engineering proceedings

MDPI

Abstract

Transform Physical Assets to 3D Digital Models †

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† Presented at the 1st International Online Conference on Infrastructures, 7–9 June 2022; Available online: https://ioci2022.sciforum.net/.

Keywords: point cloud; contextual knowledge; surface extraction; digital twin; infrastructure inspection

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Citation: Truong-Hong, L. Transform Physical Assets to 3D Digital Models. *Eng. Proc.* **2022**, *17*, 5. https://doi.org/10.3390/engproc2022017005

Academic Editor: Joaquín Martínez-Sánchez

Published: 6 May 2022

It is clearly a huge benefit for infrastructure monitoring, inspection, and management when a digital twin (DT) is developed to represent a real physical infrastructure. Three-dimensional (3D) geometric models of physical assets, particularly as-is 3D models, is the backbone of the DT, which are used to integrate real-time information of the physical assets and are fundamental components for modelling and simulation to predict responses of infrastructure. In the DT concept, the digital model requires to automatically update changes of physical infrastructure in an accurate and timely manner. Today, laser scanning sensors and cameras integrated into laser scanners, drones, and other surveillance equipment allow us to capture 3D topographic information of objects' surfaces in a 3D space with different level of detail and accuracy. As such, 3D point clouds representing to surface information of infrastructure derived from these surveying tools are to be a fundamental resource in creating 3D geometric models for DT. Automatically generating digital models from the 3D point clouds presents many challenges due to adverse quality and quantity of data points, massive data points, and highly complex geometries of 3D objects and scenes [1]. Moreover, in practice, existing workflows to achieve detailed, precise 3D geometric models of physical assets are mostly based on human work, implying high time consumption, cost, and possibility of human error. This paper proposes a framework using both spatial information of point clouds and contextual knowledge of objects to automatically extract point clouds of individual surfaces of objects of infrastructure (e.g., buildings and bridges). Contextual knowledge can include lower and upper bounds of dimensions of the objects, and a geometric relationship with adjoined objects. The main goal of the use of contextual knowledge is to support in estimating input parameters, to roughly extract point clouds of interest, and to filter unrealistic objects to be recognized. By integrating contextual knowledge into the framework, only a subset containing the point cloud of each object of interest needs be processed to extract the surfaces, the proposed framework can handle large bridge data sets. Once the point cloud of individual surfaces of each structural component are available, the 3D models of the structure can be created, or surface damage can be identified. Buildings and bridges are selected as case studies to demonstrate the proposed framework [2,3].

Funding: This study was funded by the generous support of the European Commission through H2020 MSCA-IF, "BridgeScan: Laser Scanning for Automatic Bridge Assessment", Grant 799149.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Acknowledgments: The authors also thank Dat Hop Company Limited, Ceotic., JSC and GeoInstinct Vietnam for their providing the laser scanning data.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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