Semantic segmentation of bridge components from point cloud data using Random Forest machine learning

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The diverse topography of Taiwan makes bridges the vital infrastructures for connecting domestic transportation. To ensure the safety of all bridge users, regular inspection and monitoring is essential. The traditional bridge inspection method is considered risky, time-consuming, and labor-intensive. Nowadays, many studies are focusing on smart bridge inspection and Bridge Information Model (BrIM). BrIM is a digital modeling approach that uses Building Information Modeling (BIM) technology specifically for bridge design, construction, and management. In general, it often consists of geometrical and non-geometrical bridge information. For the structural and geometrical information of bridges, with various instruments and techniques continuously developing and updating, it is easy to obtain the laser- or image-based three-dimensional (3D) point cloud data. However, the current modeling processes still heavily rely on manual work. Automated identifying and segmenting the bridge components from point clouds is one of the most challenging tasks.

In this study, image data is collected from both unmanned aerial vehicles (UAV) and handheld digital cameras. By using the photogrammetric approach, we produce dense 3D point clouds of the bridge through SfM-MVS techniques. We perform Random Forest machine learning tasks to automatically segment different components of reinforced concrete bridges, including slab, pier, pier cap, girder, and diaphragm. We perform the accuracy assessment through common validation indexes to evaluate our semantic segmentation results. As the starting point, the results provided a potential solution to automatic semantic segmentation of the bridge components. After semantic segmentation, point cloud data can be converted into meaningful categories for further processing and analysis.

Keywords: Bridge components, Point cloud data, Semantic segmentation, Random Forest