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A canopy protection cyber-physical system (CPCPS) for smart agricultural management of frost damage in an apple orchard

Dissertation presented to The Pennsylvania State University, University Park, Pennsylvania, USA

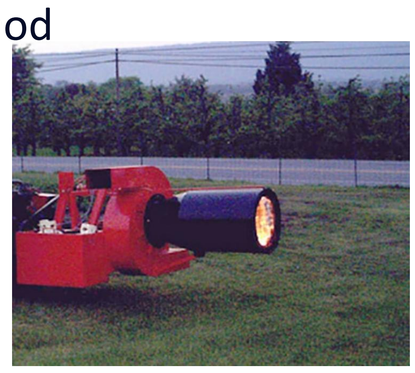
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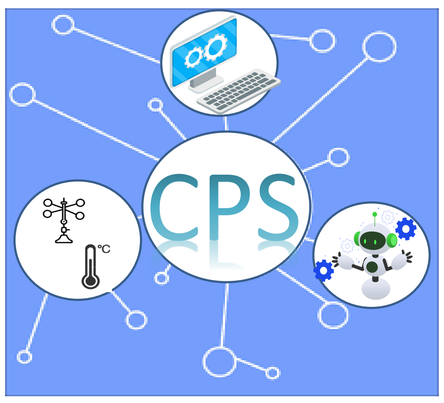
1 Introduction

- Frost causes huge economic loss in agriculture
- Heating is an effective protection method
- Growers determine when and how to heat based on their experiences and available labor, leading to either insufficient heating or wasteful energy









- A cyber-physical system (CPS) is to combine sensor networks with embedded computing for monitoring the environment and improving the efficiency of the mechanical equipment

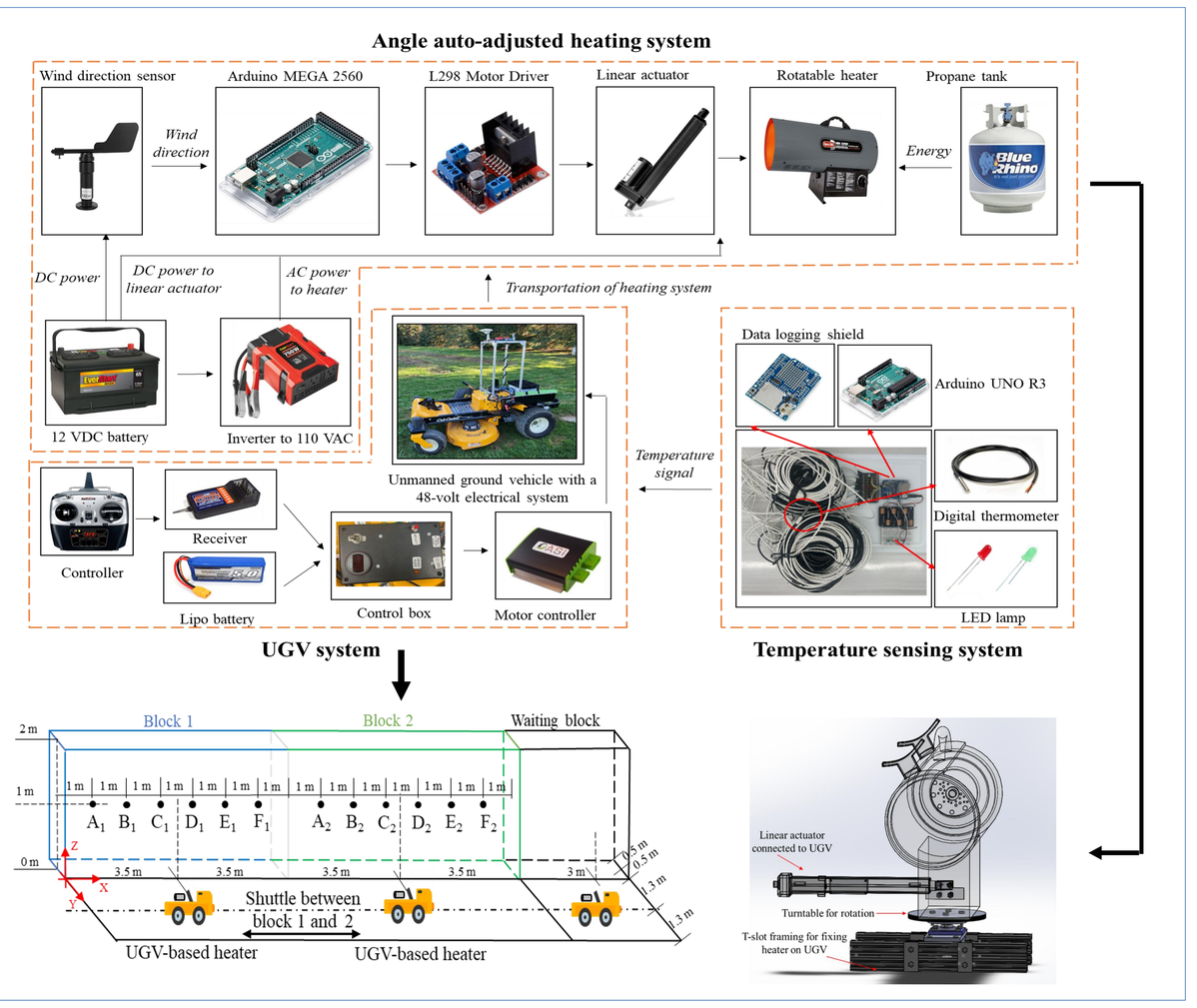
2 Objectives

- Development of a real-time temperature and wind direction sensing system
- Development of an angle auto-adjusted and mobile heating system
- Experimental verification of the CPCPS in an apple orchard

3 Significance

- To fill the gap in CPS-based heating in the frost management field
- To reduce the cost of labor for frost management
- To reduce the economic loss caused by frost damage

4 Methodology



5 Results



Compared to the non-CPCPS, the CPCPS effectively enhanced the protection performance during the two low-temperature field tests, resulting in the percentage of protected time γ increasing by 198.8% and 111.9%, respectively.

Evaluation of Protected Performance of CPCPS:

$$\gamma = \frac{t_{protected}}{t_{total}}$$

where $t_{protected}$ is the protected period (s), t_{total} is the total test duration (s)



6 Conclusion and Future Research

CPCPS has the capacity to sense environments (wind/air temperature) and make corresponding decisions based on the environmental data for smart frost management. Full automation of CPCPS by UGV automatic navigation and real-time communication between temperature sensors and UGV.

7 Scan here!

Read the article!
Watch the video!

If you have any questions,
feel free to email Weiyun at wvh5223@psu.edu

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