NRI: INT: COLLAB: Leveraging Environmental Monitoring UAS in Rainforests

Brittany Duncan and Carrick Detweiler
School of Computing
University of Nebraska, Lincoln

Gretchen Miller
Civil and Environmental Engineering
Texas A&M University

Joshua Peschel
Agricultural and Biosystems Engineering
Iowa State University

Motivation

Rainforest canopies are important ecosystems for diverse plant and animal life, however validating the model-based predictions for scientific decisions about these environments is difficult due to a lack of efficient data collection methods.

Key Problems

This proposal presents a vision aimed at advancing heterogeneous multi-Unmanned Aerial Systems (UAS) technologies, practices, and understanding to increase the reach of human sensing in challenging, hard-to-access environments while increasing scientific understanding of forest canopy health.

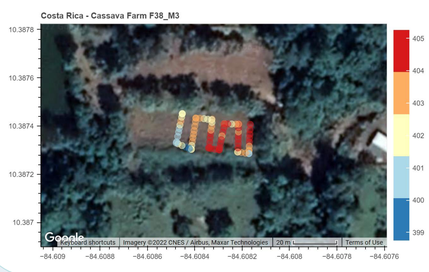
The vision addresses key goals in co-robotic system development:

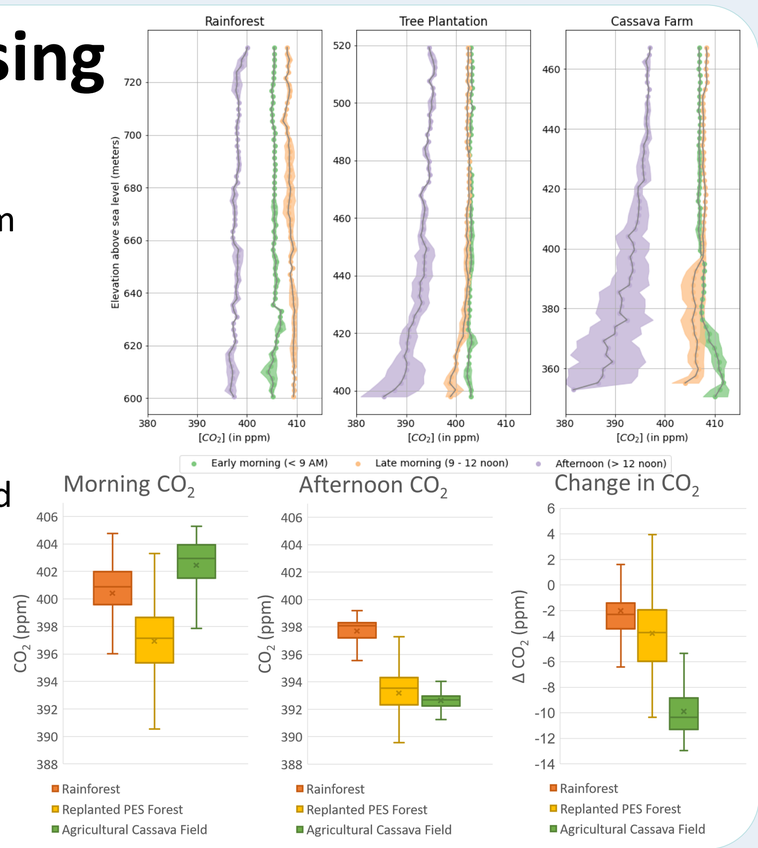
- the available attention of the humans involved,
- site selection for complementary sampling,
- and improvements in robot design and decision making for sample collection

These goals will be developed in local environments before being refined in yearly tests in the harsh, dense forests of Costa Rica, while contributing to progress in fundamental co-robotic challenges.

Scientific Sensing

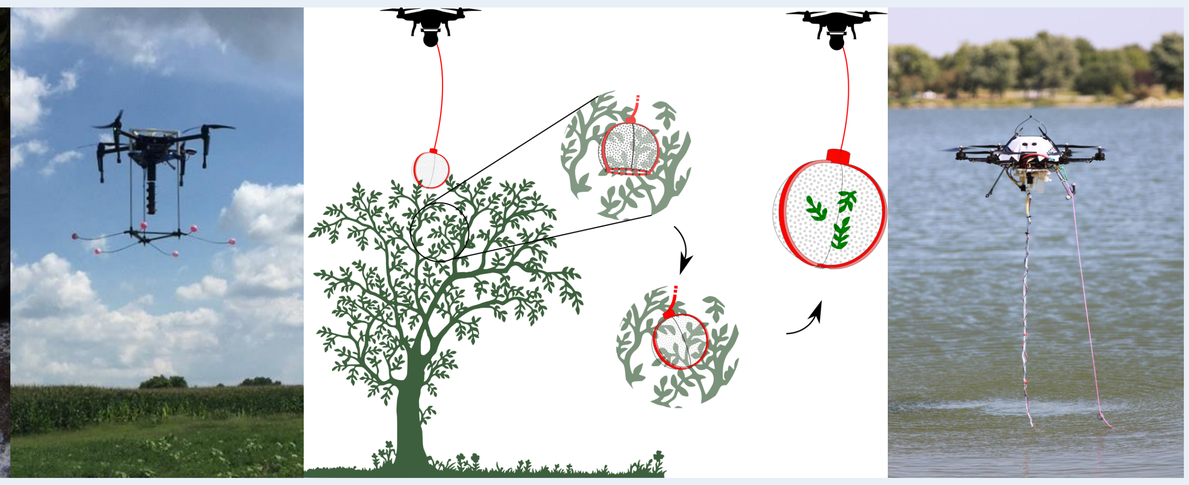
The rainforest appears to have lower rates of carbon uptake than the cassava farm or tree plantation. This is consistent based on both time of day and altitude of sensing. Data such as this can inform decision-making for carbon sequestration and climate change.





Expected terrain for deployment.

Example water collection site.



Concept designs for soil, leaf, and water sampling.

Solution

The proposed activities will result in:

1. Timing rules and motion-based communications for conveying multi-UAS intention and knowledge to end-users,
2. Perception algorithms that map the environmental knowledge and domain expertise of a scientist into a fleet of vehicles to support semi-autonomous collection of samples above and below the canopy,
3. Vehicle innovations to improve mechanisms and algorithms for sample collection in new contexts, and
4. Improved data collection in forest canopies to advance the science of plant hydraulics and streamflow generation.

The proposed work will advance the NRI 2.0 Co-Robotic agenda, through focusing on scalability of both systems and teams, inspired in the context of UAS-based forest canopy monitoring, taking a multidisciplinary approach that requires efforts at the intersection of robotics, computer science, systems engineering, and forest ecohydrology and management.

Initial Robotic Results

1. Initial trials have given insight into user perception of motion-based communication based on shape, viewing angle, and distance. These findings will be integrated into field trials in the next year.

2. Development of a pipeline for generation of realistic forest data, then augment real world data with synthetic depth to select areas for sampling, which will be deployed this summer.

3. Investigation of canopy-aware sensing methods to maintain distance above canopy while sampling and testing of entanglement-resistant leaf sampling, both planned for deployment this summer.

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Nebraska Intelligent MoBile Unmanned Systems Lab
nimbus.unl.edu