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SmartDDS-Plant Disease Detection via Smartphone

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ABSTRACT

SmartDDS is a three-year-study, financed by the German Ministry of Agriculture. Our ambition is to develop an app for mobile devices that can identify plant diseases by analysing digital images at minimal computational costs. The first aim is to identify fungal leaf spots on sugar beet which are hard to differ like *Cercospora beticola*, *Ramularia betae* and *Phoma betae*. First tests showed promising results with a recognition accuracy of more than 97 %.

Keywords: Sugar beet, smartphone, app, pattern recognition, plant disease, Germany

1. INTRODUCTION

Plant diseases cause worldwide enormous damages and it is a big challenge to control them professionally. Especially in remote areas farmers cannot get the support of experts that could give specific advices. Therefore it would be helpful to evolve a tool that could detect and identify plant diseases by analysing digital images. SmartDDS is such an approach. In this three-year-study, financed by the German Ministry of Agriculture our ambition is to develop an app for mobile devices that can identify plant diseases by analysing digital images. The first aim is to identify fungal leaf spots on sugar beet which are hard to differ like *Cercospora beticola*, *Ramularia betae* and *Phoma betae* (see Fig. 1) . There are several apps on the market that help the user to identify plant diseases by displaying similar disease symptoms as a decision support; but none of those tools is an automated intelligent system.

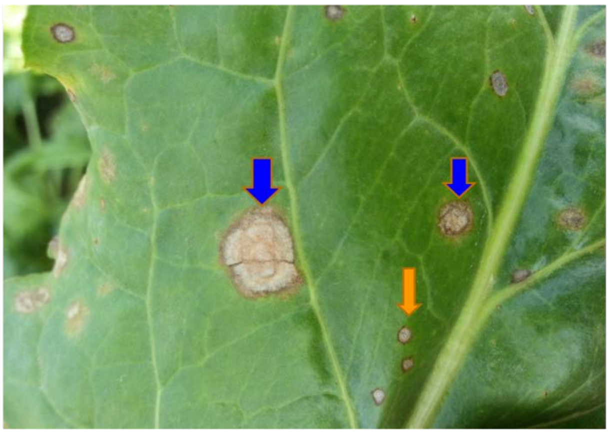

Figure 1. *Ramularia*- and *Cercospora*-leaf-spots (Klatt 2013).

2. MATERIAL AND METHOD

An image database is set up with photos of diseased sugar beet leaves taken in the field in various situations (respecting e.g. angle, illumination, distance). The recorded leaves are taken to a laboratory where the spots are examined and classified by experts. These ground truth data will be used for training a classification algorithm that will be implemented in the app. Using ordinary smartphones or tablet PCs (see Fig. 2), the user will photograph the plant in a certain distance to the symptom. The app will pre-process the images before the data will be sent to a local server for further analysis. This will lower the computational costs and speed up the process. The first step is to down-sample the input image (see Fig. 3) to increase sharpness. A max RGB filter will be applied (see Fig. 4) to pronounce the reddish/brownish image regions which may hint at diseases. Then a binary image will be computed to put the reddish pixels in the foreground and the greenish/bluish pixels in the background. To compute a region image (see Fig. 5) median filtering, component analysis, hole filling, filtering of regions adjacent to the image borders, as well as filtering of regions where the width/height ratio of their bounding boxes is not in the interval [1/2, 2] will be applied. The last step of the pre-processing procedure is to convert the input image to a grey scale image and suppress all pixels in the grey scale image that are background pixels in the region image; then unsharp masking will be applied. The resulting image contains all the information for the subsequent analysis on a local server (see Fig. 6). To extract the features of each region the local binary patterns (LBPs) of the gradient magnitudes will be computed and binned into a histogram to use its entropy as a descriptor. The classification of the leaf spots will be accomplished by thresholding entropy measures of the texture descriptors using naive Bayes-classifiers. The classifier attaches the regions to a certain class which was defined previously e.g. *Cercospora beticola*, *Ramularia betae*, *Phoma betae* or a *reject* class (objects that cannot be classified). The user will receive the result immediately on his mobile device. It is also planned to embed weather based decision support systems like CERCBET1 and CERCBET3 (www.isip.de) to get further information on the epidemiology or a recommendation for the disease management.

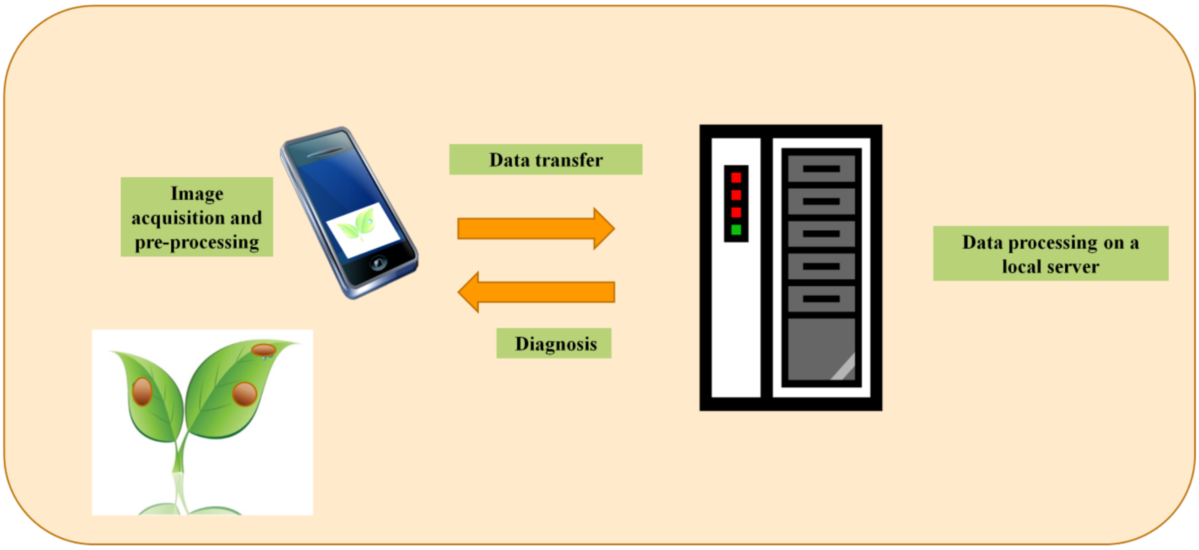

Figure 2. Graphic presentation of the app´s operating mode (Klatt 2013)

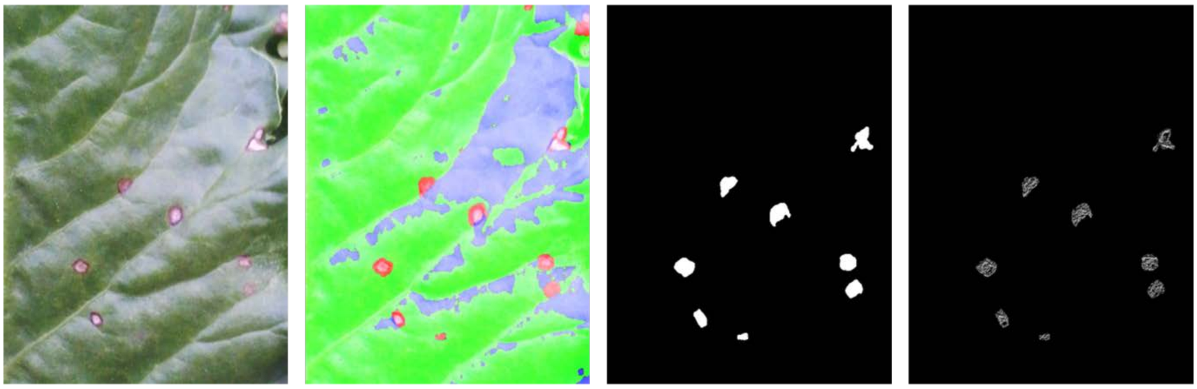

Figure 3-6. Image pre-processing (Bauckhage 2012)

3. RESULTS

First tests seemed to be very promising. With a data set of 20 images containing symptoms of *Phoma betae* and *Cercospora beticola* the presented recognition algorithm achieved accuracy rates of more than 97 % if entropy measures are computed from histograms of 16 and more bins. Image pre-processing, feature extraction and classification were computed in fractions of a second even though the input images were fairly large.

4. CONCLUSIONS AND OUTLOOK

Mobile devices become more and more affordable and the computational power as well as the incorporated digital cameras improve continuously. The app is always available and enables the user to identify plant diseases without expert knowledge. The tool is not designed to quantify the disease incidence or severity. The algorithm will be extended for the detection of further plant diseases and the usability of the app will be improved. This tool can help farmers in remote areas who have no access to expert knowledge. It is neither very time consuming nor expensive.

5. ACKNOWLEDGEMENTS

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