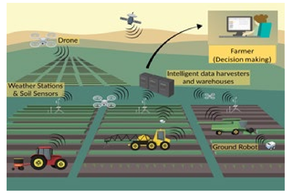
Smart Integrated Farm Network for Rural Agricultural Communities (SIRAC)

A.K. Singh, Iowa State University

Award Type: IRG, [NSF Award ID: 1952045]

Project Challenge

Farmer to farmer connectivity and information exchange is sub-optimal



Intellectual Merit

SIRAC creates a smart and connected farm network that facilitates data sharing, knowledge exchange, and coordinated responses to production threats. **Goal 1**: Efficiently and cost-effectively improve management practices and crop yield. **Goal 2**: Contribute to community-led decisions on biological pest spread and mitigation and nutrient and water stresses.

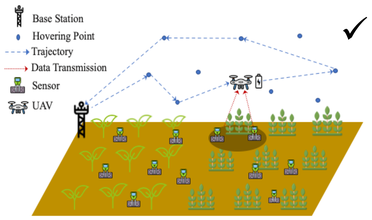
Use-Inspired Research

SIRAC was formed with the active involvement of Iowa Soybean Association, an organization with 10,000 farmers.

- ✓ Enable real-time monitoring of threats to farm production, which is critical for dealing with pests, diseases, weather, and management issues.
- ✓ Privacy-preserving data analytics for community-level decision-making across farms and monitoring real-time threats.
- ✓ Translational research to develop actionable knowledge through a feedback loop between researchers and decision makers in the farming community, informed by analysis of attitudes and trust, and behavioral economics.

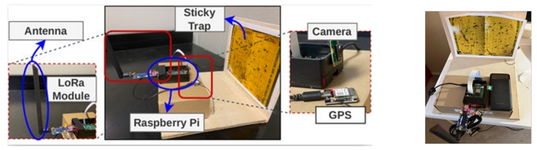
Major Outcomes/Progress

DRONE– UAV aided data collection



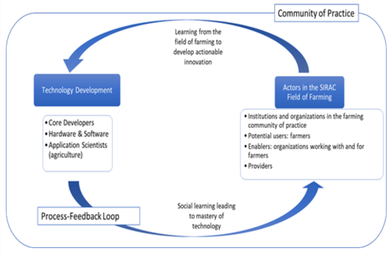
- ✓ DRONE optimally selects a subset of sensors to visit within the UAV's energy capacity and estimates the observed measurements generated by other sensors.

Insect detection and Data Privacy



- ✓ Developed on-device privacy-preserving insect classification algorithms using federated, split, and dynamic split learning approaches, ensuring robustness and privacy in data handling.

Farmer Feedback Experiments



Discrete Choice Experiment with 39 commodity farmers

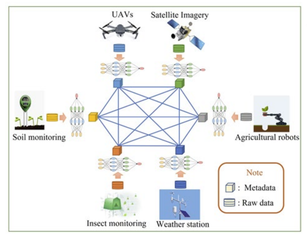
- ✓ Increase likelihood of adoption if network is managed by research institution or membership organization rather than private company.
- ✓ Decrease in likelihood of adoption if network if managed by government. Higher costs.
- ✓ To increase online recruitment ISA has done targeted social media adds as well as effective use of email listing that reaches 10,000 farmers. At this time we have had over 1,200 people sign up to participate.
- ✓ Pivoted to online virtual event for economic games.

LoRa based Networking

Long-Range LoRa Testbed

- ✓ LoRa for remote areas communications: low power consumption, extensive communication ranges (5-10 Km), and cost-efficient deployment.
- ✓ LoRa-based testbed composed of LoRa Node and Edge Server to transfer agricultural data facilitating the development of intelligent agricultural applications - insect detection, crop disease identification.

AI Decision Support Tools



- ✓ To enhance speed and effectiveness of decision-making- proposed Decentralized Iterative Merging-And-Training (DIMAT) for decentralized DL.
- ✓ DIMAT utilizes activation matching to merge models without requiring additional training.

Broader Impact

- ✓ Farmer to farmer connections for information sharing.
- ✓ Members participated in the NSF I-Corps program - awarded a $50,000 grant for customer discovery. We engaged with 115 AgTech stakeholders, including growers, entomologists, and industry professionals.

Future Goals

- ✓ Demonstrating tools and technology that enables connectivity and information sharing.
- ✓ Farming strategy recommendation system.
- ✓ Surveys and economic analysis that relate to smart connected farms.