Application Notes:

Differentiating leaf diseases

Can hyperspectral imaging help in the farming industry? – Acquiring unique surface data of plants and classifying it can be used to detect leaf diseases in very early phases from above the field. Sugar beets are susceptible to diseases such as cercospora, pseudomonas and ramularia. The detection of those diseases is being researched with hyperspectral spectroscopy technology in our project named "MartA" to impel the knowledge and use of hyperspectral imaging technology in precision agriculture.

Learning about:

- Identifying leaf diseases
- Distinguishing between leaf diseases
- Early detection of plant diseases
- Crop protection (Smart Spraying)
- Sugar beet - cercospora, pseudomonas, ramularia

General measurement settings:

- Wavelength range used 450-900nm
- Image taken in milliseconds

Field measurement settings:

- Standard field of view: 1m x 1m
- Resolution: 2cm per pixel

Greenhouse measurement settings:

- Standard field of view: 2,5cm x 2,5cm
- Resolution: 0,5mm per pixel

One of the objectives of the MartA agriculture research project is to achieve a reliable identification of leaf diseases in early phases to minimize the use and harm of pesticides. At the moment, there is minimal differentiation and an extensive, nonspecific use of disease treatment because of missing information about the type and the focus position of a disease. The resulting challenge for a hyperspectral camera application is to differentiate spectra of diseases independently of spectral disturbance factors like containing low/high water or nutrition.

distinguishing different leaf diseases through reflectance measurements

Figure 1: Overview image of an infected spot on a leaf (left). Pseudo RGB image taken with a hyperspectral camera (middle) and a selective spectral view of some specific areas (right). Marked are three dots of diseased area (cercospora) and two non-infected leaf dots.

To accomplish this task, we take close-up images of infected leaves of sugar beets during all growing phases with a hyperspectral camera covering a wide wavelength range (450-900nm). By analyzing the spectral data, we can identify the specific wavelengths and therefore channels which show the biggest differences between the different diseases. A classification algorithm will then have to be trained to use the representative spectra to identify each disease automatically. During this training step, we hope to identify a small number of important wavelength ranges. Using just a few channels makes it possible to use cameras with higher spatial resolution, which in return enables the identification of the diseases from a workable distance like a tractor or drone. Dr. Helmut Schomburg, head of the MartA project gives a simplified summary of the method:

„... every plant disease has a different degree of brightness". (1)

Dr. Helmut Schomburg, process technology engineer (BOSCH) and head of the Marta project

Gathering pure disease spectra is the goal of doing controlled conditions measurements in a greenhouse. This allows to verify Dr. Helmut Schomburgs statement by distinguishing different leaf areas. In the final model the most important spectral components will be chosen and analyzed using methods like 2nd order derivative or principal component analysis.

Leaf and disease differentiation seems to be easy when comparing the spectra of Figure 1. Is it also possible differentiating diseases from one another? This question is analyzed in figure 2

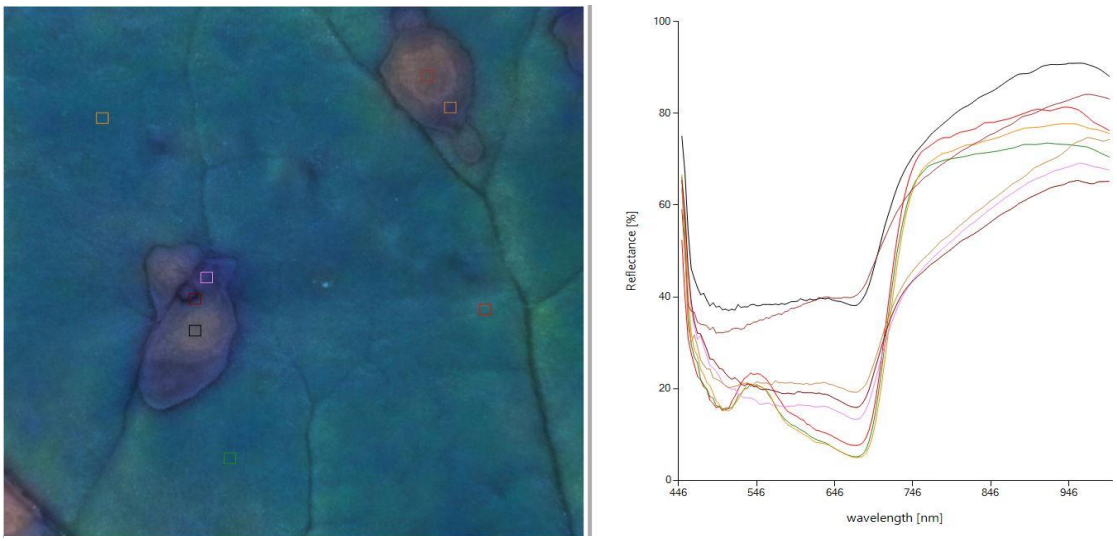

Figure 2: Selected areas of a pseudo RGB image (left) shown on spectral level (right).

The pseudo RGB image on the left contains pseudomonas areas and one cercospora area inside the left pseudomonas area. Selected are three leaf areas which result in the expected leaf spectra shown on the right side. There are also four areas of pseudomonas selected which all show the same spectra. The one cercospora spectrum (2nd from the top at 600nm) clearly differentiates from the others in many bands and the general trend.

Our hyperspectral camera technology provides the possibility to reproducible determine the state of leaves in respective to leaf diseases within milliseconds. It is even possible to distinguish different diseases on spectral level from a fairly workable distance contrary to microscopy or late phase detection methods. Classification through spectral data enables a variety of application possibilities (visit related topics).

For further information on this and other topics, please contact us at: info@cubert-gmbh.de

Tags: labelling, leaf disease detection, classification, distinguish leaf diseases, PCA

Related topics: identifying nutrition of plants, measuring physiological plant parameters

References:

(1). Robert Bosch GmbH. http://www.bosch-presse.de. [Online] 18. Oktober 2016. [Zitat vom: 2017. 02 02.] http://www.bosch-presse.de/pressportal/de/de/hightech-fuer-gruene-patienten-72640.html.

Project Partners: Robert Bosch GmbH - https://www.bosch.com/de/

Universität Hohenheim, Fachgebiet Allgemeiner Pflanzenbau - https://www.uni-hohenheim.de/pflanzenbau/

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