Integrating AI-Guided Robotics, Mathematical Optimization, and GAN-Based Crop Analysis for Precision Methyl Jasmonate Pest Control in Autonomous Smart Agriculture

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Global pest infestations cause over 220 billion in crop losses and approximately 700,000 human deaths each year. Traditional pesticides not only harm human health and the environment but also incur huge labor costs. Our project integrates Methyl Jasmonate, an eco-friendly pest deterrence compound with an automated vehicle for precise pest control. The first phase of our project was testing MeJA's effectiveness. Two types of positive and adverse data, namely leaf damage area, insect count, plant height, and soil pH were collected over the span of ten days. We quantified pest damage by measuring leaf area loss accurately through a 2-stage Generative Adversarial Network. All data was analyzed using a Gaussian Process Regression along with a weighted score to identify the optimal MeJA concentration for maximum crop yield. The second phase of our project was building an autonomous vehicle for MeJA delivery. The vehicle first traverses a field without spraying, scanning the lanes and assigning them a pest damage score. It then calculates an optimized path using an A-star algorithm that minimizes travel distance and avoids obstacles while prioritizing highly damaged areas. The vehicle has a bi-directional view of the field and is able to change height. Upon pest detection, the Methyl Jasmonate will be sprayed precisely to the affected location. The vehicle trains itself, improving its pest identification ability over time by saving low-confidence detection images, adjusting spray concentration based on an increase or decrease of pest damage among crops. By integrating Methyl Jasmonate with an autonomous vehicle, our project offers a promising strategy to revolutionize future agriculture as well as significantly reducing human harm and labor costs.

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