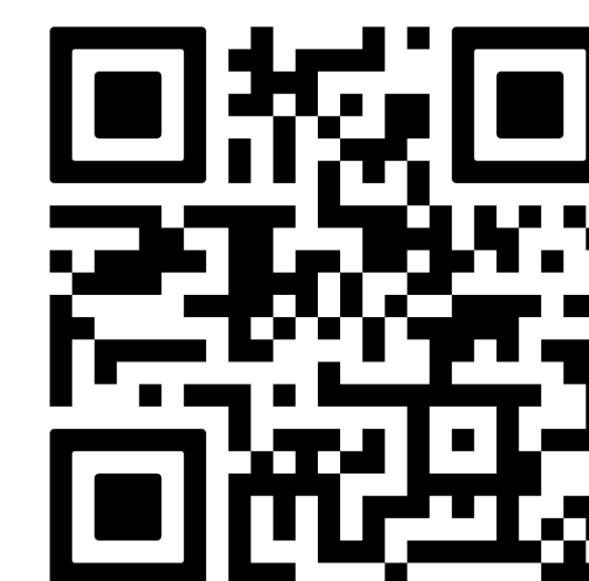


Figure 2: W-MSR on 10 Node system with malicious node

Videos



Real World Experiment

- 3 drones placed at distinct 3D points
- W-MSR consensus applied with cycle graph
- Consensus executed by each drone

Future Work

- Scale experiments to larger swarms
- Evaluate resilience under more adversaries
- Characterize required topologies
- Develop methods to identify and isolate faulty agents

Results

- **Consensus reached** in simulation and experiment
- Malicious node successfully **ignored**
- **Convergence achieved** in reasonable iterations
- Physical trajectories **matched theory**

Acknowledgements

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