Near infrared image sensors for monitoring insect pests in crop fields

In the frame of HALY.ID project, the present study aims at investigating the potential of near-infrared spectral cameras for monitoring the presence of the brown marmorated stink bug (*Halyomorpha halys*) in crop fields.

General context

Field monitoring of insect pests is fundamental in crop management to gain information about presence and abundance of pests to timely adopt proper actions to face infestation and avoid economical losses. Traditional methods for monitoring insect pests imply direct inspection of the field by technicians, which is time and money consuming, or the use of traps, which are not always reliable and may eventually have the drawback of increasing crop damage around the trap.

To improve pest management, HALY.ID project (*Halyomorpha hALYs Identification: Innovative ICT tools for targeted monitoring and sustainable management of the brown marmorated stink bug*), aims at implementing a prototype of a digital platform for field monitoring of the presence of the brown marmorated stink bugs, which is a highly invasive pest of global importance.

In particular, spectral cameras mounted on Unmanned Aerial Vehicles (UAVs) and other Internet of Things (IoT) devices can be used as an innovative technology allowing fast, efficient and real-time monitoring of insect infestations.

The dark brown colour of *H. halys* makes this bug hardly detectable with digital colour cameras or spectral cameras based on the visible range, since it can be easily confused with the tree bark or dry leaves. To overcome this problem, it can be useful to move to cameras working in the near infrared (NIR) range to allow a better detection of the pest.

Experimental and preliminary results

NIR-hyperspectral images of *H. halys* specimens were acquired in the 980-1660 nm range considering different background types, including green leaves, yellow leaves, dry leaves, grass, soil, bark, tree branches, and their mixtures. These background types were selected to mimic a real field application scene.

A masking procedure was performed by applying Principal Component Analysis (PCA) to the acquired hyperspectral images to effectively identify the pixel spectra of the bugs and those related to the different background types. In this manner, it was possible to build a library of reference spectra of brown marmorated stink bugs and of the different vegetal backgrounds.

This database of spectra was used for classification purposes to discriminate stink bugs from the background using Partial Least Squares Discriminant Analysis (PLS-DA) algorithm obtaining a prediction accuracy of 0.94. The classification ability of the model was also successfully tested at the pixel-level by predicting the hyperspectral images and visualizing the corresponding prediction images (Figure 1).

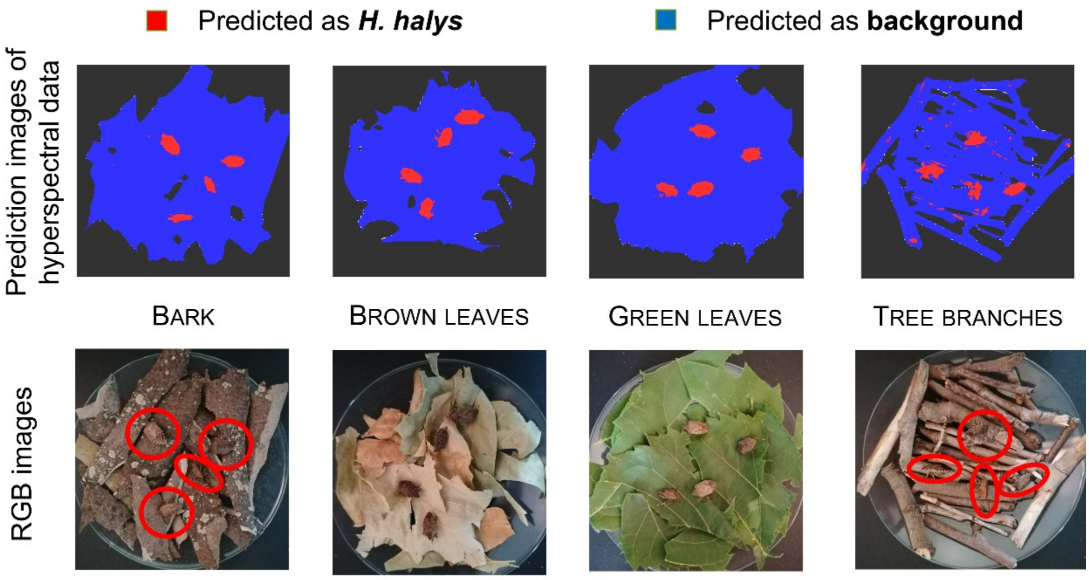

Figure1. *Prediction images of H. halys on different vegetal backgrounds, together with the corresponding RGB images.*

Future work

Further investigations with proper variable selection algorithms will be carried out to identify few relevant wavelengths for the detection of the bugs on the vegetal background. Based on the selected wavelengths, it will be possible to implement cheaper and faster multispectral cameras to be used on UAVs and UGVs for the automated monitoring of the presence of *H. halys* in crop fields.

Further information about HALYID project can be found here: https://www.haly-id.eu/

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