Deep Learning-Based BIM Automation: Advanced 3D Reconstruction with Material Integration for Indoor Elements

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Abstract

Building information modeling (BIM) models play a crucial role in reducing project expenses, supporting building design and renovation efforts, and enhancing the efficiency of building management. However, BIM models often emphasize geometric details while neglecting essential material attributes, which are vital for accurate facility assessments, budgeting estimation, and sustainable design practices. Current material recognition techniques typically exhibit limited accuracy and focus on a narrow range of materials, with an emphasis on 2D image detection rather than 3D reconstruction. This research introduces a novel scan-to-BIM framework that employs deep learning to automatically incorporate both geometric and material attributes from a terrestrial laser scanner point cloud data. It offers a precise workflow for reconstructing structural and non-structural 3D BIM models, capturing geometry, position, quantity, shape, and orientation features. A novel material classification model based on point cloud characteristics is proposed. An integrated algorithm is also included in the Revit platform to enable automated 3D modeling of indoor components. The findings demonstrate the framework's effectiveness in achieving high geometric accuracy for structural elements while ensuring non-structural 3D BIM models retain key real-world characteristics. Furthermore, the material recognition model showed promising performance, with a point-based weighted average F1-score of 0.97 and an object-based weighted average accuracy of 94.74%.

Keywords

Building information modeling (BIM), scan-to-BIM, material classification, point cloud data, deep learning.