Convolutional Neural Network Approaches for Smartphone-Based Rapid Detection of Tomato Diseases Supporting Mitigation of Unwarranted Pesticide Usage

Sentil, Sruthi (School: James Rickards High School)

Collectively, around 4.1 million tons of pesticides are applied to crops annually, but less than 0.1% is absorbed by target plants, with residue transmitted well out of intended areas into delicately balanced ecosystems. Current diagnostic practices either rely on the knowledge of experts, which is prone to error, or on laboratory facilities, which are costly and inefficient for the average farmer. Detecting pests early in their development is essential to reduce crop damage and significantly lower the volume of pesticides required for control. Growth in the availability of low-cost smartphones shows AI-based recognition from mobile phone pictures to be a practical option for disease detection. Paired with an attachable 30x phone microscope, costing less than $1, users have an inexpensive setup to capture high-quality imagery. This study assessed 18 Convolutional Neural Network approaches on their ability to distinguish 17 biotic and abiotic issues of tomatoes, a notorious “Dirty Dozen” crop. Manifestations of disease symptoms (n=100) from diagnostically validated plant samples, either on the upper or underside of the leaves or on the surface of fruits, were self-collected and imaged at the 30x level with a smartphone and attachable lens. This validated data was compiled into a dataset of around 10000 images, on which the models were trained and tested. The highest performing model attained an accuracy of 93.45%, significantly greater than that of current diagnostics, and will be exported to a mobile application for widespread use. Globally, this inexpensive approach can be integrated within the pest and disease response for virtually any crop, empowering extension pathologists, farmers, and supply chain management with a reliable tool for efficient disease management.

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