Wildland Fire Observation, Management, and Evacuation using Intelligent Collaborative Flying and Ground Systems
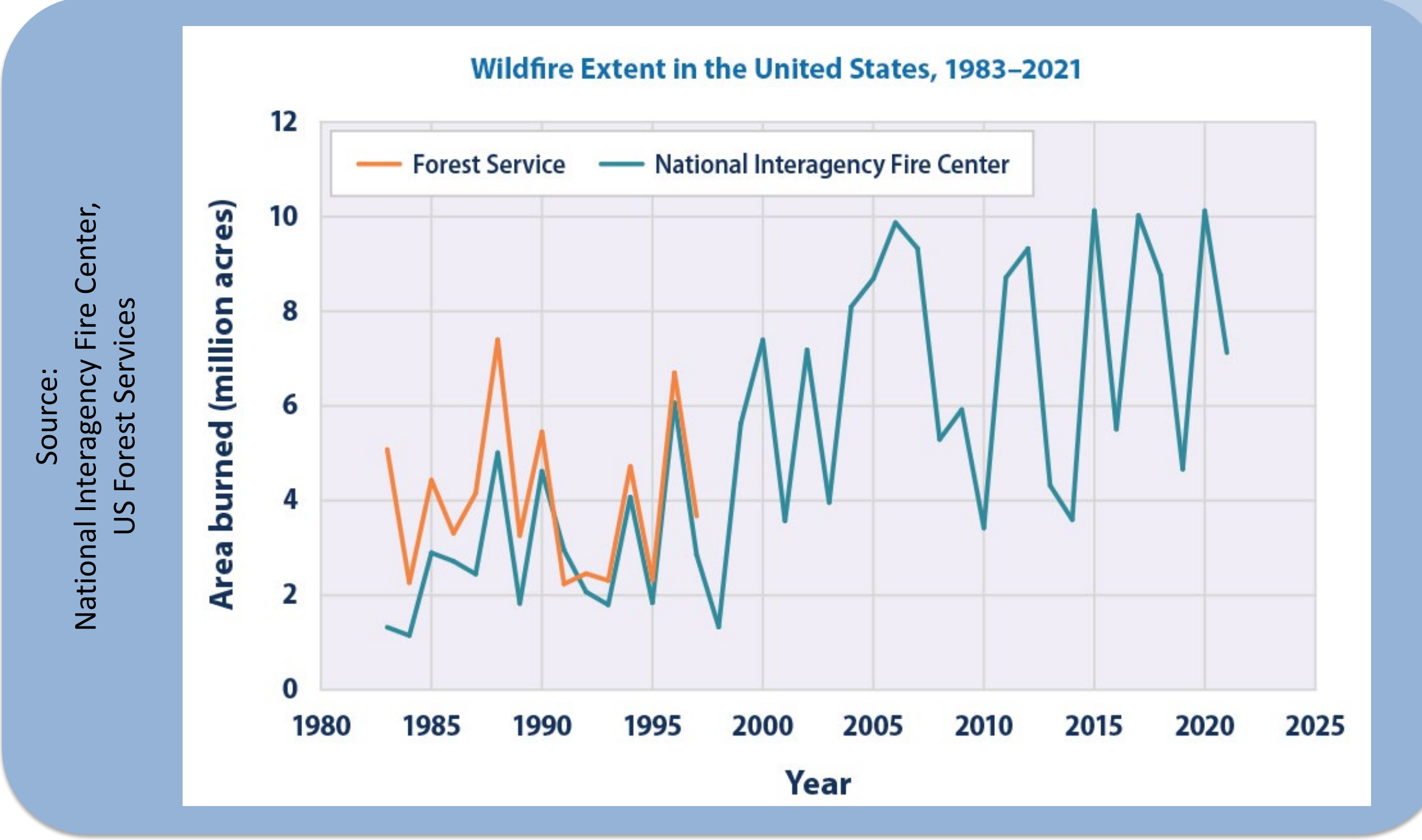
PIs: Fatemeh Afghah[1], Abolfazl Razi[1], Eric Rowell[2], Peter Fule[3], Janice Coen[4], Kyriakos G Vamvoudakis[5]
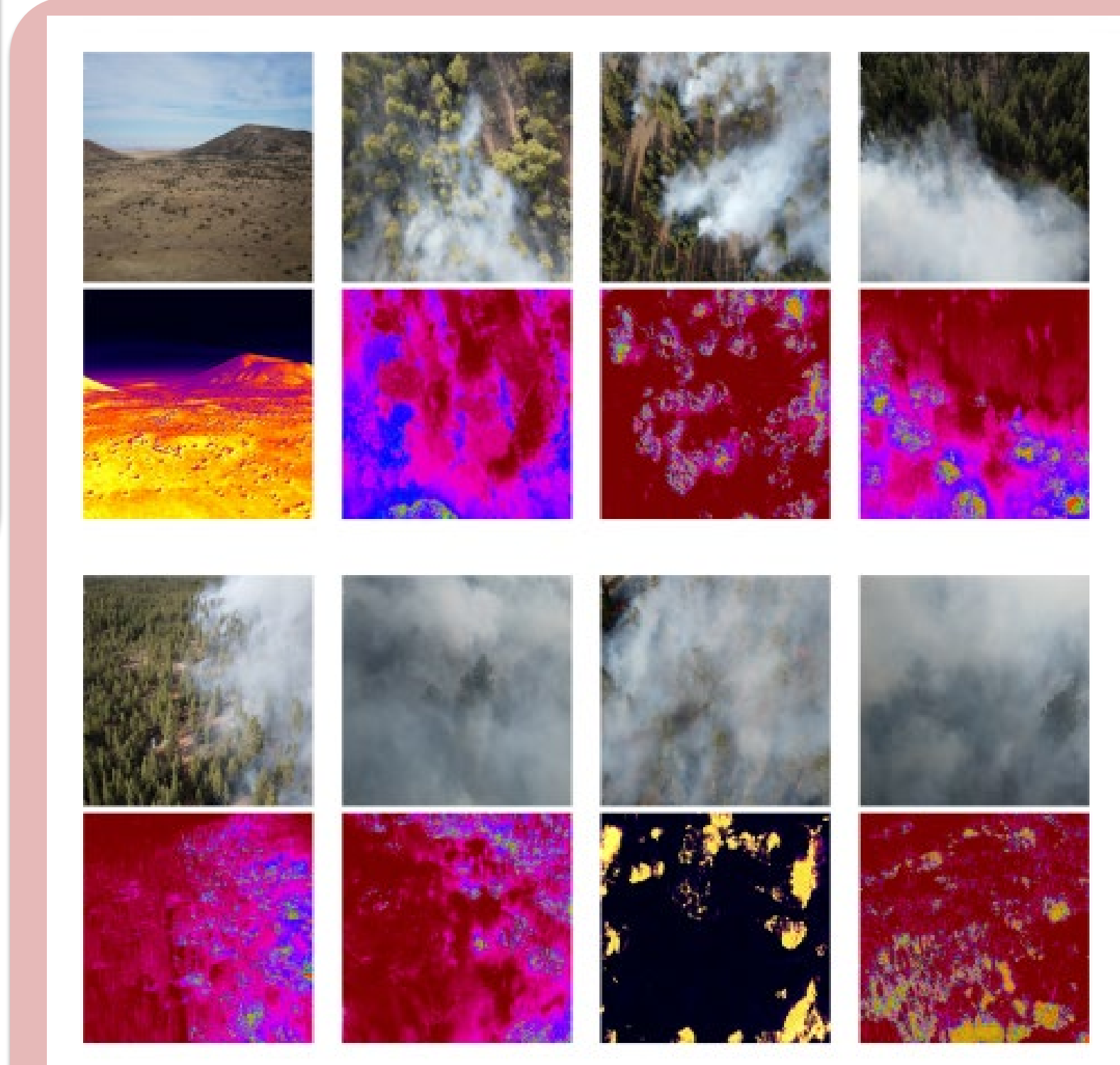
Collaborators: Adam Watts[6]

Project Link: https://iswin-lab-clemson.github.io/CPS%20Fire%20Management.html

Affiliations: [1]: Clemson University, [2]: Desert Research Institute, [3]: Northern Arizona University, [4]: University Corporation For Atmospheric Research, [5]: Georgia Institute of Technology, [6] U.S. Department of Agriculture Forest Service

Increasing wildfire costs—a reflection of climate variability and development within wildlands—drive calls for new national capabilities to manage wildfires. This project develops UAS-based fire management strategies to assist first responders during fire detection, management, and evacuation.

Increasing wildfire severity demands new wildfire management solutions.

Wildfire Extent in the United States, 1983–2021
Source: National Interagency Fire Center, US Forest Services

O'Neill, Leo, et al. "Pixels to Pyrometrics: UAS-Derived Infrared Imagery to Evaluate and Monitor Prescribed Fire Behavior and Effects." *International Journal of Wildland Fire, Northern Arizona University,* preprint (2024).

Pyrometrics extracted from UAS-collected thermal imagery effectively quantify fires, offering avenues for burn assessment and evaluation.
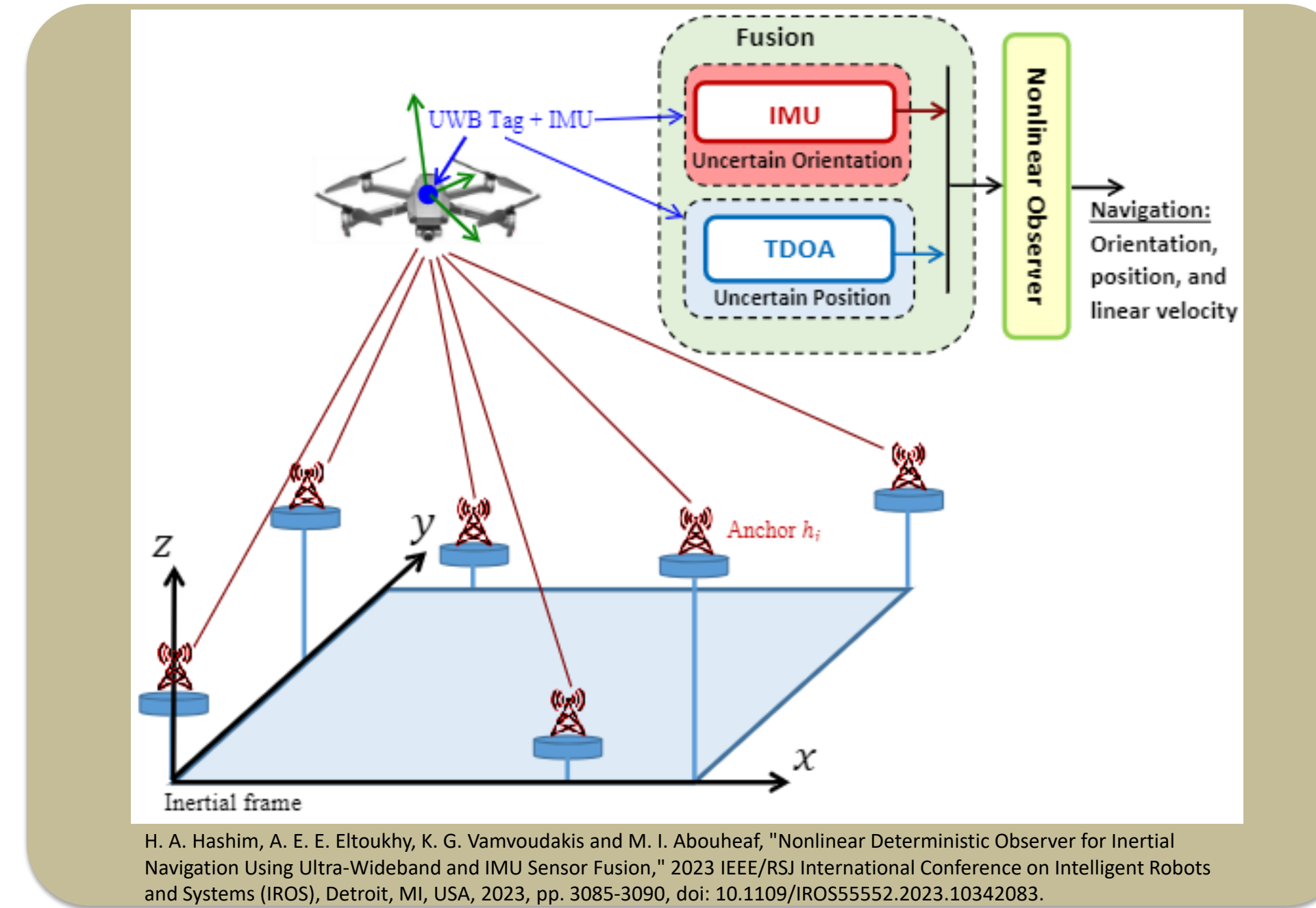

FLAME Datasets offer researchers collections of side-by-side multi-spectral UAV-collected wildlands fire imagery, enabling data driven modeling and assessment.

Bryce Hopkins, Leo O'Neill, Fatemeh Afghah, Abolfazl Razi, Eric Rowell, Adam Watts, Peter Fule, Janice Coen, August 29, 2022, "FLAME 2: Fire detection and modeLing: Aerial Multi-spectral imagE dataset", IEEE Dataport, doi: https://dx.doi.org/10.21227/swyw-6j78.
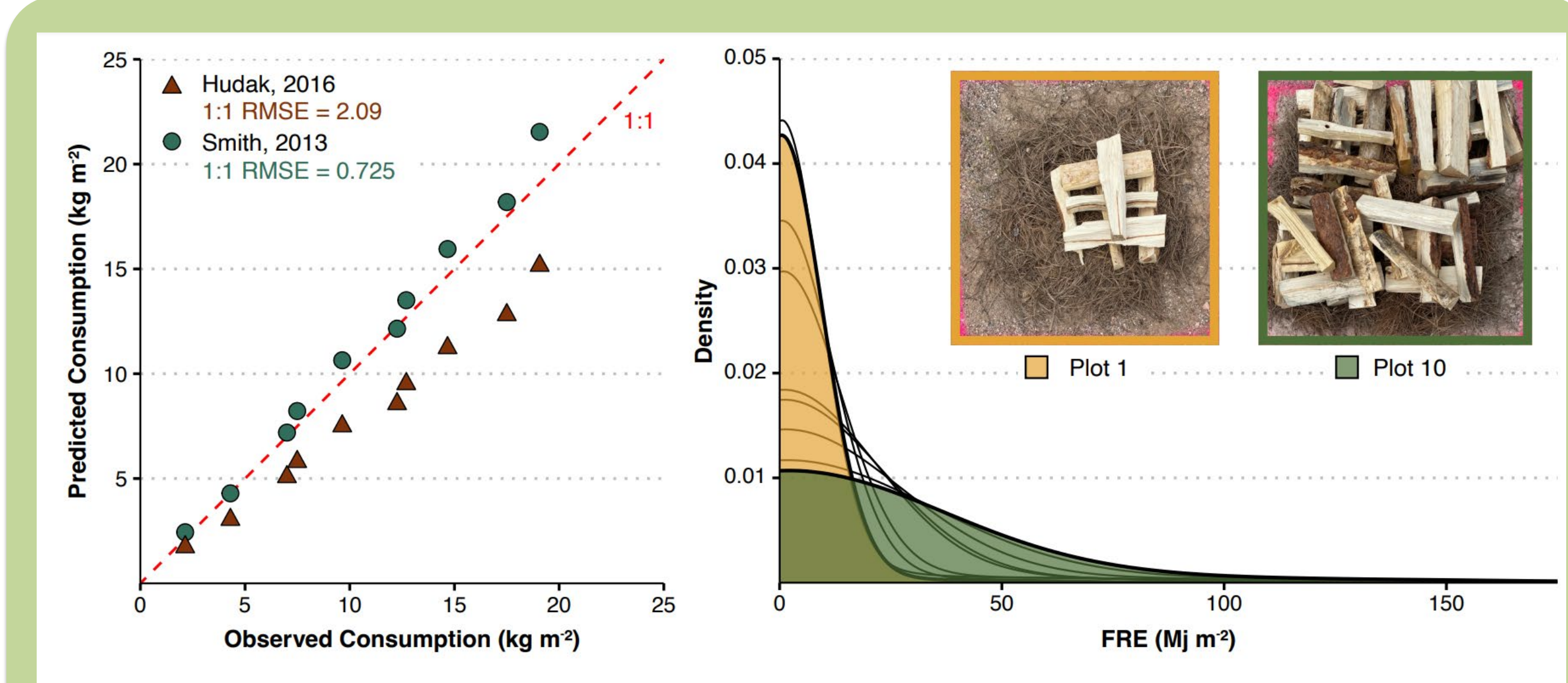

Belief State
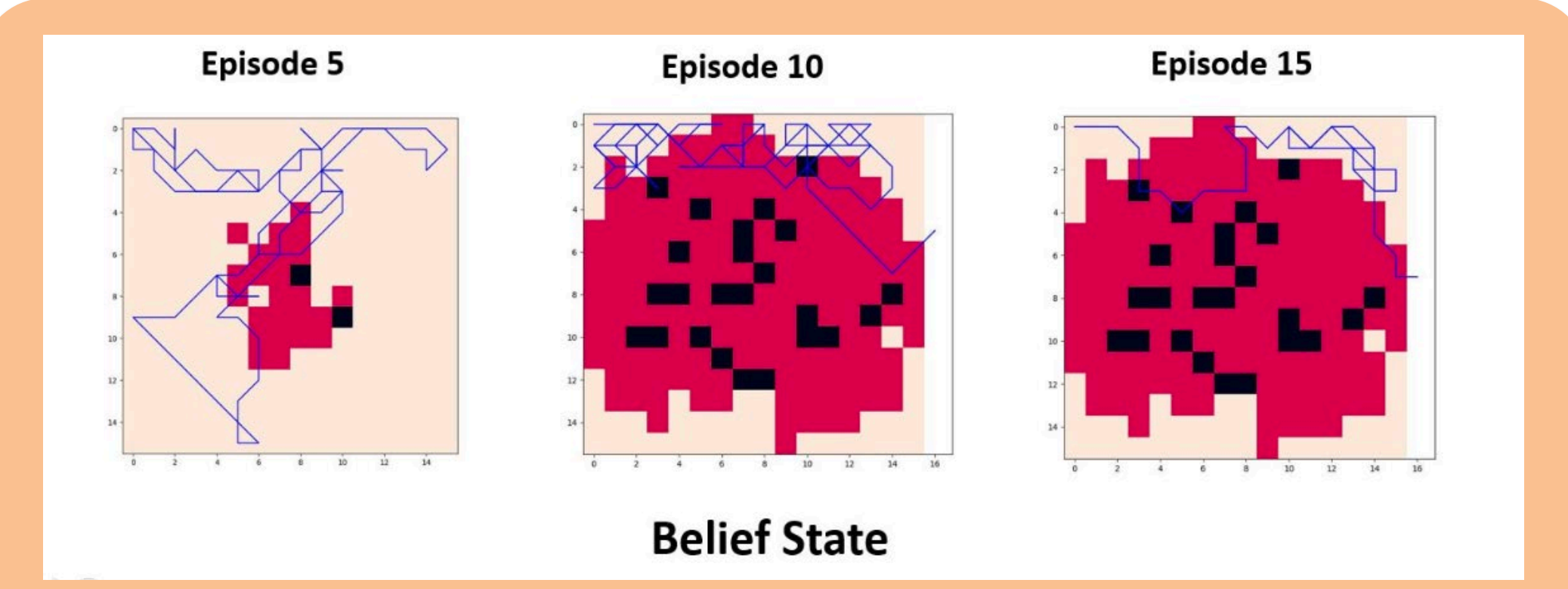
Wildfire Monitoring with Belief-Based Deep Reinforcement Learning (DRL) of POMDP modeled system– one step closer to real-world **DRL-optimized UAV pathing**.

Boroujeni, Sayed Pedram Haeri, and Abolfazl Razi. "Ic-gan: An improved conditional generative adversarial network for rgb-to-ir image translation with applications to forest fire monitoring." *Expert Systems with Applications* 238 (2024): 121962.

IC-GAN: An improved framework for RGB-to-IR Image Translation that **extends sensing capabilities** of visible spectrum cameras.
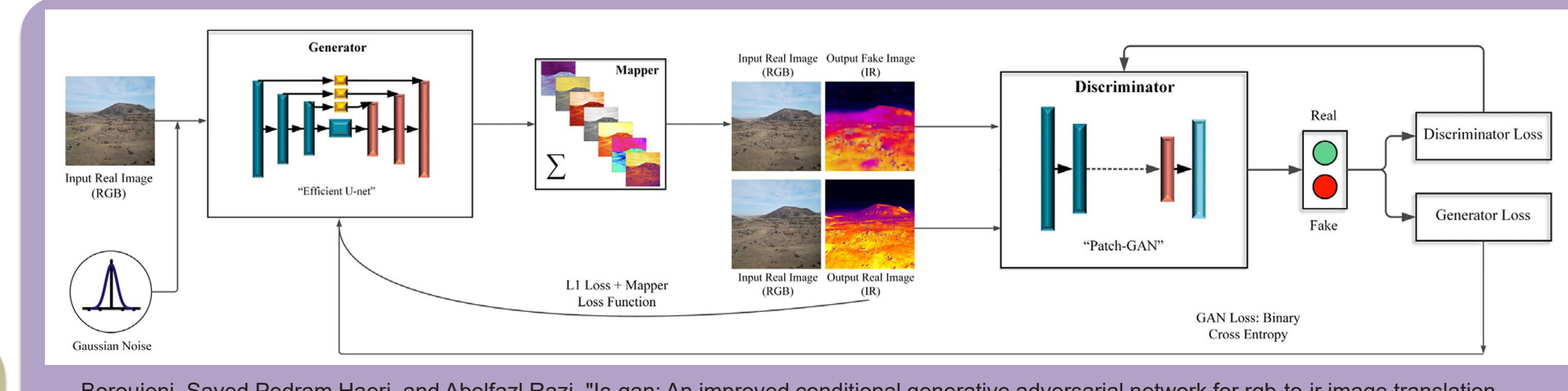
H. A. Hashim, A. E. E. Eltoukhy, K. G. Vamvoudakis and M. I. Abouheaf, "Nonlinear Deterministic Observer for Inertial Navigation Using Ultra-Wideband and IMU Sensor Fusion," 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Detroit, MI, USA, 2023, pp. 3085-3090, doi: 10.1109/IROS55552.2023.10342083.

Wireless UWB tag and IMU data fusion provides reliable **GPS-denied navigation**, further extending applications for developed UAV-centric technologies

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