RGB -Thermal Sensor Fusion for Leaf Temperature Estimation in Field-Phenotyping

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Abstract

Segmenting the thermal signature of plants from the soil background is a challenging problem in field phenotyping applications. The difficulty lays in distinguishing leaf and shadow temperature levels. One approach to this problem is the co-registration of data from multiple sensors and the subsequent separation of ground and canopy. However, aligning the images is a challenging task. Recently, various image fusion techniques have been proposed for uncalibrated sensor fusion, such as MSER, SIFT, SURF and ORB. However, those feature-matching based methods essentially compute a Homography transformation, which can only be used for the fusion of planar scenes. For more complex scenes, depth information is necessary to find the correct mapping between sensors.

This work describes a novel approach for thermal – RGB image fusion, which relies on the stereo reconstruction from three jointly calibrated sensors of the Field Phenotyping Platform of the Crop Phenotyping Group at ETH Zurich. The reconstructed 3D point cloud was used to sample colour and thermal information from different sensors through perspective projection. For this, a toolbox for joint sensor calibration, dense stereo reconstruction, and point cloud processing has been developed. The method was tested on a set of soybean canopy images of different varieties. Additionally, two different methods for leaf-ground segmentation were implemented and tested on the set. The two approaches rely on a height and colour threshold respectively. The results were compared to a traditional image segmentation method and are presented in this report. The results show that the proposed methods offer a viable alternative to conventional segmentation approaches.

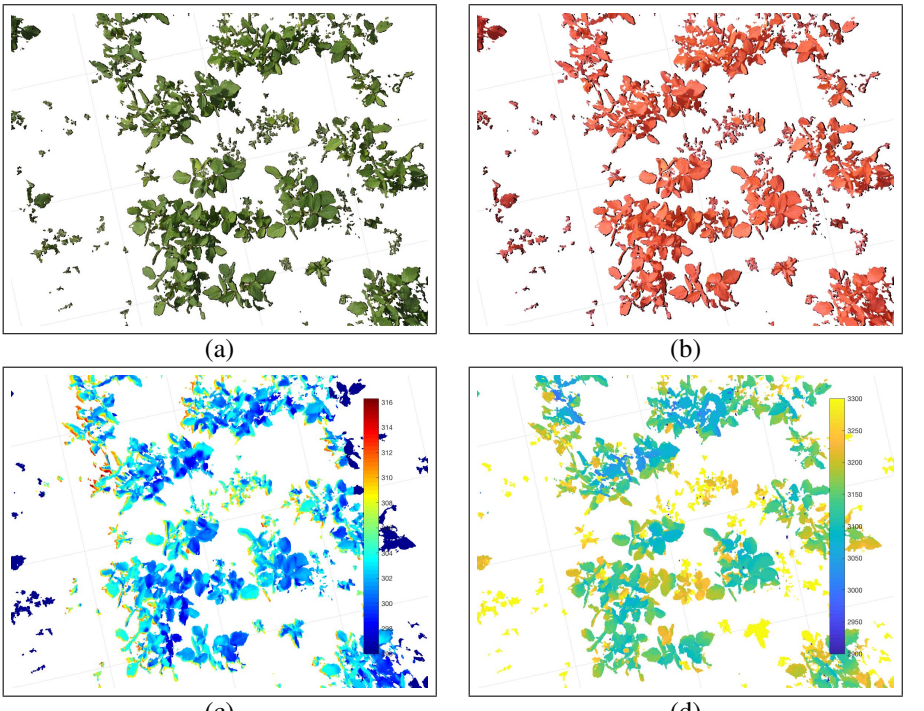

Figure 1: Point clouds after colour segmentation with different colour maps: (a) RGB; (b) IGB; (c) Thermal, displayed by jet colour map, ranging from 296 K (blue) to 318 K (red) and (d) depth, ranging from 2900 mm to 3300 mm (distance to camera).

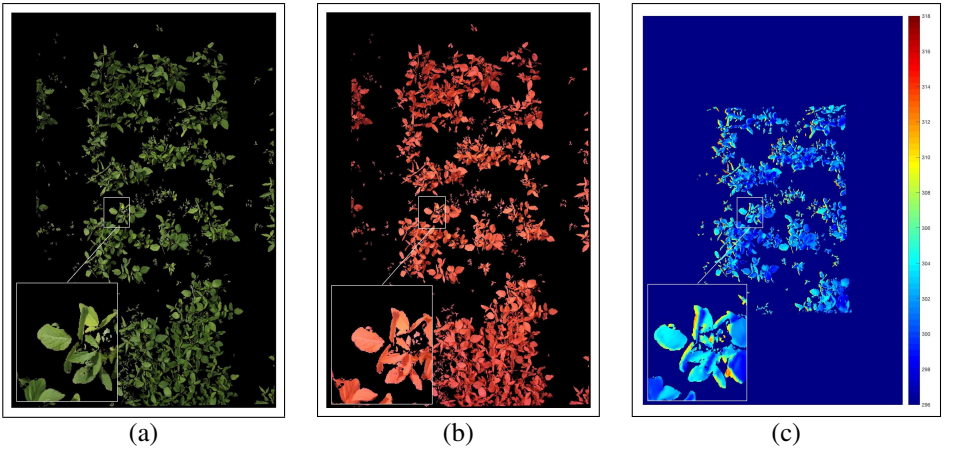

Figure 2: Segmented leaf points projected into RGB camera frame: (a) RGB points; (b) IGB points; (c) Thermal points, displayed by jet colour map, ranging from 296 K (blue) to 318 K (red)