Developing a Robust, Distributed, and Automated Sensing and Control System for Smart Agriculture

Ali Karimoddini, Leila Hashemi Beni, and Abolghasem Shahbazi (North Carolina A&T State University)

https://www.nsf.gov/awardsearch/showAward?AWD_ID=1832110

Challenges:

- Developing a distributed airborne networked sensor system and an effective planning mechanism for a team of UAVs to monitor a farm
- Processing the high-resolution aerial imagery information collected by heterogeneous sensing systems and decision-making

Scientific Impact:

Our CPS project enables the coordination of UAVs with different capabilities and payloads for regularly surveying the entire farm for assessing crop health and growth to possibly detect zones with damage or nutrition deficiency.

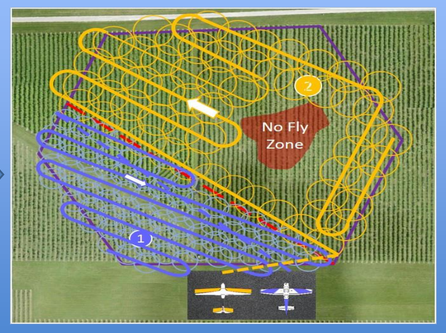
Solution:

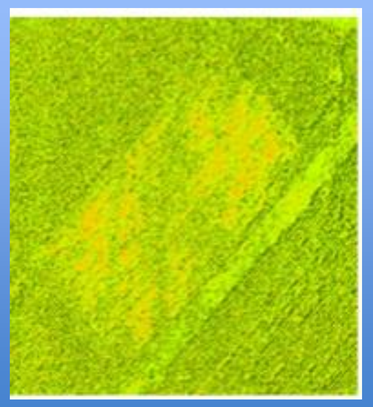
Sensing requirements

Safety constraints

Optimal Decision-making and Path Planning for Cooperative Control of UAVs

UAV capabilities and physical constraints





- Monitor and evaluate the condition of a farmland
- Determine crop yield for different block treatments
- Crop growth monitoring from planting to harvest
- Weed detection
- Crop lodging detection

Results:

- Developed an area-decomposition based approach for cooperative tasking, planning, and coordination of UAVs to monitor a Farm
- Developed semi-formal BT-based safe decentralized tasking of autonomous vehicles.
- Developed a comprehensive workflow for UAV data acquisition
- Developed effective sensing techniques for precision agriculture using ML and DL approaches.

Broader Impact:

- Developed approach for airborne monitoring of agricultural fields minimizes deployment of on-the-ground operations, avoiding damaging crops on healthy parts of the farms and enabling the detection of crop issues at early stage,
- Worked with 48 graduate and undergraduate students in the project; mentored several senior design projects; and developed teaching modules for coordination of AVs and smart agriculture.