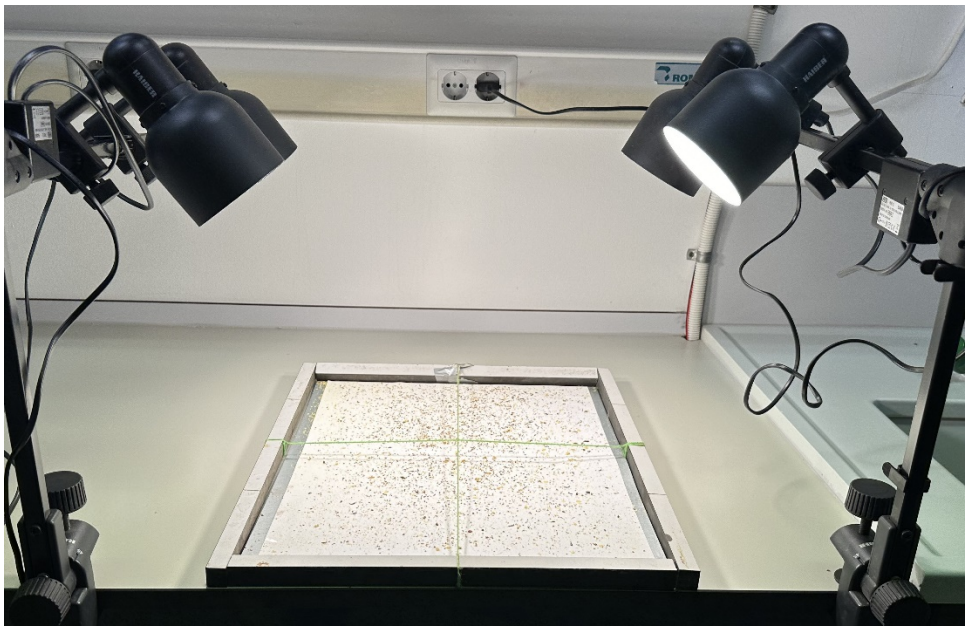
VarroDetector open software

The *VarroDetetor* software is a new free and automated tool for the analysis of natural *Varroa* mite fall on sticky sheets from images captured by a smartphone. It works on standard computers and no installation is required.

The software is designed for continuous improvement through the integration of new images from different devices, allowing it to adapt to user needs. VarroDetector has been trained using images captured with a Iphone14 Prom Max (at 48 MPixels) and a Xiaomi Poco X5 Pro (at 108 MPixels). You can use a different Smartphone (with at least 48 megapixels camera), but it is advisable to train the system with the images from your Smartphone to improve accuracy. For doing that, you only have to label properly your images using the VarroDetector editing possibilities (see below), save and send the original and labelled images to the software developers.

1. Materials

- Sticky sheets: we use cheap, thin and white adhesive sheets purchased in large rolls, which are then cut to fit the dimensions of the hive base. To prevent bending, these sheets are attached to a reusable 1 mm thick PVC base using double-sided tape.
- Smartphone camera with 48 Mpx or higher
- Frame with perpendicular green strings to divide the sticky board into four frames (photographs)
- Uniform illumination, for example like the following (or other intense and diffuse light)

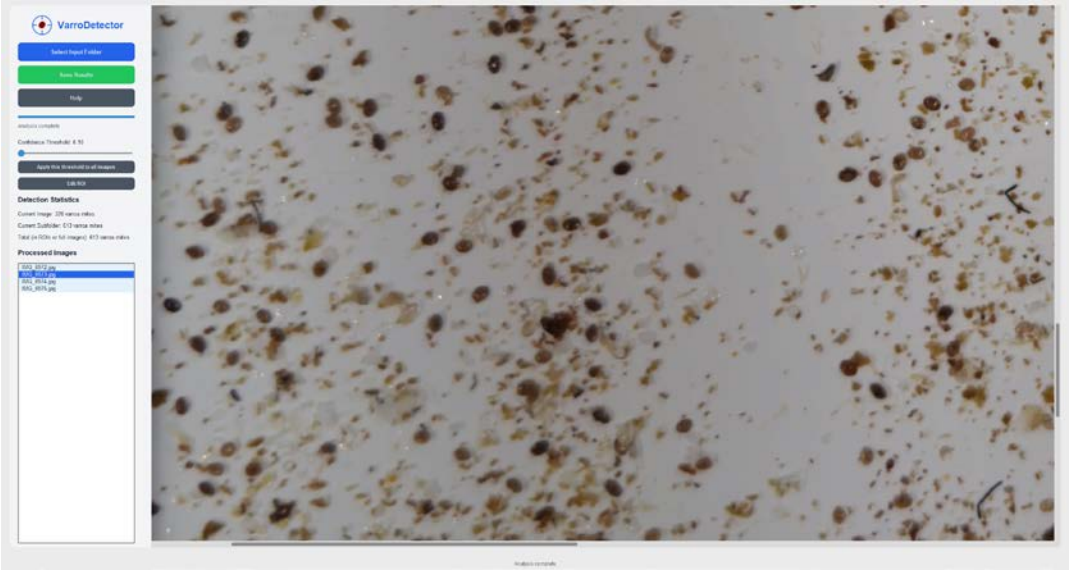


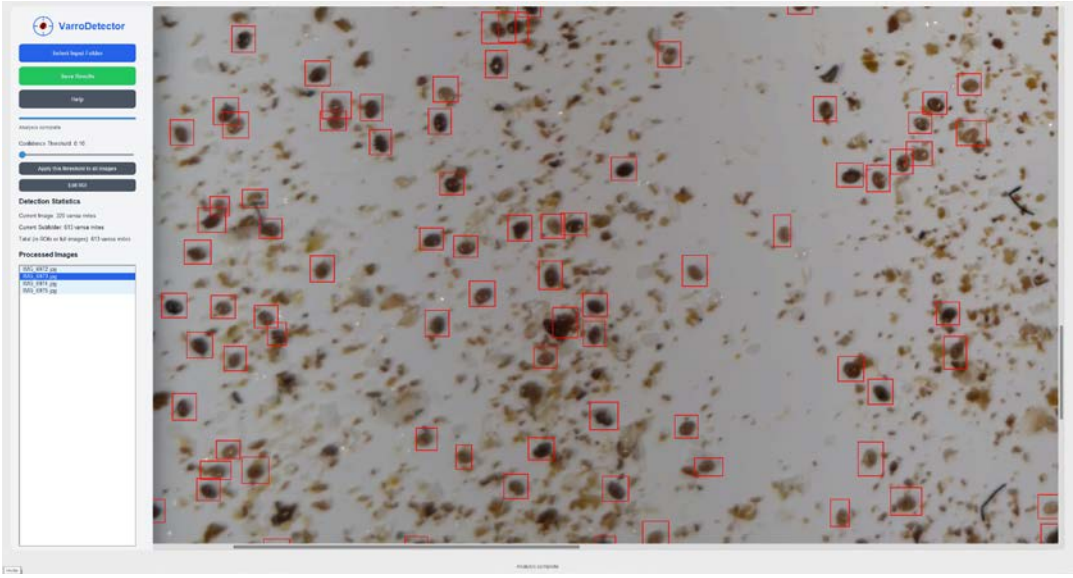
2. Image acquisition

Capture four images per sheet at at least 48 megapixels resolution avoinding the Macro option.

3. Software interface

The software features an intuitive user interface, as illustrated in the next Figure.





How to use:

1. Organice the images in subfolders, each one corresponding to a colony

2. Click "Select Input Folder" and choose a folder with your images. The analysis will be also performed to any image contained in subfolders of the input folder.

3. Wait for the processing to complete

4. Click on any image in the list to view it.

5. Use the confidence slider to adjust detection sensitivity. The confidence score can be set up individually for each image. Lower confidence score will show more detections, but possibly with more false positives. The "Apply Threshold to All Images" button allows the user to quickly set the same confidence threshold across all the images.

6. Click "Save Results" when you're done. This will save the images (with the printed detections) and the coordinates of the detections (the labels) in a folder named "results" within the input folder. Two .csv files (compatible with Excel) will also be recorded, one with the detailed information for each image and the second corresponding to the subfolder (colony).

Controls:

- Zoom: Mouse wheel

- Pan: Middle mouse button

- Add varroa mite: Left click and drag

- Delete varroa mite: Right click on box

- Press (and keep pressing) the key h to temporarily hide the detections.

- Once the key h is released, the detections will be shown again

Region of Interest (ROI):

- Click the "Edit ROI" button to define a specific area for counting varroa mites

- Left click to add points and create your ROI polygon

- Double click to complete the ROI

- Right click to delete the current ROI

- The statistics will update to show mite counts only within the ROI

- ROIs are saved per image and will be included in the final results

This software is completely free. If you wish to collaborate (for instance, providing new images with corrected detections to improve the underlying AI model), please contact:

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