Supplementary Materials for:

Four-band Thermal Mosaicking: A New Method to Process Infrared Thermal Imagery of Urban Landscapes from UAV Flights

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This Supporting Information file contains additional results, including the following:

- Figure S1: The temperature map of Beaver Pond Park

- Figure S2: The misalignment caused by shutter delay (with additional description)

- Figure S3: Overall comparison between the HSV-based and the original RGB-based orthomosiac

- Figure S4: Detailed comparison between the HSV-based and the original RGB-based orthomosiac

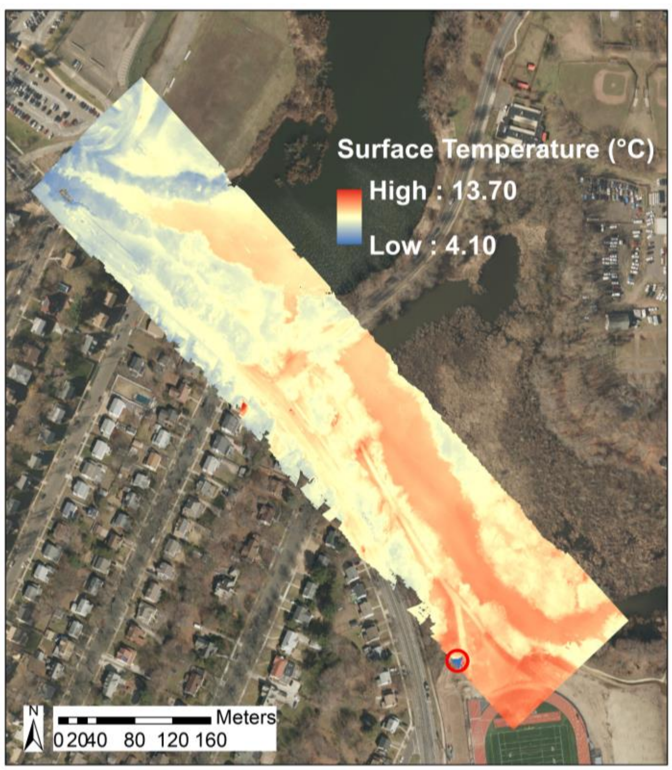
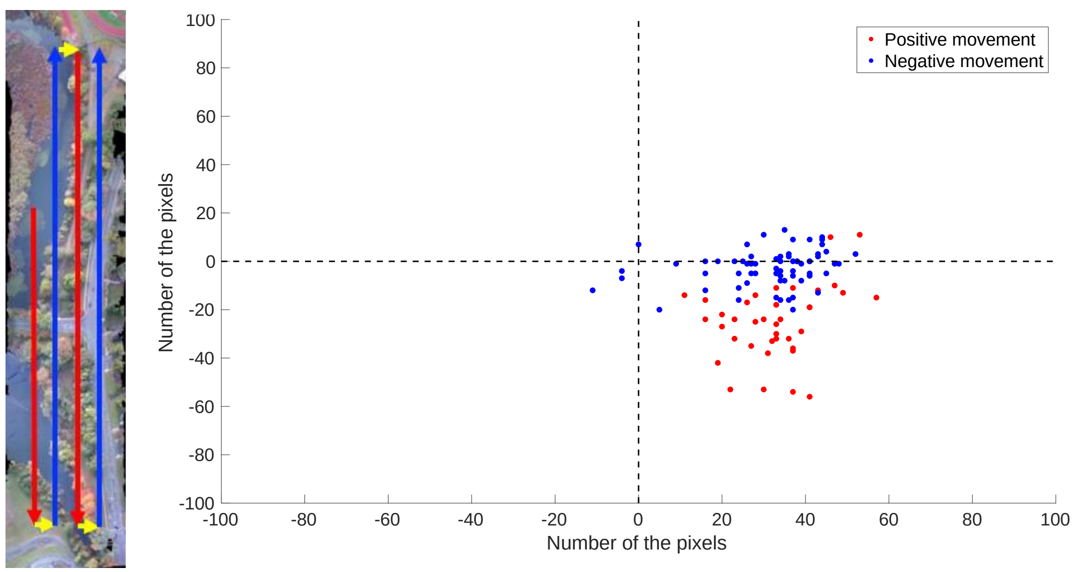


Figure S1. The temperature map in degree Celsius converted from the DN value in the thermal othomosaic (Figure 6b) by the regression equation (Figure 10b). The red circle indicates a spot with an extremely low temperature (-6.7 °C) due to the low-emissivity of a metal roof on a garage.

Additional description regarding positional error caused by shutter delay

We discovered that the shutter delay between the visible lens and the thermal lens is an important source of error. The flying route was indicated by arrows in Figure A1a, where we define the direction of blue arrows to be positive and the direction of red arrows to be negative. Through the whole flight, we sampled 103 distinguishable features from the thermal and the RGB photo pairs. The inter-band misalignment of the features was recorded in Cartesian coordinates system just like the object-based calibration method (Figure 8d). We found that the misalignment during positive movement is overall greater than that during negative movement (Figure S2, panel b).

To explain this, we assume that there existed a consistent systematic positional error which will not change with the motion state. As the UAV is moving back and forth, however, the shutter delay will create misalignment in opposite directions. When the opposite misalignment is superimposed onto the systematic error, the overall positional error will be offset by the negative movement but exacerbated by the positive movement. As a result, the entire error will be separated to two clusters. For quantification, -3 and -25 pixels are the mean errors in y axis during negative and positive movement, respectively. By averaging the mean errors in both the directions, we obtain the systematic positional error which is -14 pixels in the y axis. Using this positional error and the UAV speed of 10 m/s, we estimated that the shutter delay is approximately 0.07 seconds. Although delay seems small, the associated errors are not negligible.



(a) (b)

Figure S2. The misalignment caused by shutter delay for different moving directions. (a) The RGB orthomosaic with the flying route marked by arrows. The positive movement is indicated by red arrows and the negative movement by blue arrows. (b) Scatter plot of misalignment in two dimensions. Red dots indicate positive UVA movement and blue dots indicate negative movement.

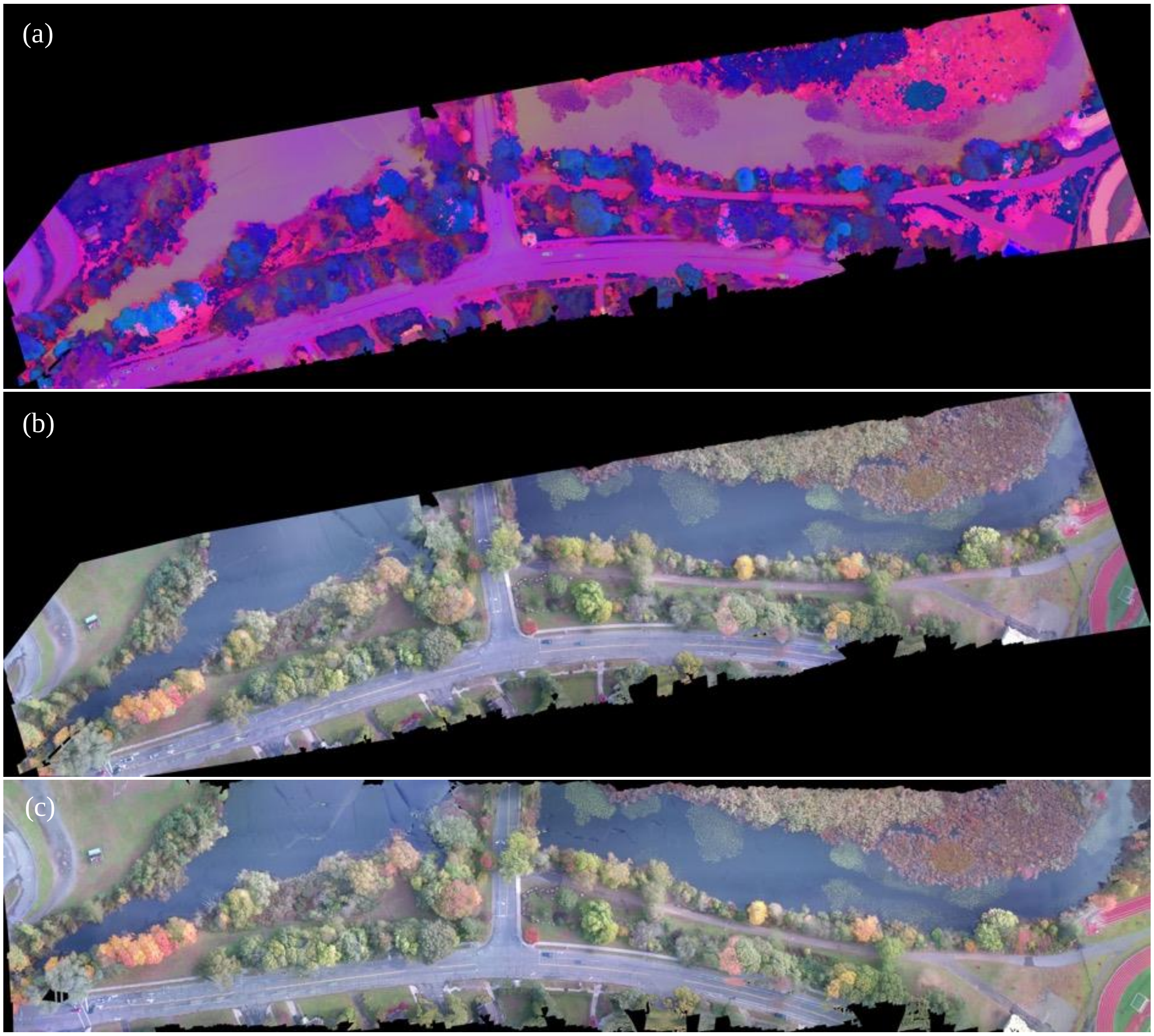


Figure S3. Comparison between the HSV-based orthomosaic and the original RGB-based orthomosiac: (a) The HSV-based orthomosaic in HSV color. (b) The HSV-based orthomosaic converted to its corresponding RGB colormap. (c) The original RGB-based orthomosaic (Figure 4a).

Figure S4. Detailed comparison between the HSV-based and the original RGB-based orthomosiac. (a) and (c) are two enlarged views from the RGB orthomosaic, and (b) and (d) are their corresponding views from the HSV orthomosaic. The locations of these two views are marked in (e).