

Collaborative Research: CPS: Medium: Wildland Fire Observation, Management, and Evacuation using Intelligent Collaborative Flying and Ground Systems

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Objectives: Early detection of forest fires using autonomous drones, and developing fire management systems using a fleet of autonomous drones and robots.

Challenges:

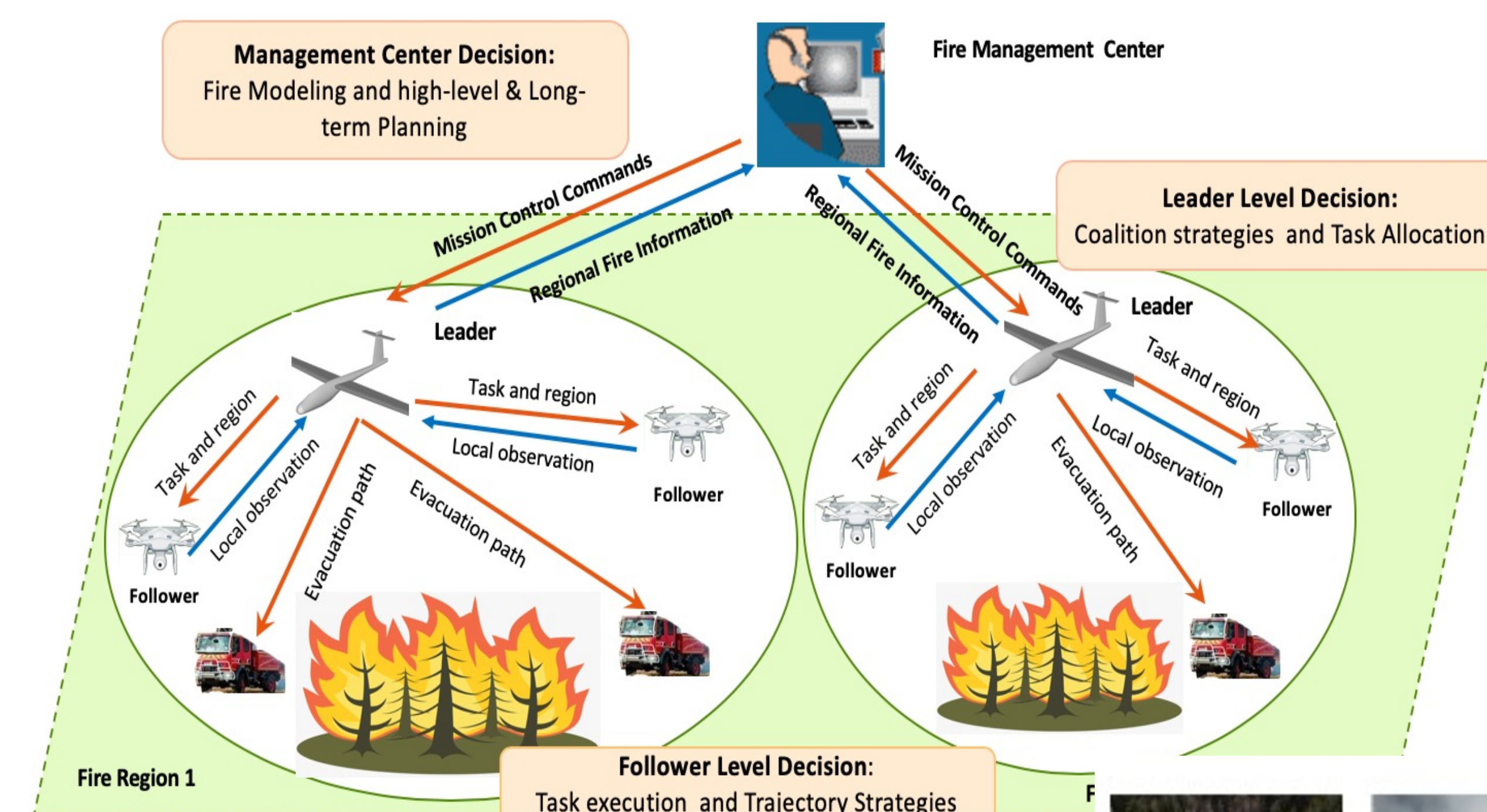
- Current wildfire detection techniques using sensor networks or satellite images are slow and inaccurate.
- Current fire management techniques involve the presence of first responders in a fire zone that endanger their lives.

Solutions:

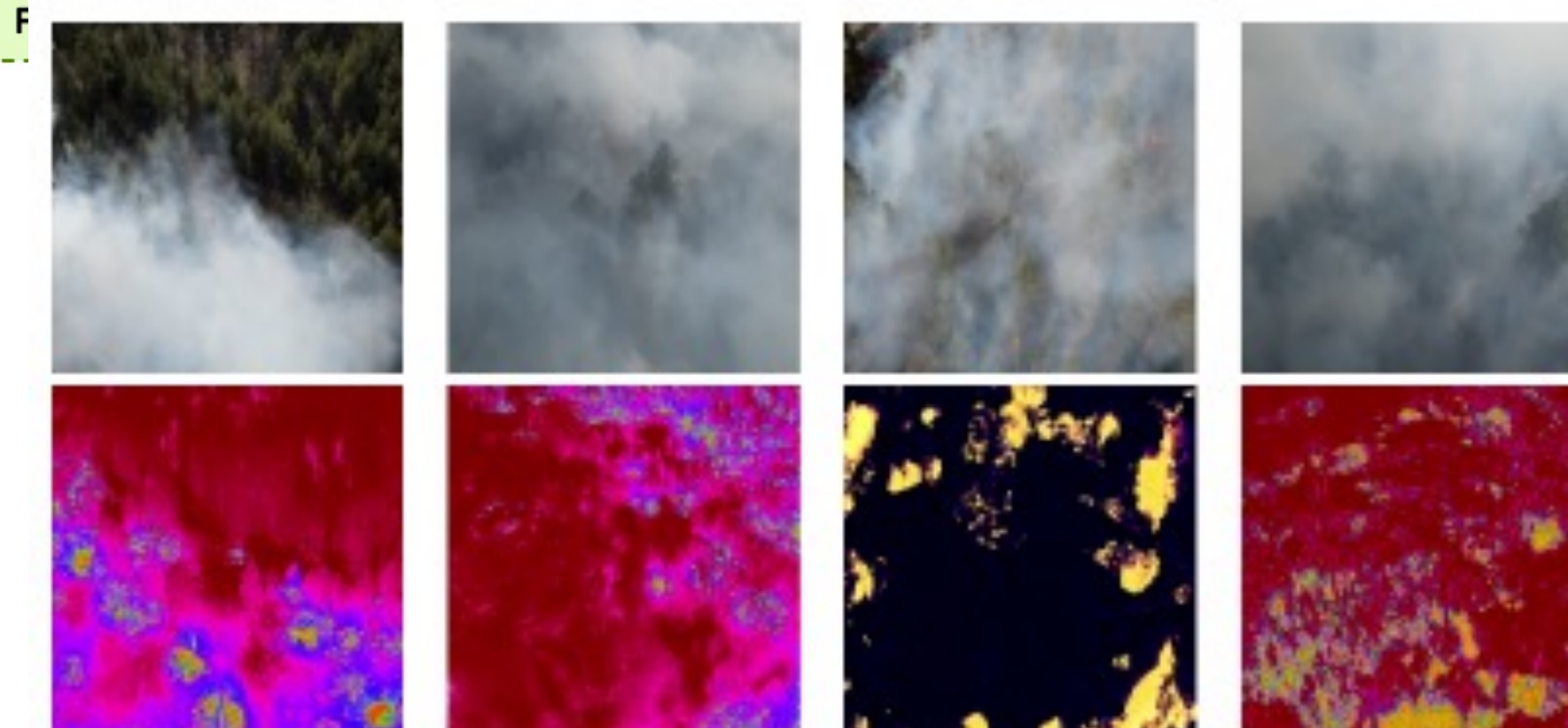
- Early fire detection in remote and forest areas using autonomous UAVs.
- Fast active geo-mapping of the fire heat map on flying drones.
- Developing pursuit-evasion games for adaptation of autonomous agents to an unknown cluttered environments.
- Agile leader-follower task allocation among autonomous drones during disaster missions

Broader Impacts, Education, and Outreach:

- Practical solutions for utilizing a network of small and autonomous UAVs in disaster management,
- Public datasets of drone-collected images during several prescribed fires in the west US to be used for fire detection and fire modeling research.
- Training for first responders and firefighters to use UAS for fire monitoring



FLAME2 drone-collected fire image dataset



Selected Outcomes:

1. B. Hopkins, X. Chen, H. Wang, L., Neil, P. Fule, A. Watts, J. Coen, E. Rowel, A. Razi, F. Afghah, FIRE DETECTION AND MODELING: AERIAL MULTI-SPECTRAL IMAGE DATASET- **FLAME2 Dataset**, IEEE Dataport, 2022.
2. Nick-Marios T. Kokolakis and Kyriakos G. Vamvoudakis, "Safe Finite-Time Reinforcement Learning for Pursuit-Evasion Games," IEEE CDC, 2022.
3. Nick-Marios T. Kokolakis and Kyriakos G. Vamvoudakis, "Safety-Aware Pursuit-Evasion Games in Unknown Environments using Gaussian Processes and Finite-Time Convergent Reinforcement Learning, IEEE TNNLS.
4. B. Hopkins, X. Chen, H. Wang, L., Neil, P. Fule, A. Watts, J. Coen, E. Rowel, A. Razi, F. Afghah, Detection and Spread Modeling of Prescribed Forest Fires using UAV-collected images, submitted, 2022.