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Hyperspectral Imaging Combined With Machine Learning to Classify Flavescence dorée Symptoms

One of the main reasons for money loss for European winegrowers is represented by diseases affecting vines. Flavescence dorée is a phytoplasma transmitted by a leafhopper (Scaphoideus titanus); thus, after a few plants are diseased, the whole vineyard is quarantined and destroyed in the most severe cases. Flavescence dorée symptoms may vary according to the variety, including altered coloration and texture of the leaves. Scientists typically detect the disease using molecular analysis, but only recently have they been leveraging visual inspection techniques, such as hyperspectral imaging. However, the molecular test is insufficient to detect the disease in asymptomatic samples. The presented work proposes a novel approach based on hyperspectral imaging and machine learning to increase the success rate of disease detection on asymptomatic samples. The average spectral response of 100 samples was collected, subdivided into 3 classes: Healthy, Asymptomatic, and Diseased. Due to the low number of samples in the dataset, we also propose a synthetic augmentation procedure leveraging a Constrained Generative Adversarial Network. From the synthetic spectra, we calculate 10 vegetation indexes: NDVI, RGI, CI, mCARI, REP, CUR, mARI, custom index mARI2, ACI, and mACI. These values are used as the input features of an Ensemble of 30 Bagged Trees to classify the samples into the 3 classes. The model was tested on the real 100 samples, achieving a True Positive Rate (TPR) per class equal to 80%, 93%, and 96%, respectively. As a further contribution, the system's performance was evaluated on real data using a Bayesian test.

Author : Cristina Nuzzi (cristina.nuzzi@unibs.it)