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Capability Project

Methodology for integrated satellite and airborne data-based synoptic damage assessment

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ABBREVIATION	DESCRIPTION
CNN	Convolutional Neural Network
EMS-98	European Macroseismic Scale 1998
GLCM	Grey Level Co-occurrence Matrix
GIS	Geographical Information System
GSD	Ground Sampling Distance
SVM	Support Vector Machines
UAV	Unmanned Aerial Vehicle
VHR	Very High Resolution
WP4	Work Package 4

GLOSSARY OF TERMS

Histogram	The number of occurrences of each category in a given boundary
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.
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.
Texture	Frequency of change and arrangement of tones in 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 was developed solely by ITC and delivered in D4.1. The developed sub-system is fully automatic, requiring 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 buildings are detected and quantified in terms of m^3.

One of the other objectives of RECONASS is how to determine the use of the local damage assessment provided by the developed sub-system using the UAV images of the RECONASS monitored and neighbouring buildings to validate and calibrate the damage maps produced for larger areas. This objective is proposed because in general, after a disaster event, numerous damage maps are produced by many agencies to aid emergency response actions. However, these maps are often not validated due to lack of ground truth data, which creates challenges for potential stake holders to choose a suitable and reliable damage map. Moreover, assessments in satellite maps are often found to be either under- or overestimating actual damage due to various reasons. Perhaps the variations in assessments could be systematic with respect to some physical or functional entities associated with the damage area. In such case, the systematic variations can be corrected by designing an appropriate calibration procedure. Also, operational damage maps continue to be generated by manual visual interpretation, typically of satellite images. However, with the advancement in the technologies, automated damage detection from satellite images is becoming feasible. For example, supervised learning models developed based on appropriate training samples have been shown to be capable of mapping damage automatically from the images. However, for all the aforementioned processes such as validation, calibration and automated damage mapping from images, a significant number of ground truth samples is required. Manual collection of ground truth data is typically not practical in case of emergency circumstances. The local assessment of damaged buildings with the RECONASS sub-system is considered to be more accurate and reliable compared to the assessment from satellite images, due to the superior characteristics of UAV images. Hence, these assessments can serve as ground-truth for the aforementioned processes. To address these aims two independent conceptual frameworks are developed for validation and calibration of damage maps using the local assessments from RECONASS subsystem, installed in well-distributed geographic locations, as ground-truth. Also, a method for automated classification of satellite image for damage detection is developed using the supervised learning method by considering the aforementioned type of assessments from RECONASS subsystems as ground-truth samples for training the model.