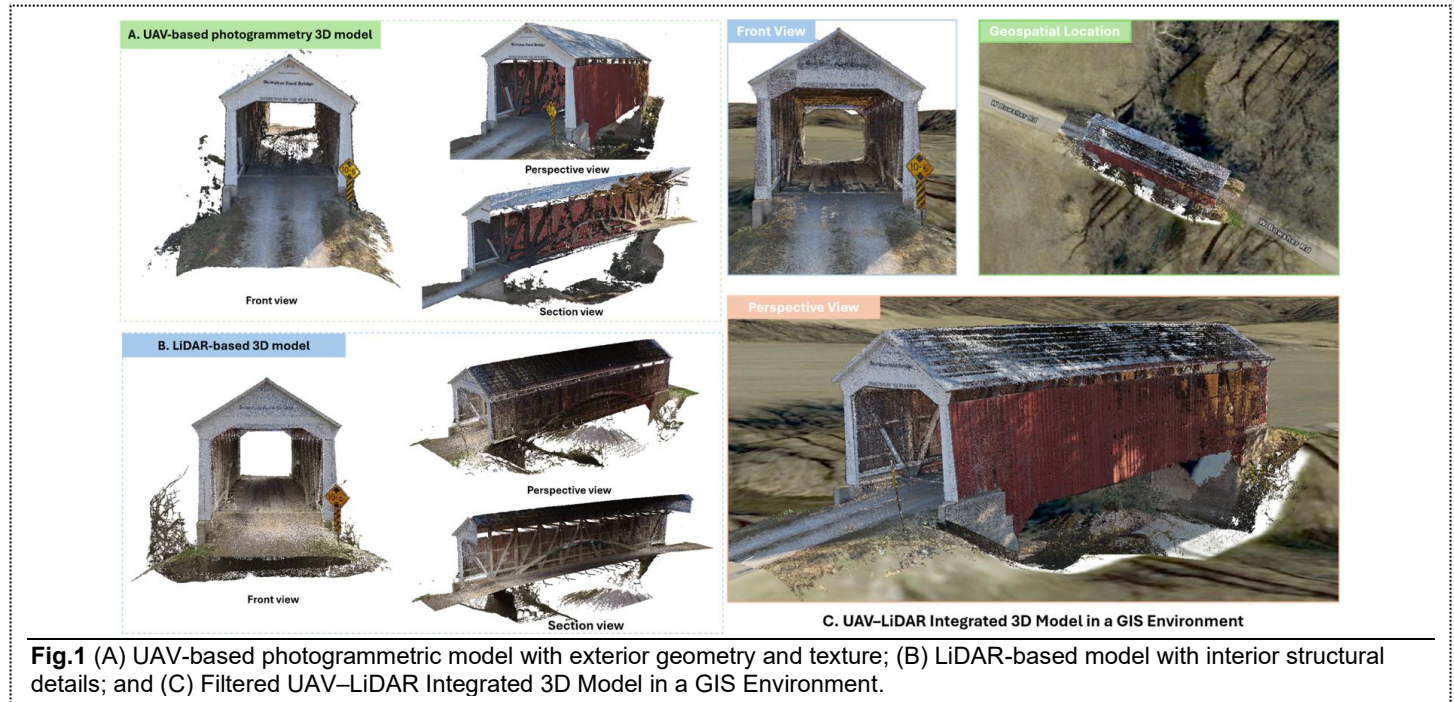


Applied Deep Learning–Enhanced Remote Sensing for Indiana Infrastructure Assessment.

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Background: Covered bridges are an important part of historic infrastructure, and their preservation requires detailed documentation of both exterior appearance and interior structural features. However, their enclosed configuration and complex geometry make comprehensive 3D data acquisition challenging relying on a single sensing technique. UAV-based photogrammetry efficiently captures exterior surfaces with rich visual texture, while LiDAR scanning directly captures 3D geometry and is less affected by non-uniform or limited illumination inside the bridge. Deep learning–based filtering is applied to remove surrounding environmental elements, such as trees and vegetation. The processed UAV and LiDAR point clouds are integrated and georeferenced within a GIS environment to create a comprehensive 3D dataset of the covered bridge for structural health monitoring and assessment.

Framework: The project integrates LiDAR, UAV-based photogrammetry, deep learning methods, and GIS to develop a comprehensive 3D dataset of covered bridges. UAV imagery is processed using Structure from Motion (SfM) and Multi-View Stereo (MVS) to reconstruct a 3D point cloud that captures the exterior geometry and rich surface texture of the bridge (Fig. 1A), while LiDAR scanning is used to acquire detailed interior geometry under limited and non-uniform lighting conditions (Fig. 1B). Deep learning methods are applied to rapidly and automatically remove surrounding environmental elements, including trees, shrubs, vehicles, and

other irrelevant or noisy points. The processed UAV and LiDAR point clouds are then registered and integrated into a unified 3D model, combining the exterior geometry and texture information captured by UAV photogrammetry with the interior structural details captured by LiDAR. Following spatial calibration and georeferencing, the integrated model is imported into ArcGIS and integrated with terrain data to represent the covered bridge within its real-world geographic and topographic context (Fig. 1C).

Main Results:

- Developed an integrated framework combining the complementary strengths of UAV imagery, LiDAR, deep learning, and GIS to establish a comprehensive 3D covered bridge dataset.
- Created an integrated 3D dataset containing rich exterior texture, detailed interior structural geometry, and real-world geospatial information of the covered bridge.
- Established a spatially referenced 3D dataset that provides comprehensive structural and geographic information for structural health monitoring.

Reference:

Sestras, P., Badea, G., Badea, A. C., Salagean, T., Roșca, S., Kader, S., & Remondino, F. (2025). Land surveying with UAV photogrammetry and LiDAR for optimal building planning. *Automation in Construction*, 173, 106092. <https://doi.org/10.1016/j.autcon.2025.106092>