Visualization of infected regions with spectral data

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***Abstract*— Gray mold is recognized as a common disease in tomato production. Once infected, the affected parts change color to a deep brown. However, visual identification of the infection is challenging, making early detection difficult. This study explores the potential of using spectral data to visualize infected regions.**

***Keywords*— Spectral imaging, Tomato, Gray mold**

I. Introduction

Pesticide pollution remains a global concern, with agriculture often identified as a primary contributor to water contamination in numerous nations. Consequently, the European Commission announced the plan to reduce the consumption of the chemical pesticide by 50% by the year 2030. Similarly, Japan's Ministry of Agriculture, Forestry, and Fisheries has set a goal to reduce the use of chemical pesticides by 50% in risk weighted. If it becomes feasible to identify infections before they escalate into disease, implementing environmental management without relying on pesticides could potentially prevent diseases or minimize the need for pesticide consumption.

The hyperspectral camera is widely used in agricultural research due to its ability to evaluate objects across in more than 100 bands [1]. In this paper, we propose a visualization of the infected regions of the tomato leaf by gray mold using the data obtained by a hyperspectral camera because hyperspectral camera is able to detect changes in material properties and object conditions that remain imperceptible through visual observation limited to only 3 bands.

As shown in Fig. 1, the gray mold infection regions typically spread over the course of days. The infected regions cannot be observed by human inspection because it is green as the healthy region, but it will turn brown after a few days. Note that the diseased region is brownish and the healthy region remains green until the end. The spectral data was acquired with a hyperspectral camera, shown in Fig.2. In the disease spectral data, the reflectance of visible light and infrared light decreases compared with healthy and infected spectral data. While visual inspection might suggest that healthy and infected areas share a similar green appearance, there are discernible differences when analyzed through spectral data. Consequently, the visualization of infected areas becomes feasible using spectral data. When dealing with infections, the reflectance of the red wavelengths is higher than in the healthy spectral data, and the reflectance of the infrared wavelengths is higher than in the diseased spectral data.

II. Proposed Method

We show that it is possible to visualize the infected region using NDVI(Normalized Difference Vegetation Index) of the tomato leaf by gray mold. The NDVI = (NIR-Red)/(NIR+Red) which is known to be effective in representing plant conditions. In our experiment, we substitute the value of 750 nm for NIR and the value of 680 nm for Red.

Visualization of the infected region is as follows: First, we generate a heat map using NDVI values. Then, the infected region mask is created in all patterns by changing the threshold value between 0.1 and 0.9 in increments of 0.01, and the coincidence ratio, Precision, Recall, and F value between the actual infected region and the created infected region mask is calculated. Finally, the infected region mask is obtained by removing the vein from the infected region mask with the highest value.

III. Findings

The proposed method was validated on images of 25 tomato leaves infected with gray mold. The results showed an average match rate of 60%, an average Precision of 76%, an average Recall of 75%, and an average F value of 75%. Despite the challenge of visually distinguishing between healthy and infected areas, we were able to demonstrate the potential for visualizing infected areas through the utilization of spectral data.

IV. Conclusion And Recommendations

In the proposed method, the threshold was set manually to examine the possibility of infection visualization by spectral data. For practical use, it is necessary to automate the judgment of the threshold.

Fig. 1. Spread of gray mold disease area

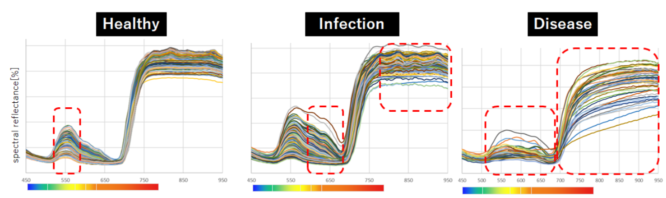

Fig. 2. Spectral data

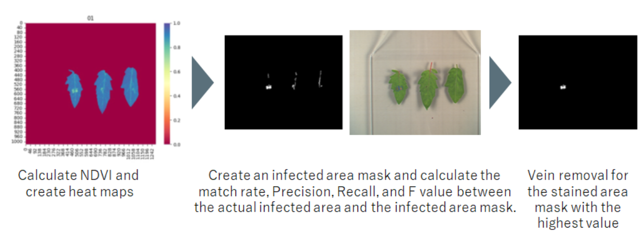

Fig. 3. Data Analysis Procedure

References

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