Acquisition and Processing of Thermal Data Using Lidar Scaner in Industrial Heritage

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Abstract

This work presents a methodology for the acquisition, validation, and processing of geometric and thermal data obtained through LiDAR scanning of industrial heritage buildings. The objective is to generate a digital thermal model capable of associating surface temperature values with architectural and structural elements of the environment. The proposed methodology combines the acquisition of an omnidirectional thermal point cloud with the generation of a BIM model in IFC format, enabling the automatic assignment of temperature values to construction elements. Results demonstrate the feasibility of integrating dense thermal data into digital building models for energy assessment and heritage rehabilitation purposes.

1. Introduction

Recent advances in LiDAR technologies have enabled highly accurate geometric digitization of indoor building environments, facilitating the generation of digital models for inspection, maintenance, and rehabilitation purposes. In parallel, thermal sensing technologies have greatly evolved ([1], [2]) and are increasingly being incorporated into building analysis workflows, as they provide valuable information regarding energy losses, thermal anomalies, and the overall thermal behaviour of construction elements.

The combination of three-dimensional digitization and thermographic sensing has recently attracted considerable attention in the Architecture, Engineering and Construction (AEC) domain. Several studies have reported the use of thermal digitization systems to obtain thermal point clouds of indoor environments or heritage buildings, supporting tasks related to building inspection and energy analysis ([3], [4]). There are also approaches that establish associations with IoT sensors, which may include temperature sensors ([5], [6]). However, despite these advances, most existing approaches remain focused on the generation of thermal maps rather than the integration of thermal information into semantically structured BIM models.

In this context, the present work aims to define a practical methodology for integrating geometric and thermal information into a digital model of an industrial heritage building. Specifically, the study focuses on the acquisition and validation of thermal data and its subsequent association with the elements of an IFC-based BIM model, enabling the extraction and visualization of temperature information of the building.

2. Case Study

The study focuses on a warehouse representative of the catalogued constructions conforming the campus of the University of Castilla-La Mancha, located in the city of Toledo (Spain). The construction is a former Weapons Factory from the late XIX century, now used as a space for academic events.

Geometric and thermal data collection was carried out using a LiDAR sensor during one of the hottest days of July, ensuring representative thermal gradients in the building envelope and internal elements. The acquisition process generated a dense thermal point cloud of the environment, allowing the temperature distribution of walls, roofs, structural components, and glazing elements to be analysed.

To validate the reliability of the thermal measurements, ambient, indoor, outdoor, and local surface temperatures were monitored simultaneously at different locations using contact sensors. This comparative analysis enabled verification of the thermal consistency between the acquired point cloud and ground-truth measurements.

An application was developed to enable interactive visualization and consultation of thermal information associated with the scanned scene. In addition, an automatic algorithm based on point registration and proximity analysis was implemented to associate temperature values extracted from the thermal point cloud with the corresponding elements of an IFC model. The resulting thermal model facilitates the identification of thermal anomalies and enables future analyses related to energy efficiency and environmental performance of the building.

3. Conclusions

The experimental results demonstrate the reliability of the acquired thermal information and its suitability for integration into BIM-based workflows. Furthermore, the developed methodology facilitates the visualization and exploitation of thermal information for future applications related to building rehabilitation, energy efficiency assessment, and thermal simulation through CFD-based analyses. This work therefore represents a step forward towards the development of richer digital models for the inspection and conservation of industrial heritage buildings.

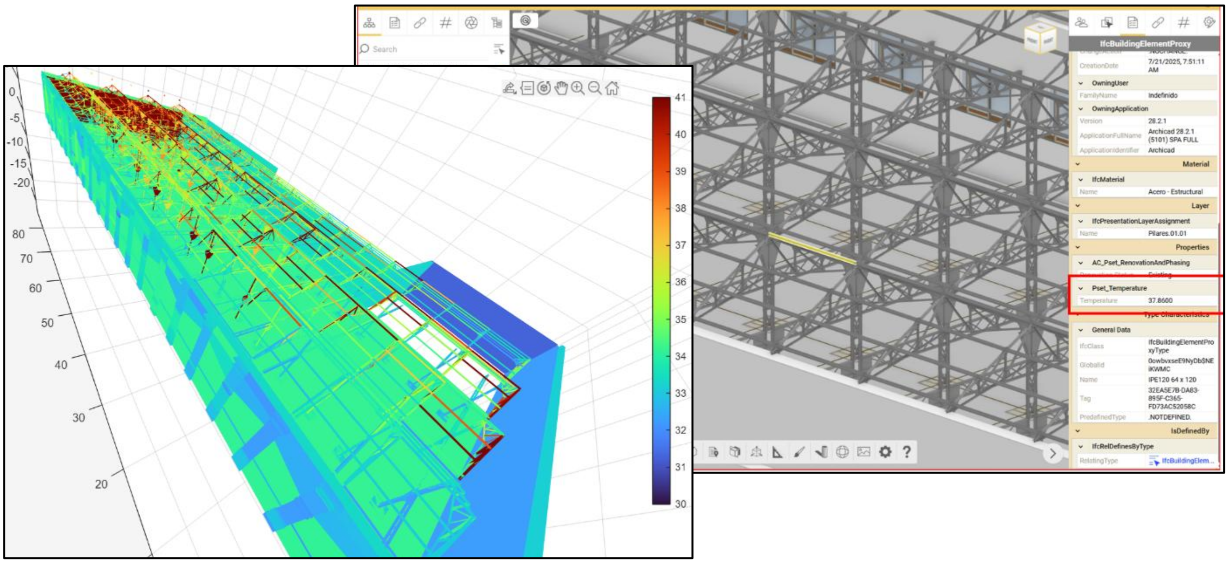

Figure 1. View from outside the IFC model using a custom viewer, where the mean temperatures of all elements are displayed through a colour code. On the right, the IFC model of the warehouse with embedded temperature information is shown in an openBIM viewer. The temperature of the selected element (highlighted in yellow) can be observed as 37.86°C.

4. Acknowledgements

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