

Evaluating the Transferability of 3DMASC Random Forest Models Across Mobile LiDAR and SfM Point Clouds for Urban Feature Classification

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SUMMARY

Accurate classification of urban point clouds is critical for application in planning, infrastructure monitoring and environmental management. Transferability across sensing modalities remains uncertain. This study evaluates a classical, feature-based approach. We test 3DMASC Random Forest models on two datasets. The first dataset is Toronto-3D mobile LiDAR (MLS), while second is an UAS Structure-from-Motion (SfM) dataset from Umngeni Valley. Multi-scale geometric descriptors were extracted, including linearity, planarity, sphericity, eigenvalue ratios and Z-range. The study evaluated three scenarios, namely training and testing within a single modality; cross-modality transfer between datasets and merged-dataset training with subsequent testing on each modality separately. Class balance was maintained using a 70:30 training-to-testing split and performance was evaluated through accuracy, precision, recall, and F1-score. The results showed strong within-modality performance, with MLS achieving 85% overall accuracy and SfM 76%. Cross-modality transfer, however, resulted in marked declines, the UAS-SfM to MLS transfer achieved only 69% accuracy and MLS to UAS-SfM dropped further to 52%. These findings demonstrated the sensitivity of vegetation and building classes to acquisition geometry and point density differences. By contrast, merged-dataset training improved robustness. The combined model yielded 83% accuracy when tested on MLS and 72% on SfM. Feature importance analysis confirmed the dominance of coarse-scale descriptors, with sphericity identified as the most influential feature. MLS performance benefited from the incorporation of vertical range information, while SfM relied more heavily on shape-based descriptors. Classical, feature-based models can generalise across heterogeneous urban point clouds when trained on combined data. Transfer remains class-dependent due to viewpoint and density differences. This study provides insights into the potential for classical, feature-based classifiers to transfer across heterogeneous urban datasets, which may reduce the need to retrain models for each new dataset.

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