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A strategy for multimodal canopy images registration

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Abstract

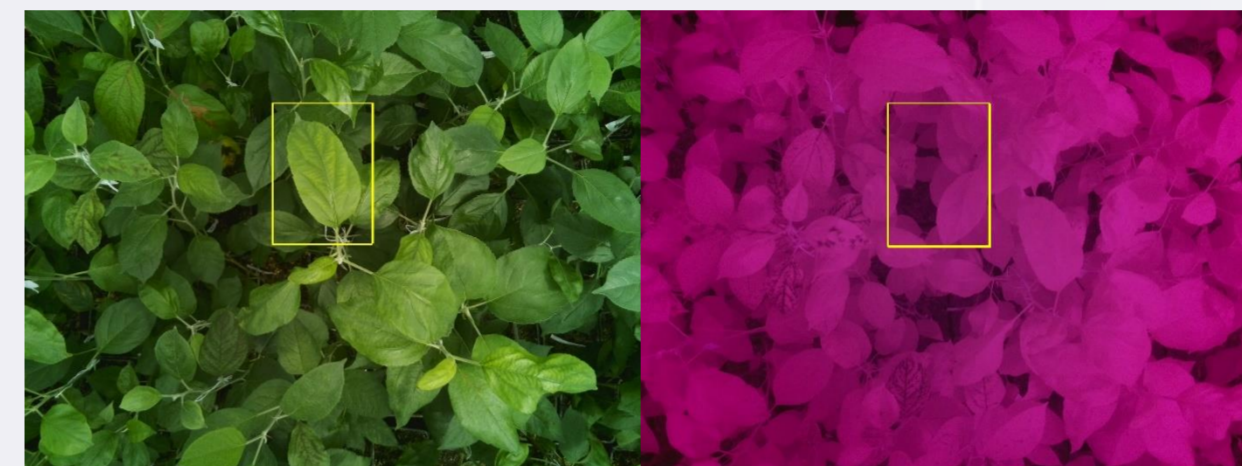
Registration of complex and self-similar images such as plant canopy images is a challenge in plant sciences. Yet, this is often a required step for multimodal imaging, where unaligned sensors yield unregistered image pairs. We propose a pipeline adapted to such constraints, applied to apple tree canopies. Specifically, we apply an intensity-based registration **on downscaled and/or Gaussian blurred** versions of the targeted images. This helps to eliminate spurious details, which smooths the optimization landscape and also helps to reduce differences between the modalities. Results show better registration than with standard feature-based or intensity-based methods.

1 Dataset



- 50 image pairs of dense apple plant canopies inoculated with apple scab.
- Acquisition in visible and in infrared domain in order to conduct a multimodal automatic scab detection.

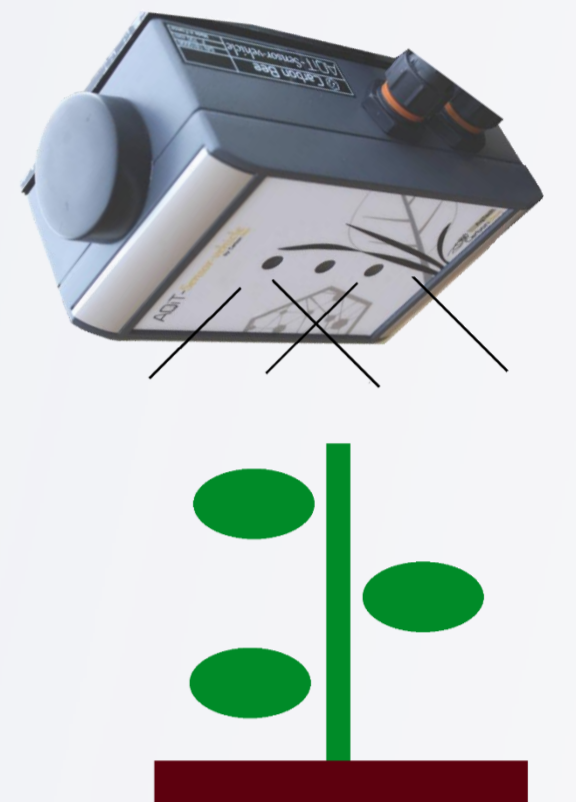
2 Offset problem



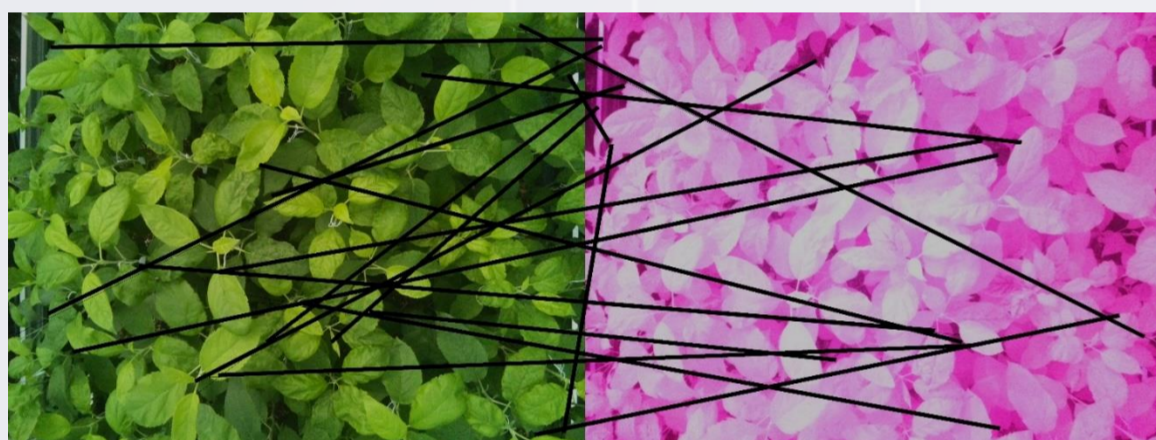
The two sensors (visible and infrared) have a physical offset, leading to unaligned images.

→ registration needed for multimodal analysis.

Carbon Bee AQiT hyperspectral sensor



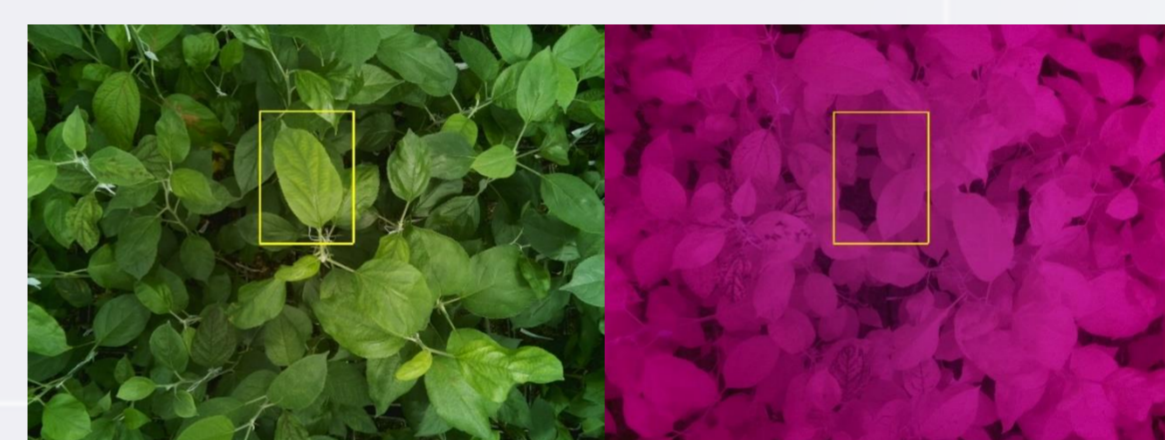
3 Limits of state-of-the art methods



Traditional feature-based registration methods such as SIFT fail because of

- high number of salient points,
- auto-similar image,
- multiple scales,
- visible/IR differences.

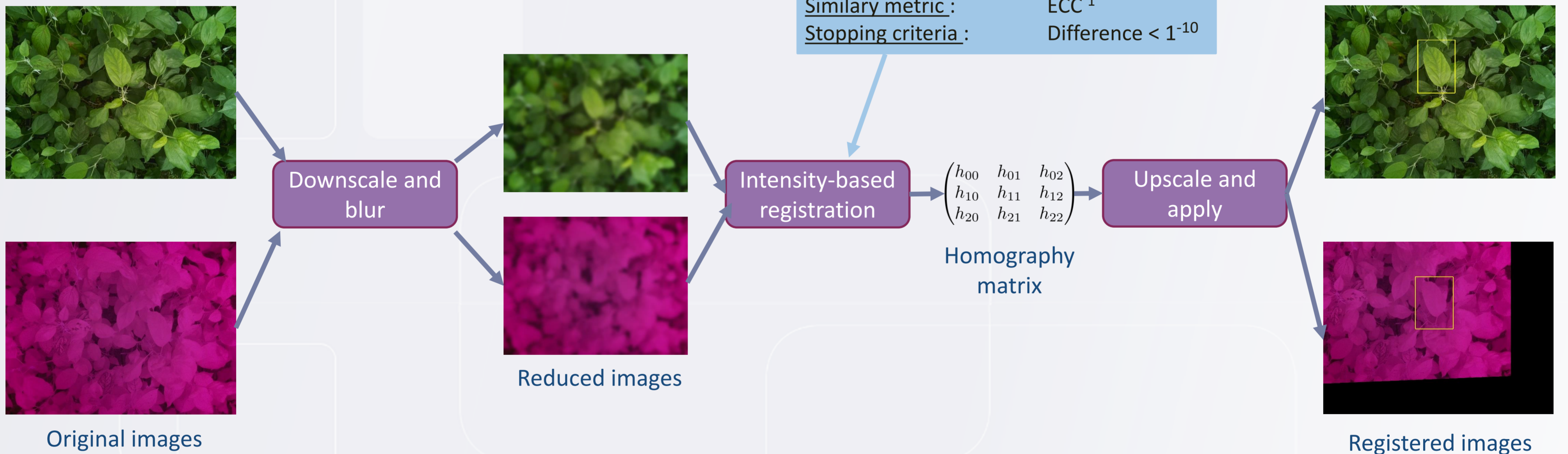
→ features incorrectly matched.



Intensity-based registration fails because the high number of salient points leads to a complex optimization landscape.

→ algorithm "stuck" in local minima.

4 Proposed approach



5 Results

Downscale ratio	Gaussian blur sigma			SIFT
	$\sigma = 0$	$\sigma = 2$	$\sigma = 4$	
$d = 1$	8.4	9.4	10.0	0.0
$d = 0.5$	9.4	10.5	10.8	0.0
$d = 0.1$	10.9	11.5	12.0	0.0

Results correspond to difference in ECC between registered image pairs and unregistered image pairs, averaged over the whole dataset.

Registration is improved when the registered images are downscaled and blurred. Note that SIFT-based registration failed completely in our case.

6 Perspectives

- Multiple resolution registration : Once images have been registered at a lower resolution, perform another registration at a higher level of detail, starting from that first registration.
- Multimodal automatic scab detection : segmentation by neural network, based on both visible and infrared modalities.

[1] Evangelidis, Georgios D., and Emmanouil Z. Psarakis. "Parametric image alignment using enhanced correlation coefficient maximization." *IEEE Transactions on Pattern Analysis and Machine Intelligence* 30.10 (2008): 1858-1865.