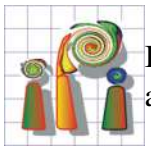

Institute of Photogrammetry
and Geoinformation

MASTER'S THESIS

Title

Evaluation of sensor technology for the measurement and material characterization of structures

submitted by

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ABSTRACT

This thesis explores the application of various sensor technologies, including thermal imaging, multispectral cameras, and laser scanners, to classify façade materials in urban environments. The integration of these technologies aims to enhance automated building material detection and recognition, which is critical for environmental sustainability and efficient urban planning. This research focuses on the use of deep learning frameworks, particularly convolutional neural networks (CNNs), to improve material detection accuracy through the fusion of multi-modal data.

The study demonstrates the potential of each sensor under different environmental and geometric conditions, evaluating their effectiveness in material classification using a late-fusion U-Net network. This approach effectively integrates inputs from various sensors, balancing their contributions based on their distinct capabilities. The research identifies challenges in data registration and feature extraction from heterogeneous modalities, emphasizing the need for improved data fusion methods and sensor configurations.

Significant findings demonstrate the notable performance of RGB cameras in material detection. However, their inability to differentiate between materials with similar visual appearances, such as aluminum and steel, emphasizes the potential benefits of fusing data from additional sensor modalities that operate across various spectral ranges. The research also reveals that sensor fusion can increase accuracy and reliability in semantic segmentation, although the optimal selection of sensor combinations remains critical.

This thesis underscores the feasibility and benefits of using advanced sensor technologies and deep learning for façade material classification, contributing to the goals of the European Union's Renovation Wave strategy by supporting more accurate and efficient building renovations. Future work should expand the dataset and explore alternative deep learning approaches, such as cross-modal attention mechanisms, to further enhance the classification accuracy and reliability of these systems in complex real-world environments.