Year 2: Designing a Terrestrial Plant Disease Suppression Robot Using Multispectral Imaging Techniques

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The main goal is to build a robot that can manage plant diseases autonomously for efficient disease management in agriculture. Conventional approaches are time-consuming, laborious, and inaccurate, leading to low crop production and economic loss. The current prototype, where a Jetson Nano was implemented for control and future AI implementations, was successfully tested outdoors in garden conditions where maneuverability, fluid spraying, and image capture quality were evaluated. A low-cost multispectral camera using OCN (orange, cyan, near-infrared) filters was used to provide greater precision when detecting crop health, mainly estimating chlorophyll content. Two YOLOv8 instance segmentation models were trained in a three-stage approach: first on a synthetic multispectral/RGB dataset, then on a synthetic multispectral/RGB plant dataset, and both models finally refining on real multispectral plant data collected in the garden where the robot will operate. OSAVI multispectral index was used with the final training data. At the final stage of model training, the RGB-pretrained model attained mAP@50 of 28.5%, mAP@50-95 of 16.1%, mAP@50 (M) of 27.9%, and mAP@50-95 (M) of 15.1%, while the synthetic multispectral-pretrained model attained mAP@50 of 25.0%, mAP@50-95 of 15.4%, mAP@50 (M) of 23.6%, and mAP@50-95 (M) of 14.3%, showing RGB pretraining led to superior final detection accuracy. The limited final dataset of only 12 labeled multispectral images by the deadline likely affected generalization for both models. On the physical side, I've utilized a new robotic arm design, compressed electronics into a lightweight 3D printed enclosure, and added fluid spraying functionality, all now operational.

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