Hyper-spectral frequency selection for the classification of vegetation diseases

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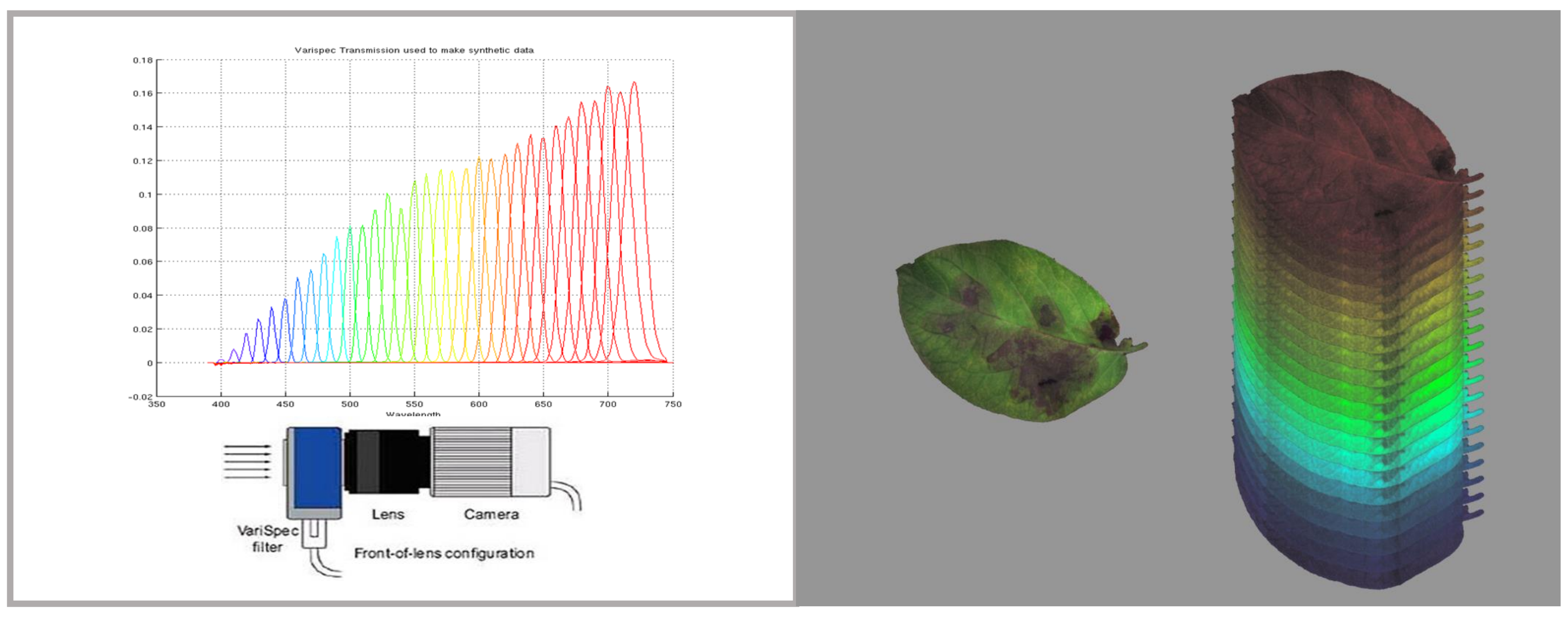
Objectives

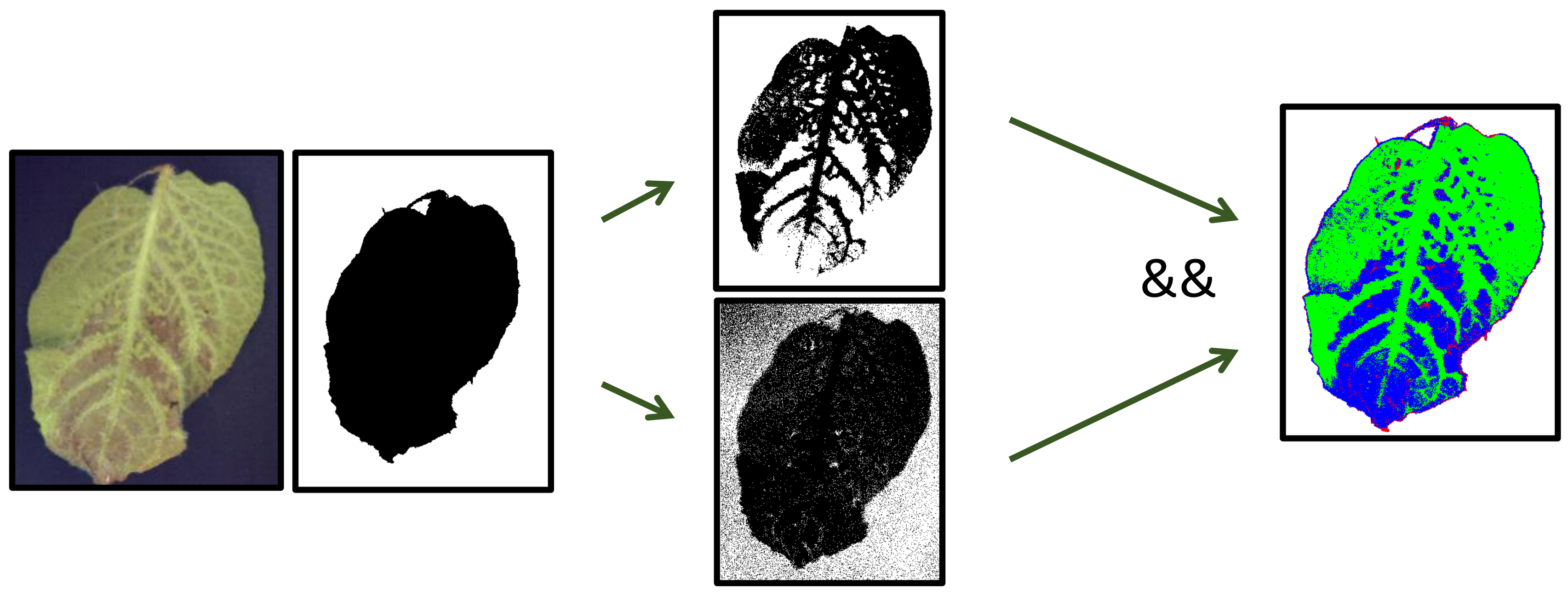
- Reducing the use of pesticides by early visual detection of potato-plant diseases.
- Narrow-band hyper-spectral imaging is required because of color similarities [1].
- Payload constraints on unmanned aerial vehicles require reduction of spectral bands [2].
- Hyper-spectral band selection and per-patch classification of individual leaves [3].

Methods

Hyperspectral imaging

Cascading classifier





1) Hyper-spectral image (28 wavelengths)

2) Classify background

3) Classify damage and disease

4) Classification result

Results

Quantitative result

All 28 wavelengths	Error Damage	Error Disease
MLP ReLU	13.6 %	**1.5 %**
MLP TanH	16.0 %	1.7 %
SVM	13.4 %	1.9 %
kNN	18.9 %	8.3 %
Gauss.	49.7 %	27.4 %

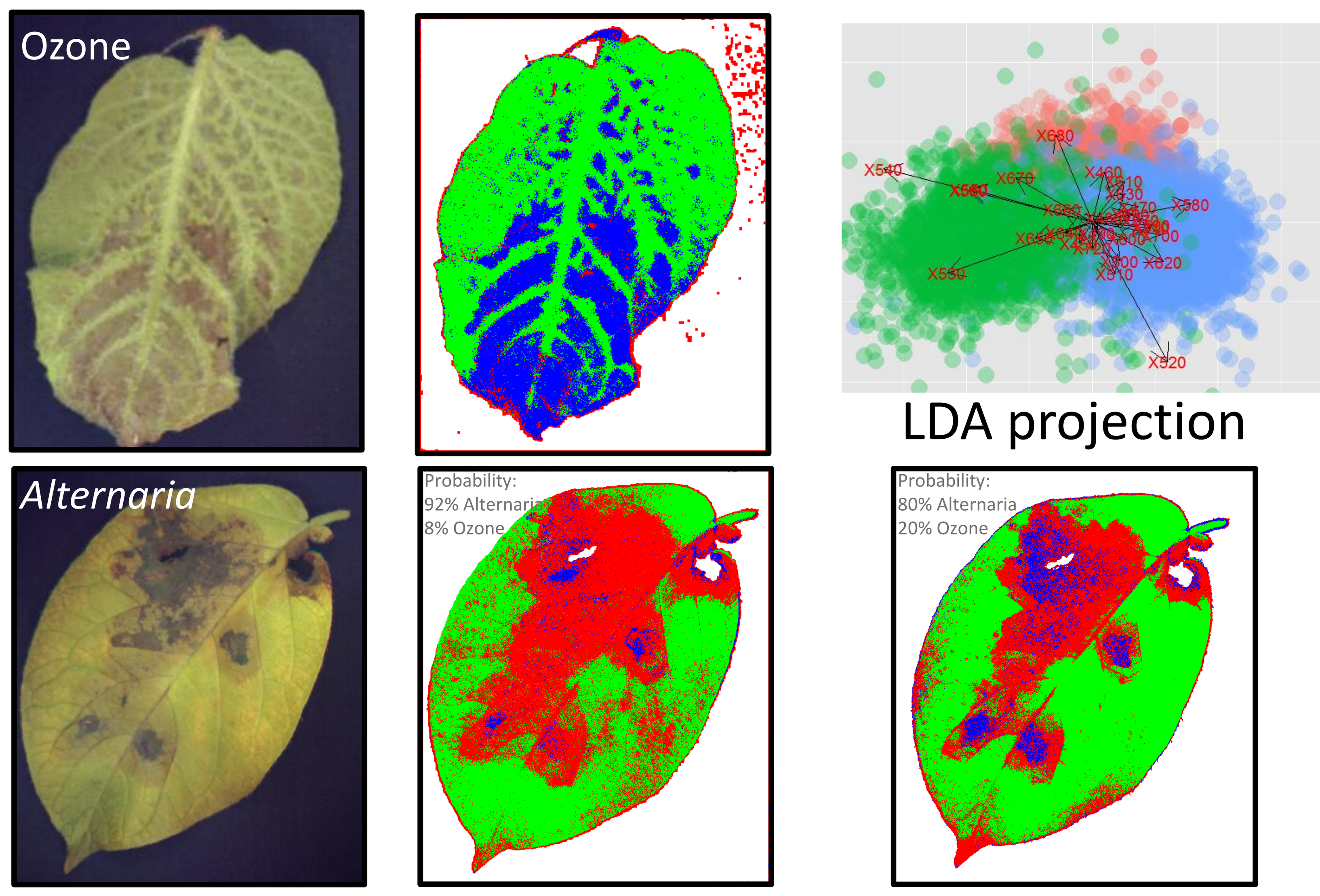
LDA projection	Error Damage	Error Disease
MLP ReLU	16.3 %	3.9 %
MLP TanH	16.8 %	4.0 %
SVM	14.5 %	2.9 %
kNN	25.9 %	11.8 %
Gauss.	14.2 %	2.6 %

Three Wavelengths	Error Damage	Error Disease
MLP ReLU	23.8 %	9.2 %
MLP TanH	24.7 %	16.1 %
SVM	23.0 %	14.0 %
kNN	22.5 %	7.3 %
Gauss.	29.9 %	29.9 %

Classification errors of different projection and classification methods with a sliding window size of 5x5 pixels.

Error Damage = *Lesion* / *Healthy*
Error Disease = *Alternaria* / *Ozone*
 # Leafs: 5 *Alternaria*, 5 Ozone
 # Patches: 20.000 Healthy, 10.000 *Alternaria*, and 10.000 ozone

Qualitative result



LDA projection

RGB Image

Classification using 28 wavelengths

Classification using 3 wavelengths

Conclusions

- A Multi-layer perceptron with a ReLU activation function obtains the best results (1.5% error)
- Detecting damage on leaves is more difficult than distinguishing diseases (13.4% vs. 1.5%)
- Reducing dimensions from 700 to 2, using LDA, slightly increases error rates (1.5% to 2.6%)
- When selecting the 680nm, 520nm and 540nm wavelengths, error rates increase to 7.3%.

References

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[2] J. van de Loosdrecht, K. Dijkstra, J. H. Postma, W. Keuning, and D. Bruin. Twirre: Architecture for autonomous mini-UAVs using interchangeable commodity components. In *IMAV 2014: International Micro Air Vehicle Conference and Competition*. Delft University of Technology, 2014.
[3] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E. Hinton. Imagenet classification with deep convolutional neural networks. In F. Pereira, C.J.C. Burges, L. Bottou, and K.Q. Weinberger, editors, *Advances in Neural Information Processing Systems 25*, pages 107– 1105. Curran Associates, Inc., 2012.

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