Automated detection of *Mycosphaerella melonis* infected cucumber fruits

Danijela Vukadinović , Gerrit Polder, Gert-Jan Swinkels

Introduction

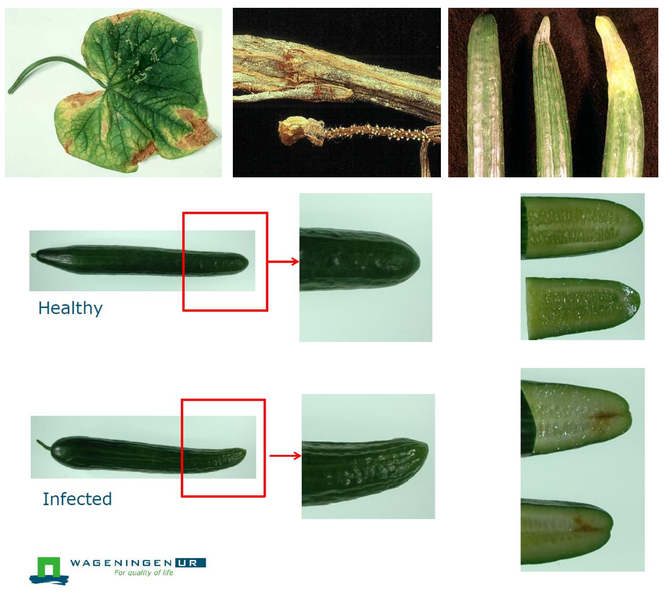

Figure 1. Top: cucumbers parts contaminated by *Mycosphaerella melonis.* Bottom: an example of a healthy and infected cucumber fruit used in this study.

Mycosphaerella melonis is a fungus that infects cucurbits. It harms all parts of the plant besides the roots and in all stages of plant development. We focus on the fruit infection that causes internal rot to cucumbers which is not visible on the outside during in the early stage. The infected cucumbers could infect the healthy fruits. During sorting, the contaminated cucumbers are difficult to recognize, even by experienced personnel.

Methods

Figure 2. Measuring devices: Nikon D70 colour camera with 3008x2000 pixels resolution (left) and S2000 fibre optic near-infrared (NIR) point spectrometer with the wavelength range 350 – 1000nm (right).

The method for automated sorting out the infected cucumber fruits consists of two steps:

- cucumber shape based classification that uses RGB colour-camera measurements (Fig. 3).
- light-transmission based classification using near-infrared (NIR) point spectrometer measurements (Fig. 4, Fig. 5).

Features extracted by this measurements were utilized by a linear classifier in order to separate healthy from infected fruits.

A cucumber was classified as infected if at least one of the two methods classified it as such.

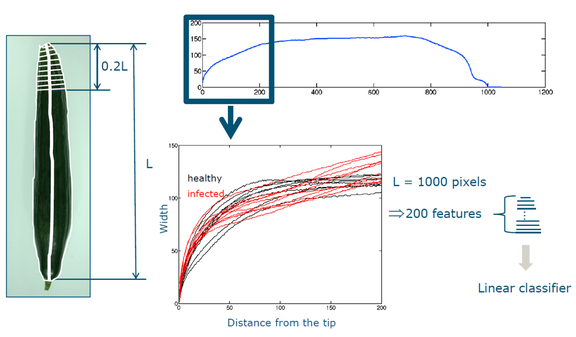

Figure 3. Classification by shape: diameters orthogonal to the cucumber centerline are extracted at the tip of a cucumber. The width distributions between the healthy and infected fruit clearly differ. Linear classifier is used for classification using diameters as features.

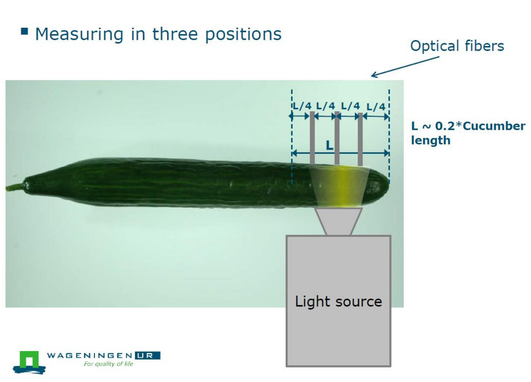

Figure 4. Spectral measurements based method: the transmission spectra is measured in three points of the healthy and infected cucumbers

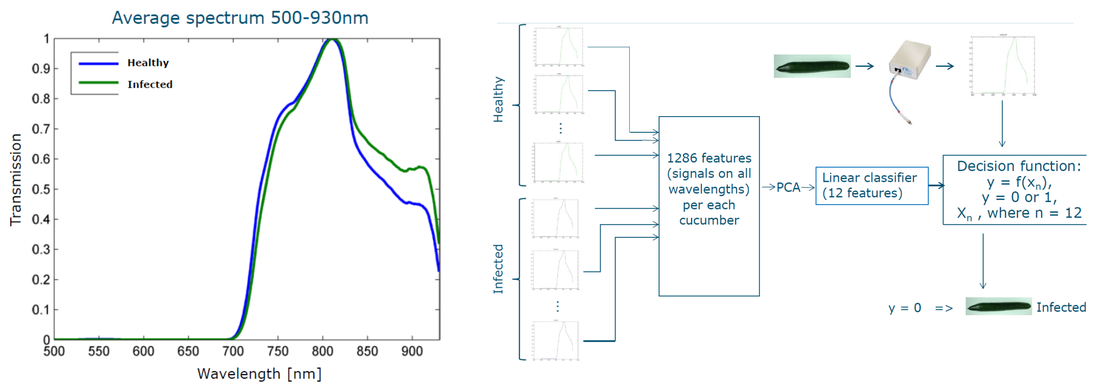

Figure 5. The average transmission spectra of the healthy and infected cucumbers are shown (left). The transmission spectra values for each cucumber on each wavelength were utilized by a linear classifier with 1286 features that were reduced to 12 features using principal component analysis (PCA) (right).

Results

The method was developed and validated on a set consisting of 260 cucumbers. The algorithm was trained on 76 cucumbers and tested on the remaining 184. The collected fruits were measured within 2 days after the collection.

The confusion matrix on the test set is shown bellow.

Ground Truth	Automated Classification			
	Healthy	Infected	Total	
Healthy	**81**	7	88	**92 %**
Infected	2	**94**	96	**98 %**
Total	83	101	184	

Healthy cucumbers were automatically classified with 92% accuracy, and the infected ones with 98% accuracy. The method reached overall accuracy of 95%.

This is a very good result when compared with an overall accuracy of 94% of the manual sorting.

Conclusions

We have developed a fast and fully automated algorithm for sorting out cucumber fruits infected by *Mycosphaerella melonis*. The accuracy of the method (95%) is higher than the accuracy of the manual sorting (94%).

Wageningen UR, Greenhouse Horticulture
Droevendaalsesteeg 1, 6708 PB Wageningen
P.O. Box 644, 6700 AP Wageningen, The Netherlands
Contact: danijela.vukadinovic@wur.nl
T +31 (0) 317 48 20 89 M +31 (0)6 41 580 524
http://www.greenhousehorticulture.wur.nl