Automated Solid State Canopy Delivery (SSCD) System to Deliver Mist-Cooling to Increase Winter Chill for Dormancy and Bud Break

Yiannis Ampatzidis, Associate Professor, Department of Physics and Engineering, California State University, Bakersfield (CSUB)
Louise Ferguson, Extension Specialist, UCCE, UC Davis
Lu Zhang, Postdoctoral Scholar, UCCE, UC Davis
Reza Abdolee, Assistant Professor, Electrical Engineering Department, CSUB
Emerson Argueta, Research Assistant**,** CSUB

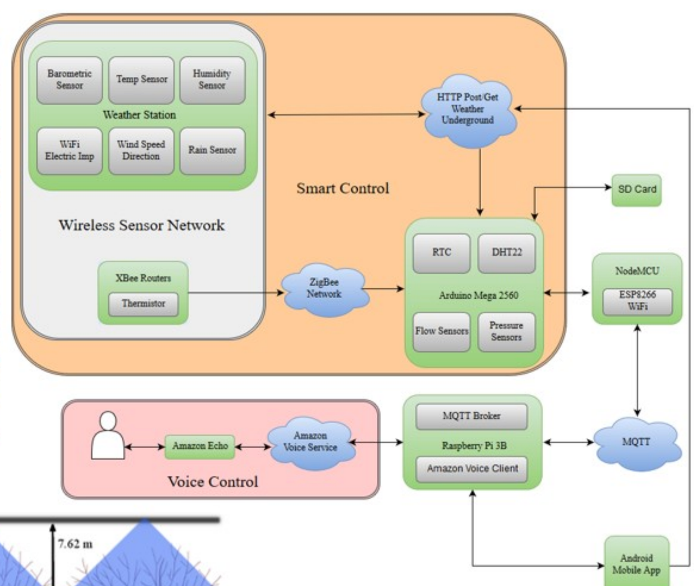
INTRODUCTION

As the Central Valley fog disappears, the chill accumulation required for dormancy breaking is decreased resulting in abnormal flowers, poor bloom synchrony, high rates of blanks and lowered yields. Kern County has been experiencing higher than average winter temperatures and is predicted to undergo an average increase of 1.8 °C to 4.5 °C annually (Cal-Adapt, 2017). It appears this warmer climate was the primary factor in the drop in California's 2015 pistachio production; 47percent from 2014 to 2015 (California Department of Food and Agriculture, 2016). We examined the ability of the user-friendly low-cost wireless Solid Set Canopy Delivery (SSCD) system to cool down bud temperatures on sunny (winter) days.

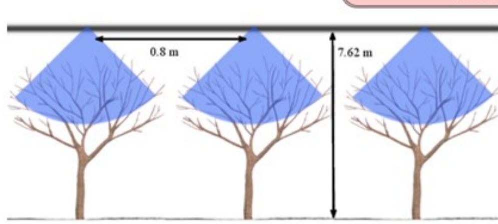
METHODS

The proposed Voice-Controlled and Wireless Solid Set Canopy Delivery (VCW-SSCD) system includes (Fig. 1):

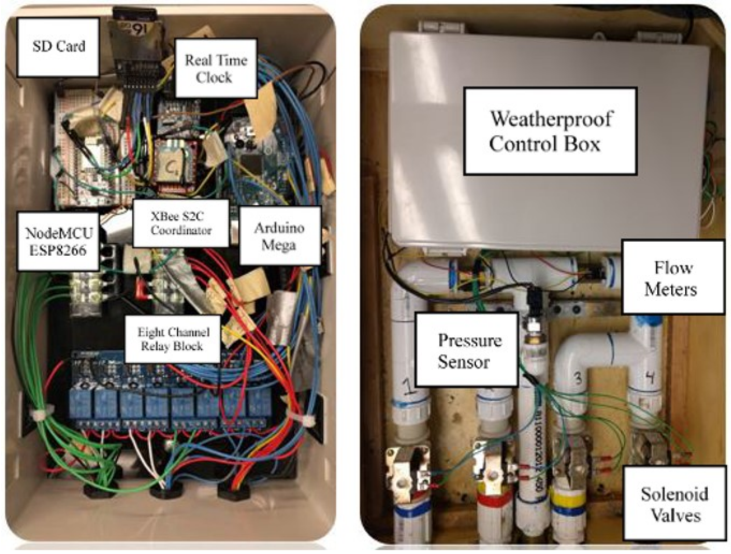
i. A SSCD system (Fig. 2) to apply mist and cool down the bud temperature.
ii. A Wireless Sensor Network (WSN) and a Weather Station (WS) to collect weather- and crop-related data from the field (several zones).
iii. A Voice-Controlled (VC) system using Amazon Alexa (Amazon Echo) and a server.
iv. A mobile app (Android; Fig. 3) to visualize the collected data and control the SSCD system.
v. A Smart Control (SC) system (Fig. 4) to collect the data from the WSN, receive commands from the VC and control the SSCD system. It communicates with the mobile app too.



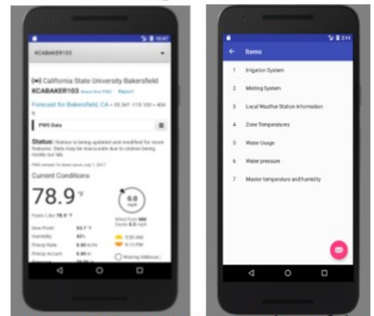
Right: Figure 1. System Block Diagram. The Smart Control (SC) system collects data from the Wireless Sensor Network (WSN) and the weather station, receives voice commands from the Voice-Controlled (VC) system, communicates with the mobile app, and wirelessly control the SSCD.



Left: Figure 2. Mounting emitter configuration of the pilot SSCD system.



Left: Figure 4. The Smart Control (SC) System includes an Arduino Mega 2560 microcontroller, a node MCU Wifi module, a XBee S2C, a real time clock, 8-channel relay block, solenoid valves, flow meters and pressure sensor.



Above: Figure 3. Screenshot of the mobile app: weather station data.

The Android application was developed to retrieve the collected data from our server (Raspberry Pi 3; data from the WS and WSN), visualize them and display all the information in graphical format (using the Androidplot software), and provide real-time data to the users. It can also control the SSCD system remotely (turn on/off the water valves). The Android application includes a user-friendly graphical interface (Fig. 3); JSON parsing (in Android Studio) was used to retrieve data from the Weather Underground web-software and our server. The mobile application is module based, allowing users to access real-time data, control water valves, and perform analysis. The user is able to view reports from certain periods of time—hourly, daily, weekly, monthly, and yearly.

RESULTS

We deployed this system in an orchard (Bakersfield, CA) that is divided into 8 zones. Each zone includes a different type of sprinkling nozzle to evaluate the effectiveness of different nozzles in wetting the trees and the effect of them on the tree's evapotranspiration. Each zone also is assigned a valve that is controlled by the SC.
We will evaluate this system during 2017-2018 season and measure:

- The duration of misting (hours/treatment) at different temperatures.
- The intervals between applications to conserve water (hours/days); and determine when evaporative cooling ceases at different temperatures.
- Droplet size for maximum evaporative cooling duration.
- Amount of water applied (volume, ha-cm) per application.
- Volume of mist and energy consumption per treatment and per tree.
- Flower quality evaluation (bloom synchrony, pollen and ovule viabilities).
- Postharvest fruit quality data (tree yields, nuts grading by processing factory).
- Investigate potential salinity and toxicity problems (water, soil and plant analysis).

CONCLUSION AND PRACTICAL APPLICATIONS

The main goal of this project is to develop a novel Wireless Solid Set Canopy Delivery system to deliver mist-cooling, and to evaluate the effectiveness of the misting system (different types of nozzles, system configuration, etc.). We developed and deployed the SSCD system in a commercial pistachio orchard in Bakersfield, CA; we will evaluate it during 2017-2018 season. This system will help California growers to further understand, and perhaps manipulate, the chilling requirements for pistachio.