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Characterizing the errors in UAV-based thermal mosaicking process

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UAV-based thermal sensors provide surface temperature with an ultra-high spatial and temporal resolution, which has increased opportunities to understand in-field variability of crop and soil conditions. Alongside these observational advances, numerous software applications have been developed to process and analyze the obtained images. While optical and near-infrared workflow processing is quite mature, thermal processing remains challenging for a number of reasons, including: (1) rapid surface temperature changes; (2) influences by air temperature on thermal camera internal temperature; and (3) vignetting effects on the uncooled microbolometer focal plane array. Though uncooled sensors have been improved from the perspective of radiometric calibration and shutter correction, processed mosaics often suffer from radiometric inconsistencies between raw images. Here we present an assessment of UAV-based mosaicking of thermal data to improve its accuracy and precision for agricultural applications. Specific processing software (such as Photoscan or Pix4d) has been developed to generate mosaics from individual images by using the structure from motion (SfM) photogrammetric approach. However, the software has been developed to process RGB and multi-spectral imagery that does not consider the underlying physical process of thermal imagery and so, these approaches are not able to capture the rapid changes of surface temperature nor the influences of air temperature. For instance, we found a significant difference in temperature (up to 5 [U+F0B0]C) depending on the wind direction. For this study, high spatial and temporal resolution thermal surveys were obtained at different times of the day with a TeAx camera onboard a DJI M100 quadcopter over an experimental field. Along with the UAV data acquisition, in-situ plants and soil temperature was measured to evaluate image retrievals. Overall, while thermal cameras provide insight into the physiological state of vegetation and land surface temperature dynamics, the use of UAV-based systems remains challenging and further understanding and characterization of errors is required.