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Abstract

Transform physical assets to 3D digital models †

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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. One of a backbone of the DT is as-is three-dimensional (3D) geometric models of physical assets, which are used to integrate real-time information of the physical assets and are fundamental components for modelling and simulation to predict response of infrastructure. In the DT concept, the digital model must be automatically update changes of physical infrastructure accurately and timely. Today, laser scanning sensors and cameras integrated into laser scanners, drones and other survey equipment allowing to capture 3D topographic information of objects' surfaces in a 3D space with different level of details and accuracy. As such, 3D point clouds are to be a fundamental resource to create 3D geometric models for DT. Automatically generating digital models from the 3D point clouds presents high challenges due to adverse quality and quantity of data points, massive data points, and highly complex geometries of objects and a 3D scene. Moreover, in practice, existing workflows to achieve detailed precise 3D geometric models of the physical assets are mostly based on human work implying time-consuming, costly, and human errors. 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 need to 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.

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Appendix A

None

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