Monitoring of insect pests in crop fields using spectral imaging

Rosalba Calvini, Veronica Ferrari, Lara Maistrello, and Alessandro Ulrici

Department of Life Sciences, University of Modena and Reggio Emilia, Reggio Emilia, Italy.
E-mail: rosalba.calvini@unimore.it

Field monitoring of insect pests is fundamental in crop management to gain information about the presence and abundance of pests in order to timely adopt proper actions to face the infestation and avoid economical losses due to crop damages.
Monitoring of insect pests is usually performed by means of active or passive methods. Active methods, such as visual sampling, tree beating and sweep netting, are time and money consuming for farmers since they require the direct inspection of the field by technicians. On the other hand, passive methods like the use of traps are not effective for many kinds of insects and they may also present the side effect of increasing damage in crops around the trap.
In order to improve crop field pest management, 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 present study was developed in the frame of HALY.ID project (*Halyomorpha hALYs Identification: Innovative ICT tools for targeted monitoring and sustainable management of the brown marmorated stink bug*), which aims at implementing a prototype of a digital platform for monitoring the presence of brown marmorated stink bugs (*Halyomorpha halys*) in crop fields, which represent a high-invasive pest of global importance for many agricultural crops.
The dark brown colour of *H. halys* makes this bug hardly detectable with RGB cameras or spectral cameras based on the visible range, since it can be easily confused with tree bark or dry leaves. For these reasons, to effectively identify *H. halys* in crop fields it is necessary to move to cameras working in the near infrared (NIR) range.
To this aim, to overcome the problem of mimicry of *H. halys* in this study we used NIR hyperspectral imaging to identify the spectral wavebands that could allow a better detection of this bug. In particular, hyperspectral images of brown marmorated stink bugs 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, in order 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.
In a first step, this database of spectra was used for classification purposes to discriminate stink bugs from the background and 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 multispectral cameras to be used on

UAVs and UGVs for the automated monitoring of the presence of *H. halys* in crop fields.

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