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

Brittany Duncan and Carrick Detweiler
Computer Science and Engineering
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 Impact

Access is limited due to:

- remoteness,
- dense foliage,
- and venomous wildlife

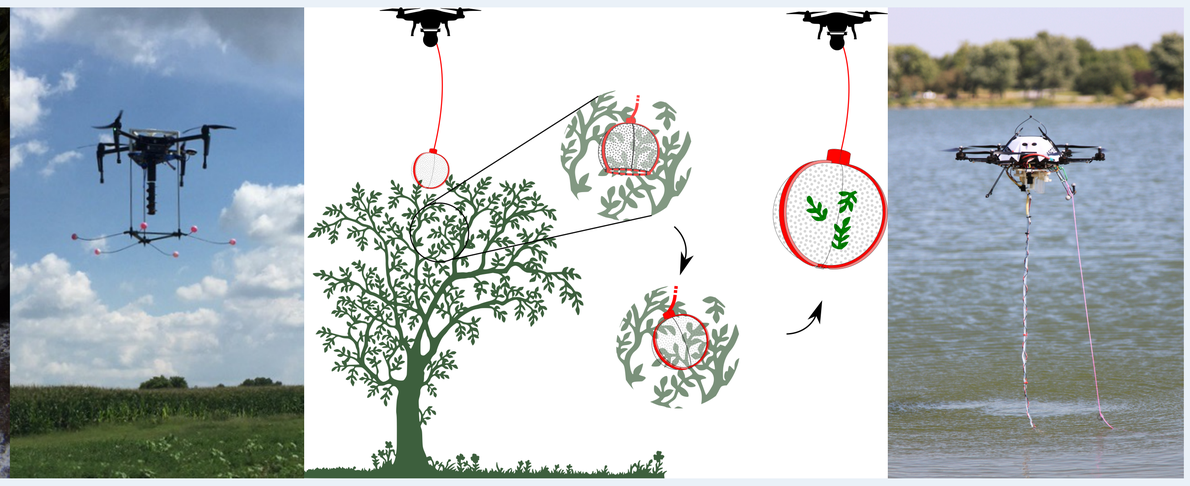
Currently, most data is collected within 50 meters of trails and 5 meters from the ground surface due to these limitations, making spatially explicit measurements sparse at best.

UASs have been used for sensor deployment and monitoring. Collecting samples at precise locations is a recent development by the project team.

This system will aid in obtaining soil, water, and leaf samples from coordinated sites to ensure coverage, enabling spatially distributed collection in areas where it is currently too costly or dangerous.

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.

Broader Impact

- A group of approximately 20 scientists will be exposed to the technology, trained through field trials and given access to the unique dataset produced through this work, and 10 will be more extensively trained on the UAS.
- Data will reach a broader community through the planned participation in workshops and the curation of the collected data and experiences, which will be made available online.
- At least four graduate students will be directly involved in conducting multidisciplinary research, along with undergraduates at two REU sites.

Funded under
National Robotics Initiative
Award ID: 1925368

Nebraska Intelligent MoBile
Unmanned Systems Lab
nimbus.unl.edu