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Capability Project

Per-Building Structural Damage Methodology Report Using Multi-View Oblique Airborne Imagery

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Abbreviations and Acronyms

ABBREVIATION	DESCRIPTION
BOW	Visual Bag of Words
DEM	Digital Elevation Model
DSM	Digital Surface Model
EMS-98	European Macroseismic Scale 1998
GLCM	Grey Level Co-occurrence Matrix
GSD	Ground Sampling Distance
HoG	Histogram of Gradient Orientation
RF	Random Forests
SIFT	Scale Invariant Feature Transform
SURF	Speeded Up Robust Features
SVM	Support Vector Machines
UAV	Unmanned Aerial Vehicle
VHR	Very High Resolution
WSN	Wireless Sensor Network

Glossary of Terms

Histogram	The histogram of an image visualises the distribution of the brightness in the image by plotting the number of occurrences of each brightness.
LiDAR	Light intensity detection and ranging, which uses lasers to stimulate fluorescence in various compounds and to measure distances to reflecting surfaces.
Nadir	Point on the ground directly in line with the remote sensing system and the centre of the earth.
Oblique image	Image acquired with the camera intentionally directed at some angle between horizontal and vertical orientations.
Overlap	Extent to which adjacent images or photographs cover the same terrain, expressed as a percentage.
Pattern	Regular repetition of tonal variations on an image or photograph.
Resolution	Ability to separate closely spaced objects on an image or photograph. Resolution is commonly expressed as the most closely spaced line-pairs per unit distance that can be distinguished. Also called spatial resolution.
Scale	Ratio of distance on an image to the equivalent distance on the ground.
Scene	Area on the ground that is covered by an image or photograph.
Stereo pair	Two overlapping images or photographs that may be viewed stereoscopically.
Supervised learning	Techniques used to learn the relationship between independent attributes and a designated dependent attribute (the label). Most induction algorithms fall into the supervised learning category.
Terrain	Surface of the earth.
Texture	Frequency of change and arrangement of tones on an image.

Executive Summary

In RECONASS, remote sensing is one of the technologies used for assessing the damage state of the buildings after a disaster event. Pertaining to that, in WP4 of RECONASS, a remote sensing based exterior building damage assessment subsystem is being developed solely by ITC. The primary objective is to provide automated detailed information of damages to every exterior element of the building using the remote sensing images and the products derived from them such as 3D point clouds. The primary prerequisites to achieve the objective are 1) automatic delineation of individual buildings and 2) automatic identification of various kinds of damage evidences required for damage assessment such as spalling, openings in building due to damage, debris/rubble piles mapping and quantification. The automatic extraction of those prerequisites demands remote sensing data with rich radiometric and geometry features and significant coverage of building (top + side views). Images of unmanned aerial vehicles (UAV) are the preferred data source, as UAVs are highly flexible in capturing images with specific characteristics, such as high frame overlap, high spatial resolution (rich radiometric features) and with multiple camera views (coverage of top and sides of the buildings). All of these are mandatory for photogrammetric processing and 3D point cloud generation (rich geometric features). The methodologies for performing the aforementioned tasks, i.e. automatic building delineation and damage evidences detection, have been largely developed as part of this sub-system that are specially (but not only) suitable for UAV images and kind of 3D point cloud derived from them. The developed methods are novel in the field of remote sensing based damage assessment. They are tested through numerous experiments using significant number of datasets of different kind. The outcome of the experiments reveals that the developed methods are significant for a reliable damage assessment. The developed methods are part of the remote sensing based building damage assessment sub-system which is fully automatic and requires only the UAV-captured images as input. From those images, the sub-system automatically generates a so-called 3D point cloud of the scene. Using the images and 3D point cloud, the sub-system automatically identifies the completely collapsed and intact buildings in the scene. The intact buildings are further analysed for the presence of damage evidences such as spalling and openings in building caused by the damage along every exterior element of the building. Also, the debris and rubble piles around the building are detected and quantified in terms of m^3. All the above derived information as part of this deliverable 4.1 are the base for performing other subsequent tasks in WP4 which will be addressed in the subsequent deliverables in due course. This includes the synergistic use of the derived information with wireless sensor based assessment from WP3 for 1) validation of the outcome of one technology with another; 2) image-based assessment as a proxy in case of any sensor information loss; 3) to improve the sensor based assessment if any inconsistency is observed. Also, the local damage assessment for the RECONASS monitored and neighbouring buildings based on UAV's data are used to validate and calibrate the damage maps of larger areas produced by different agencies based on the satellite images.