

NRI: FND: COLLAB: Multi-Vehicle Systems for Collecting Shadow-Free Imagery in Precision Agriculture

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Project Website & Publication List: <https://publish.illinois.edu/mvscsfipa/>

Challenge

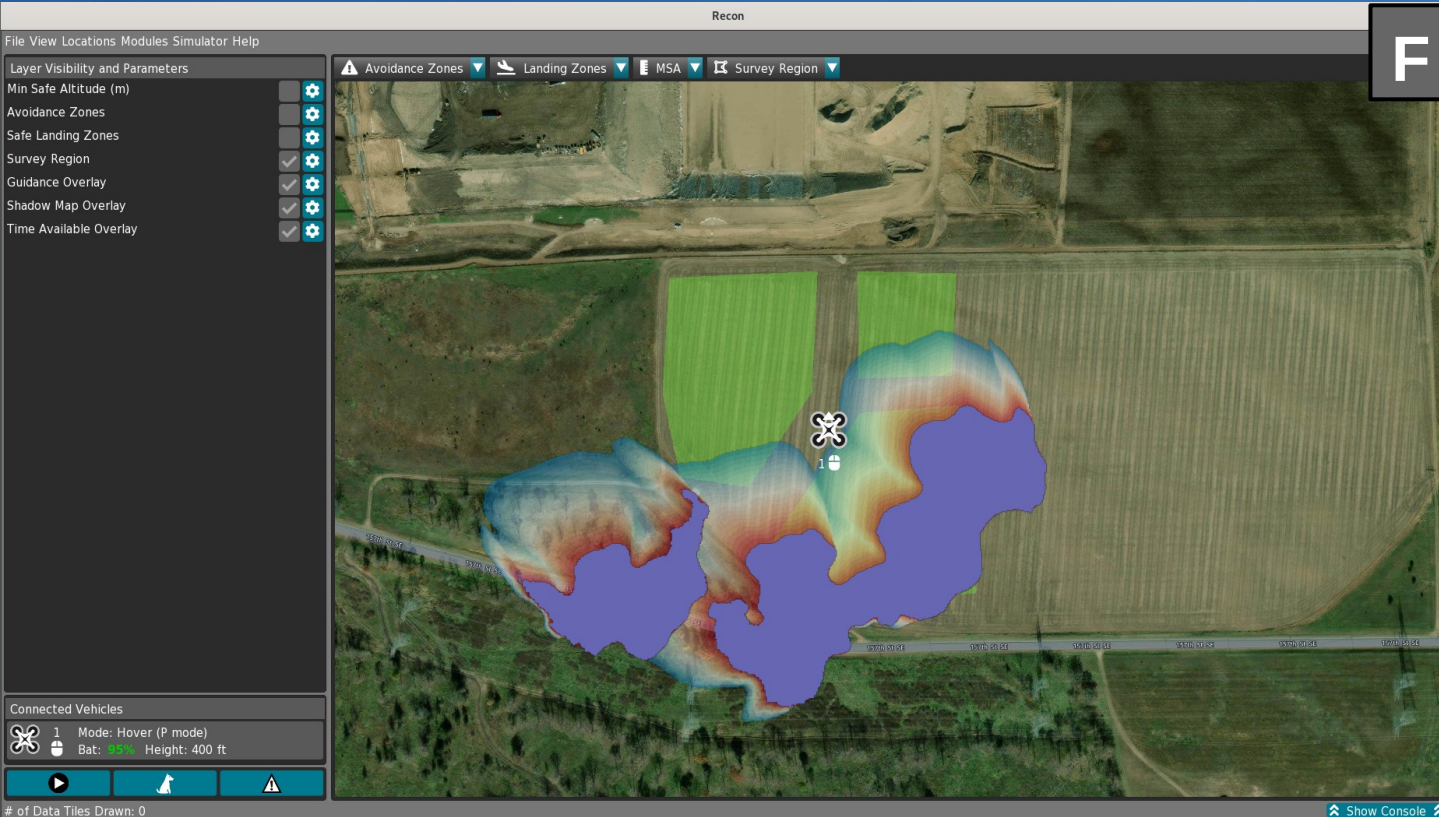
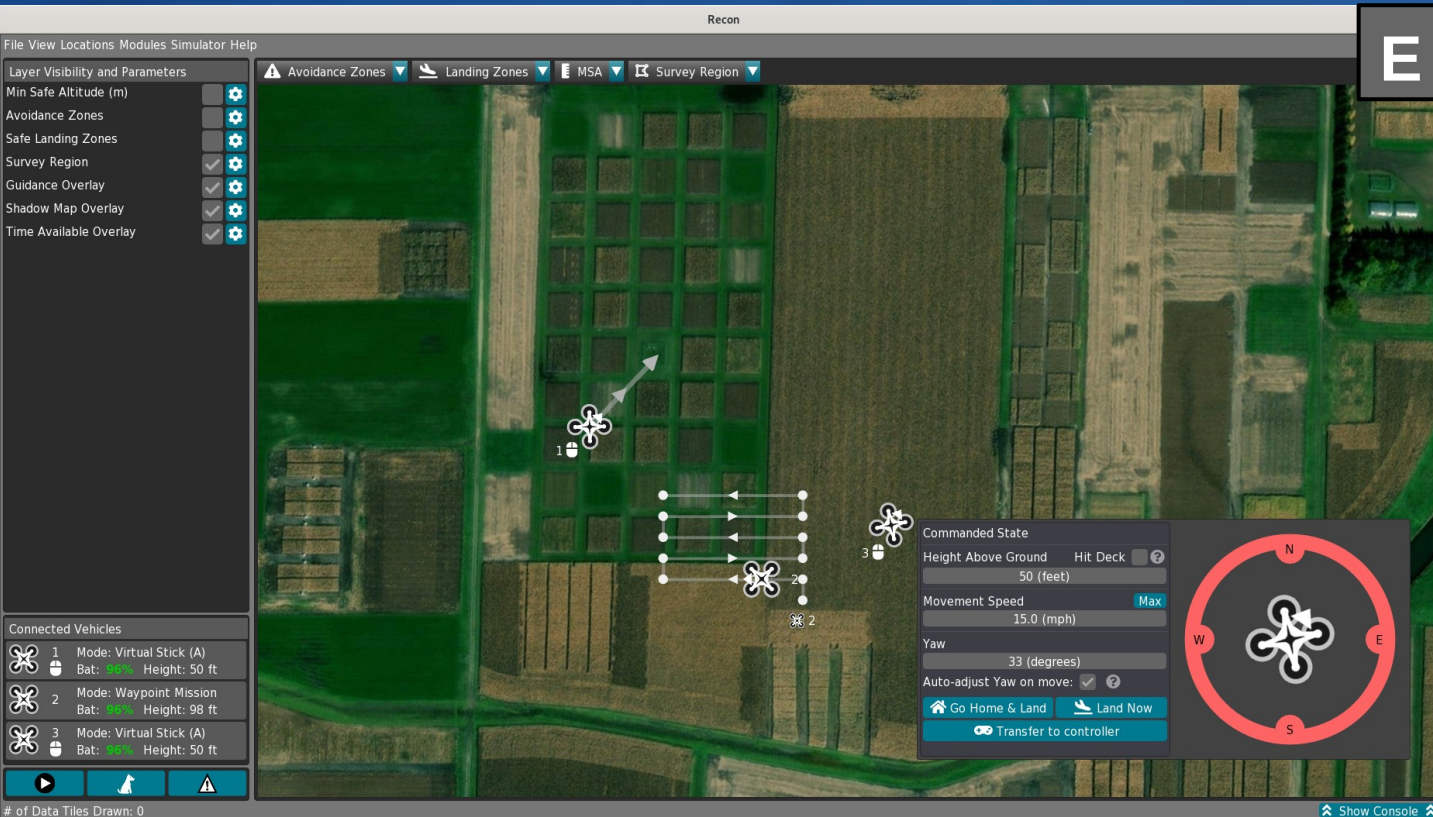
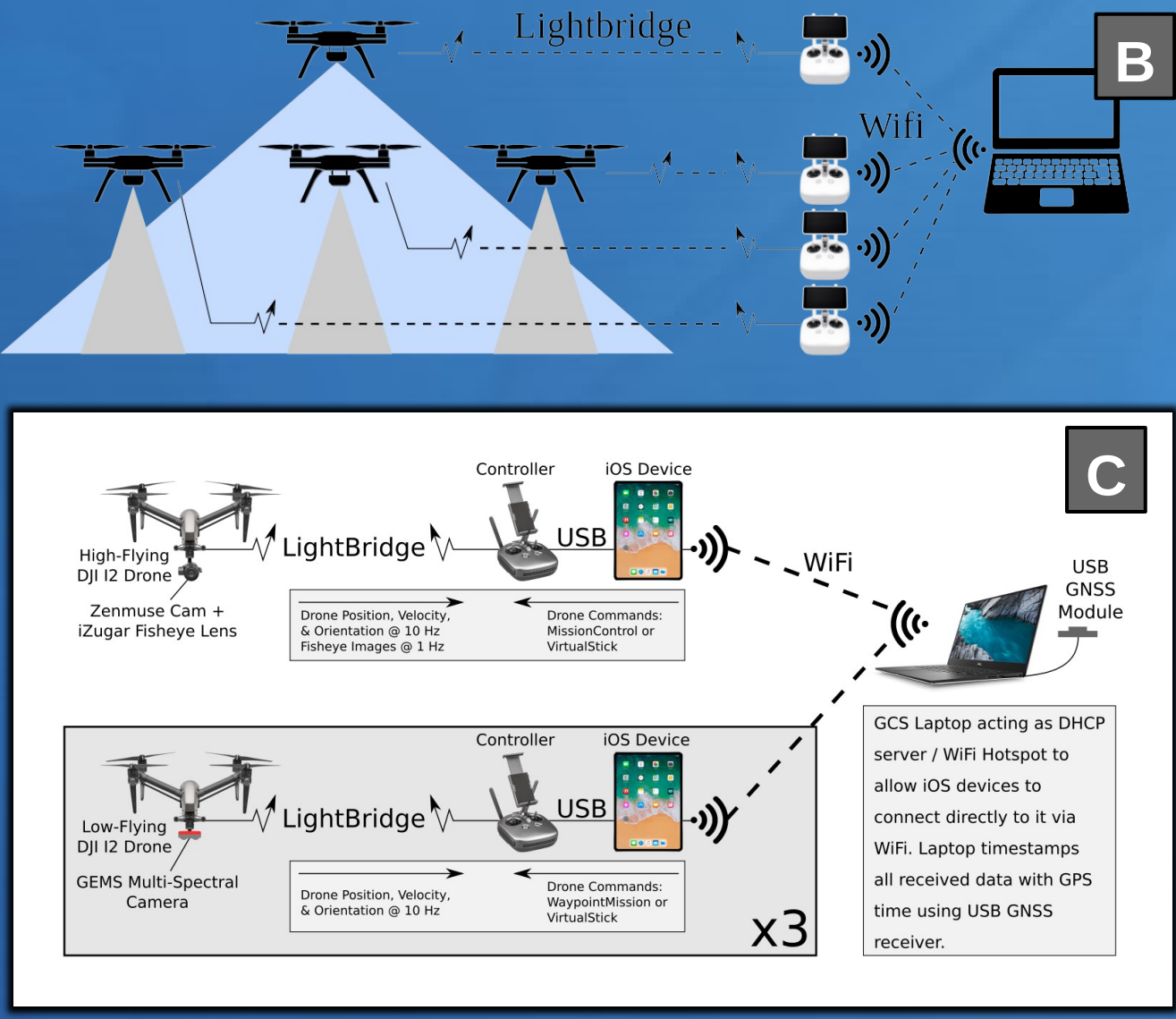
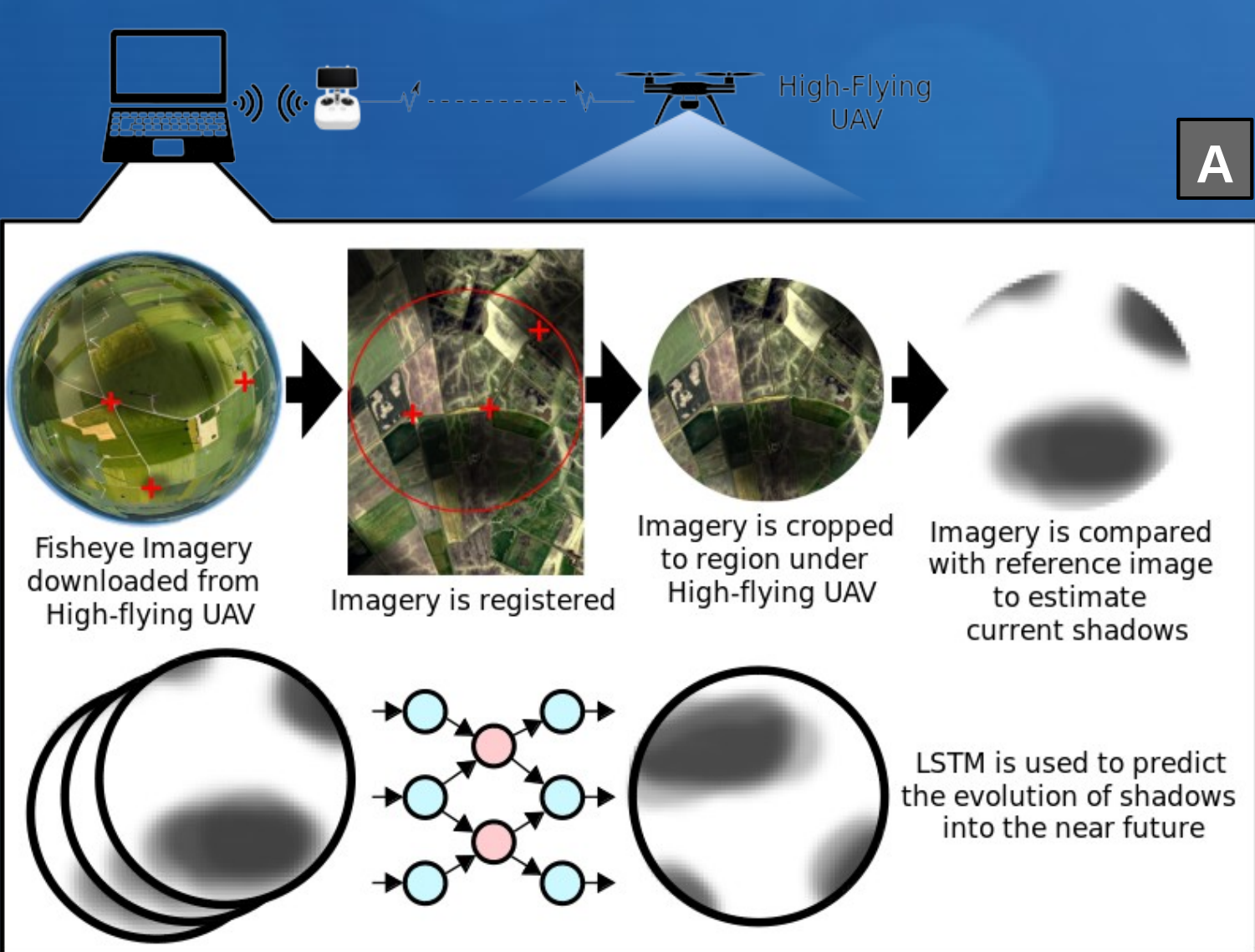
- Aerial imaging with multi-spectral cameras is widely used to detect crop nutrient deficiencies and other crop problems in precision agriculture
- Clouds cast shadows on the ground, confusing interpretation of multi-spectral remote sensing data
- Multi-objective control of multiple vehicles based on neural network predictions

Solution

- Detect cloud shadows on ground using downward-looking fisheye imagery from a high-flying drone
- Predict the evolution of shadows into the future using LSTM NNs
- Novel closed-form control laws for a team of drones to collaboratively image area, avoiding shadows, to enable shadow-free reconstruction and stitching
- Stability and performance guarantees for neural networks used in time-varying prediction algorithms

Scientific Impact

- Formal characterizations of the typical behaviors of neural networks and dynamical systems used in machine learning algorithms
- New closed-form multi-objective and multi-agent control design
- Novel application of reinforcement learning techniques to coverage control problem and comparison with classical traveling-salesman-based approach.



For more information on the Recon multi-vehicle GCS, developed under this program, see it on Github: <https://github.com/poli0048/Recon>
For an in-the-field video demonstration of Recon, see it on YouTube: <https://www.youtube.com/watch?v=aSOjmPsa1Go>

Broader Impact - On Society

- Enable the simultaneous use of multiple, collaborating robotic vehicles in precision agriculture, making it possible to scale up drone-enabled precision agriculture practices to realistic, industrial-scale fields
- Promote broader adoption of remote-sensing-based crop nutrient management solutions, thereby reducing excess nutrients left in the environment and reducing fertilization costs for farmers
- Quantification:** Triple the amount of usable multi-spectral imagery that can be collected per drone by farmers and agronomists in a season by enabling data collection in a broader range of weather conditions

Broader Impact - Education & Outreach

- Development of new educational materials in robotics and control with strong emphases on applications of robotics in precision agriculture
- New module for UCB Girls in Engineering summer program for middle school girls and contributions to Women in Engineering at Illinois programs and Engineering Open House at UIUC