LeafEye - Robust plant pests' identification and classification

S. Widmer, V. Michel •, T. Bendinelli, M. Höchemer, Ph. A. E. Schmid

A rapid and reliable identification of diseases and pests is crucial for a successful crop protection in modern agricultural production systems. Especially for high value crops grown in greenhouses, the early detection of diseases and pests permits not only a more efficient control but also a reduction of the amount of applied pesticides. In the LeafEye project, CSEM developed a prototype of a portable handheld device that can detect and count invertebrate pests on leaves. This allows for early detection and precise use of pesticide. The device also provides valuable feedback on the success of the treatment.

High value crops are commonly grown in greenhouses. An infestation of pests and fungi can be devastating to a crop. If detected early, it can be well treated, and the crop saved with low costs. Currently, if a farmer suspects an infestation, a biological specialist must investigate and identify the type of problrm on the leaves. The LeafEye device enables farmers to autonomously investigate the health of their crops without further external experts.

Figure 1: The LeafEye prototype

The prototype device consists of a custom-built illumination, two high resolution cameras which are connected to a Nvidia Jetson Xavier NX system on a module. This embedded processor is triggering and acquiring the images from the cameras, processing the pictures onboard and controls the user interaction with the operator.

Figure 2: LeafEye device in use on site

An additional, integrated GPS module stores exact geolocalization along with the images. This way, the spreading of an infestation can be more accurately monitored and assigned to different sections within the greenhouses. A small screen on the back of the device gives the operator a first glance at image quality and detected problem, while a battery at the basis of the handle provides autonomy for up to 4 hours of operation.

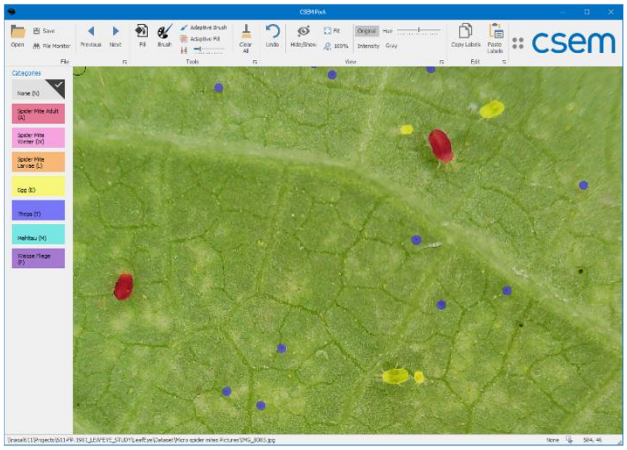

Figure 2: CSEM Labelling tool (PixA) used by Agroscope for annotation

CSEM's device uses a custom-made algorithm for detecting and locating different types of pests. The algorithm is based upon a Convolutional Neural Network (CNN) which has been trained to identify and localize pests from camera images. A team of experts from Agroscope collected and labeled data from a variety of pests to train the network using CSEM's labelling tool Pixa.

After numerous iterations devoted to optimizing performance, the final system can detect more than 10 different species of pests accurately.

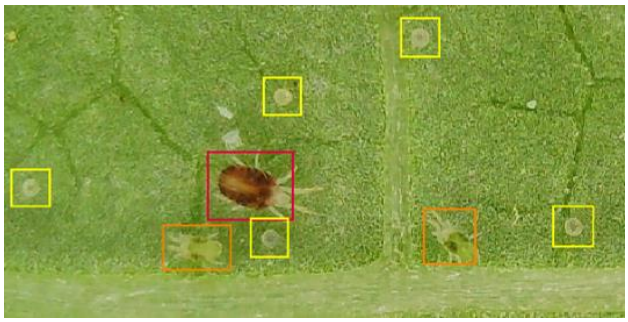

Figure 3: The algorithm takes an image as input, then outputs a bounding box and the class of each pest detected.

The algorithm is designed to run on an edge-based computer in real-time. The neural network was optimized for embedded processing in regards of power consumption, latency and memory usage. The device is portable and can be used for indoor and outdoor applications. It grants direct access over WiFi using a web interface for updates and logging.

The device provides valuable insights for greenhouse operators and pest control professionals alike. Agroscope is currently discussing potential partnerships to industrialize this proof of concept further.

• Agroscope, Conthey, Switzerland