Emissivity correction of a 3D thermal model based on image processing and deep learning

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Research project: **Climate Adaptation through Thermographic Campaign and Heat Mapping (CATCH4D)**

Research background and goal

Many cities have set the goal of being climate-neutral by 2030. Reducing CO_2 emissions from buildings requires improving building energy efficiency. Using airborne thermal imaging to detect building energy leaks is an essential technique for assessing building energy efficiency. Many studies have used UAVs equipped with infrared cameras for single-building envelope scanning, however, they are not sufficient for the goal of evaluation building efficiency at city level. Therefore, our study built a constellation of one vertical and four oblique cameras on the aerial plane and conducted a thermographic survey at the city scale to capture thermal images of building roofs and facades. The collected thermal images were used to a 3D thermal model, aiming to detect building erengy leaks and assess building energy efficiency.

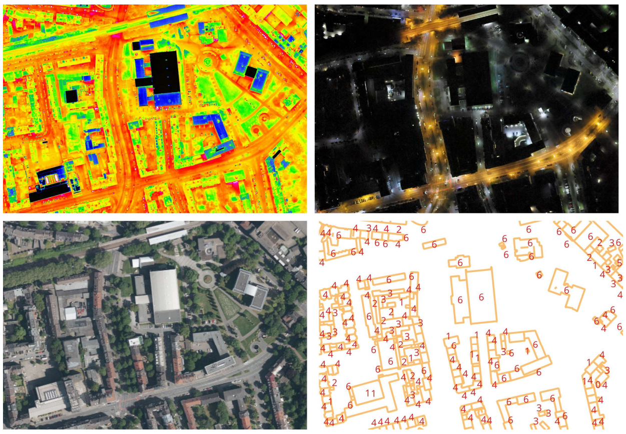
Aerial survey with nadir and oblique thermal cameras

- Survey time: Feb and March 2024
- Flight altitude: 1100m above ground
- Weather conditions: temperature between 0 to 5 °C, no strong wind, no precipitation

View	Image size	Camera	Spectral range	Direction
Nadir	1280x1024	FLIR A8580 SC	11.5–12.5 µm	Vertical
Oblique	640x480	FLIR A655 SC	7.5 – 14.0 µm	Forward, backward, left, right

Deep Learning supported emissivity correction

We developed an image processing-based workflow with deep learning support for the emissivity correction tasks. In addition to the thermal images collected from our survey, we used the existing high-resolution aerial photos collected by RGB sensors, including both oblique and nadir cameras. In the first step, we applied deep learning on the nadir RGB images to classify building materials into six classes. Then, we employed texture mapping to oblique RGB images to extract building façade images, which were later also classified into four classes based on deep learning. A similar texture mapping procedure is also applied to thermal images to extract the corresponding images for the building roof and facades. Finally, we assigned each material class an emissivity value on the RGB images and transferred these values into thermal images to correct temperature values on the thermal images.



Result

The emissivity-corrected thermal images were used as building textures to existing 3D building models (LoD2) to create our 3D thermal model. The final 3D thermal model enables us to visualise energy leaks from buildings and quantitatively evaluate building energy efficiency.

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