Integrated Design of Sensing, Network, and Cooperative Control of Multi-Vehicle Systems for Preventing Frost and Freeze Damage to Flowers and Buds of Fruit Trees

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Challenges

Among many weather-related risks, frost events can damage crops significantly and lead to substantial economic losses. The project integrates autonomous vehicles, real-time data analytics, decision making, and Internet of Things (IoT) communications to fulfill its vision of significantly reducing the cost and increasing the precision of frost protection of fruit trees.

Solutions

The level of frost damage is not only related to intensity and duration of a cold event but also flower developmental stage of flower buds. The proposed system consists of two UAV-based sensing units to monitor temperature and stages of flowers, an autonomous ground mobile unit to perform heat treatment, and a base unit (Fig. 1).

Scientific Impact

Frost protection using a novel combination of a multi-vehicle system for sensing, mission planning, and control in real-time is a unique application and has never been tested in orchard conditions. The developed system will be transferable to various sizes of orchards and types of crops as long as the appropriate hardware is available.

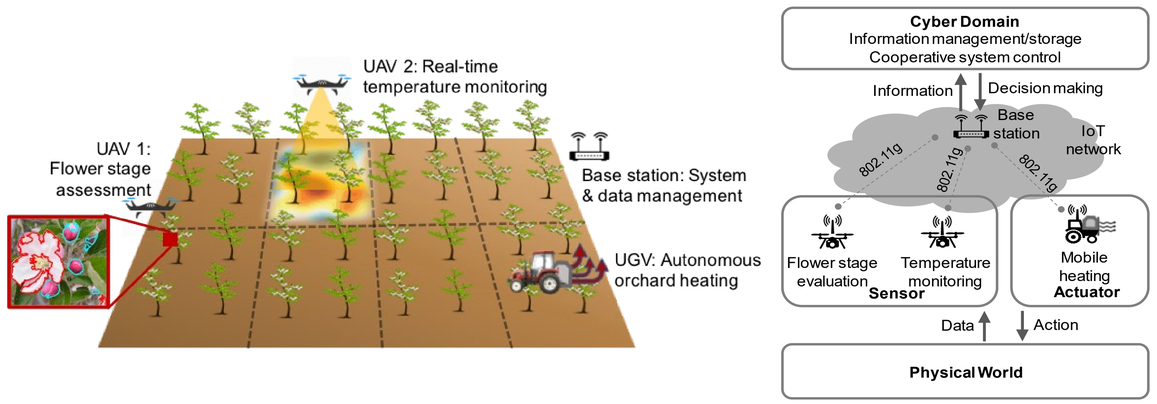

Fig. 1. Overview of the proposed CPS system for frost protection in an apple orchard.

Broader Impact on Society

Every year, the U.S. produces an average of 15 million tons of deciduous fruit. Higher efficiency in frost protection can potentially provide significant economic impacts to the industry as well as rural communities.

Broader Impact on Outreach/Education

Stakeholders will benefit from training and learning opportunities through workshops held by extension faculty. Also, our team is enthusiastic in recruiting underrepresented and minority students.

Broader Impact – Potential Impact

If the proposed technology improves 10% of the efficiency in current frost protection system, the potential economic savings can be $25.1M/yr based on the annual insurance payments for frost damage on deciduous crop.

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