POLITECNICO DI TORINO

Honors thesis

MASTER OF SCIENCE IN
ARCHITECTURE CONSTRUCTION CITY

Abstract

Drones application for safety in construction sites and in technical measures for seismic emergency response

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The alarming statistics on workplace injuries, which have occurred in Europe in recent years, place the construction industry at the top of the standings for the amount of fatal injuries. With its interdisciplinary nature and its techniques of vital importance for the management of georeferenced spatial information, Geomatics represents a discipline in which relevant relationships with the design and management of safety in construction sites arise. Although Geomatics contributions in this area have not been fully investigated, this thesis aims to highlight them.

Even in cases where the built heritage has been damaged by natural disasters, such as earthquakes, it is necessary to plan monitoring measures and interventions on buildings in a safe way. Performing urgent technical interventions in a seismic emergency is a very different task from designing an ordinary construction site, since it involves additional risks for the safety of workers. Thanks to the spread of drones, along with the improvement of photogrammetry software and image-matching algorithms, in recent years Geomatics solutions have actively contributed to this field, documenting damages to historical and cultural built heritage with fast, accurate and cost-effective procedures.

As far as traditional construction sites are concerned, an unmanned aerial photogrammetric acquisition campaign has been performed in the first part of this thesis, gathering data for the creation of the 3D model of a construction site. The generated model allowed reliable measurements in real time and it is meant to be used as an additional tool for risk assessment. Using modern cartographic tools and GIS metadata, which are available online, an operational workflow has been proposed to analyse and identify the risk factors associated with the site, including any potential circumstance that could interfere with the safe execution of the required working tasks in each context.

Regarding technical measures for seismic emergency response, and given the need to reduce fire-fighters' stay time in hazardous areas, an experimental method for rapid metric surveying has been drawn up and tested in the second part of this thesis, in order to provide a fast and reliable solution aimed at the design of provisional structures for the Italian National Fire Corps. The proposed method allowed to scale 3D models, generated through unmanned aerial photogrammetric surveys, using only a couple of measures gathered at the base of the building to shore up.

The discussed case study is part of the data acquisition campaign conducted by the Politecnico di Torino’s team DIRECT (DIsaster RECover Team), which took part in a project that involved the University in the documentation of the areas in central Italy affected by the earthquake swarm of August 2016. After demonstrating the effectiveness of the proposed method, tested on the Romanesque-Gothic portal located in the cloister of the Duomo Vecchio complex of San Severino Marche (MC), it was decided to proceed with two practical applications of the proposed procedure, with the aim of designing temporary structures both for the double lancet window of the bell tower and for the main portal of the same architectural complex.

According to this thesis, remote sensing guarantees the highest safety standards for workers; the use of low-cost sensors, especially those related to aerial photogrammetry, is a good compromise between accuracy and time for metric data acquisition. In addition, these systems are proving to be reliable in case of emergency, especially for the acquisition and management of large amounts of metric data. High-quality 3D models and textures, extracted during post-processing, can be shared through open source platforms, ensuring participatory design, both in ordinary construction sites and in urgent technical interventions in case of a seismic emergency.

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“Fish-eye” image of the construction site located in Bersezio (CN), taken using a Parrot “Bebop 2” drone.

UAV Survey of the bell tower of Duomo Vecchio di San Severino Marche (MC), carried out using a DJI "Phantom 4 PRO" drone.

Image of the west facing double lancet window of the Duomo Vecchio di San Severino, damaged by the earthquake swarm of august 2016.

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