



Hyperspectral imaging for disease detection in seed potatoes

Gerrit Polder¹, Pieter M. Blok², Jan A.L.M. Kamp³, Peter van der Vlugt⁴

Introduction



Virus and bacterial diseases are one of the biggest problems in the cultivation of seed potatoes. Once found in the field, virus and bacteria diseased potatoes lead to rejections of the tubers resulting in a big financial loss. The estimated direct damage caused by diseases for seed potato growers in the Netherlands annually counts up to approximately € 12 million. Currently detection of diseased seed potatoes is done by human selectors, with an annual labor cost of approximately € 6.5 million. Much damage occurs when the disease is not detected in an early stage, which is often the case, when the bacterial infection is latent present, showing no visible symptoms. Therefore there is a need for fast and adequate disease detection, which also detects diseased plants without visible symptoms to human observers. Early detection of diseased plants with modern vision techniques can significantly reduce costs.

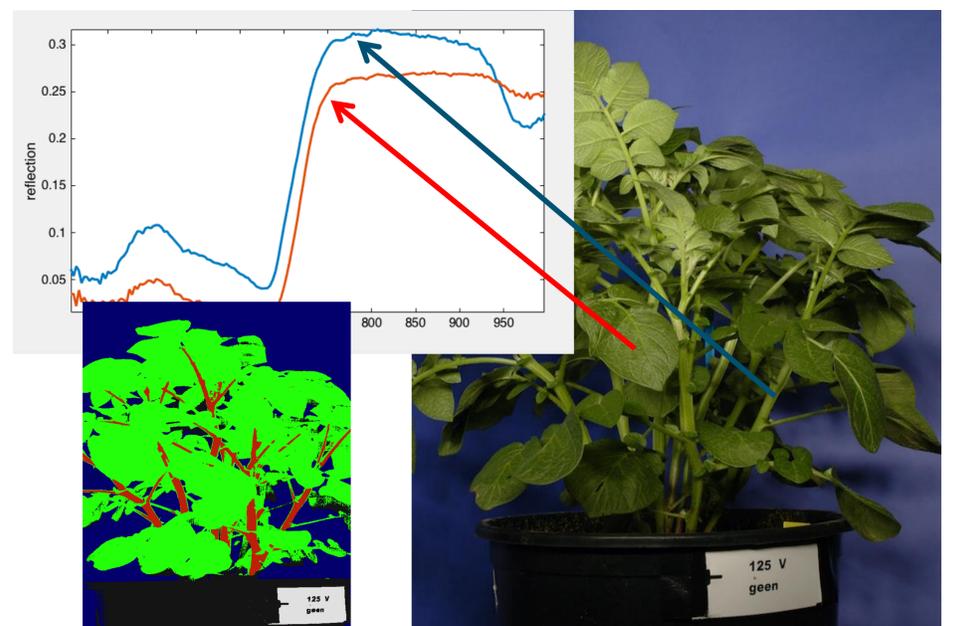
Methods

Amongst other techniques hyperspectral images of potato plants grown in pots in the open field were taken from the top and the side of the plants.

- First leaf and stem pixels were selected randomly.
- A Gaussian classifier was trained on infection yes/no at the time of planting (virus) or presence at the end of the experiment (bacteria).
- The model was tested using leave one out cross validation per plant.
- Majority voting on classified pixels determines class of each plant.

Results

Based on a few example images, using a trained linear classifier it was possible to individually select stem and leaf pixels.



Confusion matrices for classifier for stem and leaves compared to morphological symptoms by crop experts (between brackets)

Predi: True:	Healthy	Infected	Total
Healthy	7 (10)	3 (0)	10
Infected	1 (1)	13 (13)	14
Total	8 (11)	16 (13)	24

virus – stem

Predi: True:	Healthy	Infected	Total
Healthy	14 (15)	2 (1)	15
Infected	13 (7)	2 (8)	16
Total	27 (22)	4 (9)	31

bacteria – stem

Predi: True:	Healthy	Infected	Total
Healthy	9 (10)	1 (0)	10
Infected	1 (1)	14 (14)	15
Total	10 (11)	15 (14)	25

virus - leaves

Predi: True:	Healthy	Infected	Total
Healthy	15 (15)	1 (1)	15
Infected	15 (7)	0 (8)	16
Total	30 (22)	1 (9)	31

bacteria leaves

Conclusions

- Virus: Clear relation between spectral properties measured from the side, with morphological features. Spectral reflection of leaves performs better than spectral reflection of stem.
- Bacteria: As long as there are no symptoms, almost no infected plants can be classified based on spectral reflection from the side. Even when symptoms are present, almost no relation.