Application of AI/ML Techniques for Weed Detection and Removal using Aerial and Ground Robots

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Impact on California Agriculture: California is one of the world's largest producers of agricultural products. Accordingly, California's agriculture is also one of the largest users of chemicals and water. In addition, fifty-six percent of California's farmers have been unable to find enough laborers in the past five years. Exposure to dangerous chemicals is another problem. Use of artificial intelligence (AI) and machine learning (ML) in conjunction with aerial and ground robots is helpful for precision farming. The robots help reduce the dependencies on the shrinking labor through automation and mechanization for various on farm tasks including weed identification/removal and precise application of chemicals. Modernization and sustainability of agriculture in future will depend on the use of aerial and ground robots on the farms.

Rationale/Introduction: UAVs or aerial robots can acquire high-resolution images of plants and weeds from farms. They can cover a large area in a short amount of time. Ground robots on the other hand can be used for care of crops, application of chemicals, and weed removal. Collaboration and coordination between UAVs and ground robots can further help minimize the use of chemicals, reduce cost, and reduce dependencies in human labor. For example, UAVs can provide necessary information about the crops such as diseased plants and weeds and their locations while flying autonomously to the ground robots, which can then autonomously navigate to the area for the application of chemicals or removal of weeds.

Experimental Approach: An experimental design with four nitrogen treatments forming main plots and four irrigation treatments forming subplots has been used to grow strawberries. The design results in different level of weed growth at different parts of the plot. A UAV equipped with a high-resolution digital camera was used to collect data from the plot. The collected data was used to develop machine-learning models to detect weeds in the plot using two different machine-learning architectures that support real-time implementation. The developed algorithms also identify the location of weeds. A separate weed detection model for the ground robot is also being developed.

Major Conclusions: The developed machine learning models were able to detect weeds in the strawberry plot with a varying degree of accuracy. The models were deployed on a different UAV that is equipped with a camera and high-performance processor for detection of weeds in real time. The locations of the detected weeds were shared with the ground robot for autonomous navigation to the weed locations and removal. The ground robot is equipped with a robotic manipulator and gripper. This coordination can equally be used for other tasks such as detection of plant diseases and application of herbicides/pesticides.

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