CPS: Frontier: Collaborative Research: COALESCE: COntext Aware LEarning for Sustainable CybEragricultural systems

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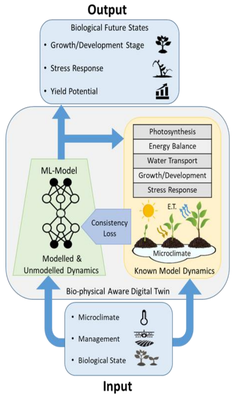
Introduction:

The COALESCE project seeks to transform CPS capabilities in agriculture by developing a novel, context-aware cyber-agricultural system that encompasses sensing, modeling, and actuation to enable farmers to respond to crop stressors with lower cost, greater agility, and significantly lower environmental impact than current practices.

Goals and Objectives

- Embed biophysics in machine learning for individualized crop modeling
- To apply multi-modal information fusion and robust learning for individualized sensing
- To implement data-driven, multi-scale planning and reasoning
- To develop individualized sensing and actuation via autonomous robots with dexterous manipulators

Technical Approach

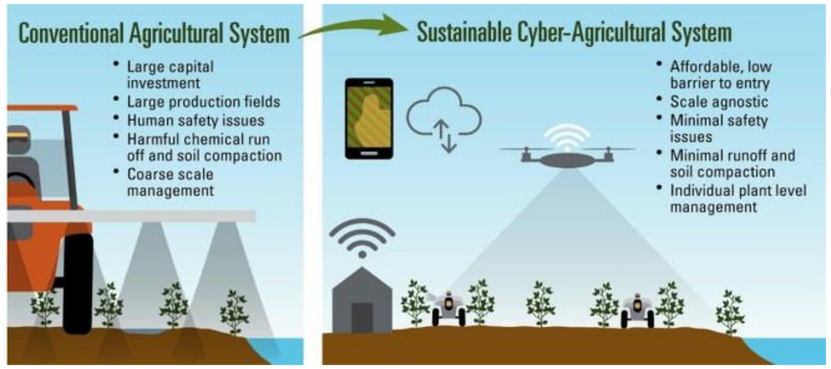


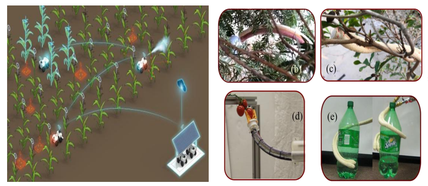
- Extraction and fusion of cross-modal features for robust perception
- Biophysics-aware ML models at individual plant/plot/field scale
- Reinforcement learning for supervisory decision support

Broader Impacts

- CPS innovations transferable for diverse applications
- Knowledge dissemination - CPS community, farmers, public
- Formal and informal education efforts for next generation workforce and farming community
- Technology commercialization
- New benchmark datasets for Cyber-Ag community

Project Overview





- Adapting multi-robot coordination
- Soft and dexterous robotic manipulators
- Networked system for autonomous ground robots
- Scalable cyber-agricultural cyberinfrastructure

Key Innovations

- Individualized sensing using multi-modal data fusion and robust learning
- Multi-scale ultra-precise farm management planning
- Individualized actuation using dexterous robots

Key Performance Indicators

- Reduction in chemical application by at least 30%
- Increase crop yield by at least 10%
- Reduce soil compaction by at least 30%

Education & Workforce Development

- Lead PI Sarkar leading the development of an Undergraduate minor on Cyber-Physical Systems at Iowa State that will begin in Fall 2021
- CPS-Ag courses will be co-developed between ISU-UIUC-UAz
- CPS adoption for farmers will be done through the ISU and ISA extension and outreach network.
- Community building will be done via MLCAS, CPS Ag workshop
- Multi-institutional plan to involve women, African American, Hispanic and Native American students in computing and engineering

Multidisciplinary Team

- Soumik Sarkar (ISU)
- Girish Chowdhary (UIUC)
- Baskar Ganapathysubramanian (ISU)
- Asheesh Singh (ISU)
- Girish Krishnan (UIUC)
- Kris Hauser (UIUC)
- Radhika Mittal (UIUC)
- Nirav Merchant (UA)
- Edwin Skidmore (UA)
- Aditya Johri (GMU)
- Arti Singh (ISU)
- Darren Drewry (OSU)
- Peter Kyveryga (ISA)
- Daren Mueller (ISU)

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