Road Damage Extraction From Post-Earthquake UAV Images Assisted by Vector Data

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I . Introduction

- **Why Earthquake?**

Earthquake is one of the most devastating natural disasters followed by secondary geologic disasters, such as landslide, collapse and debris flow, and it usually cause huge damage to roads network.

- **Importance of road damage information?**

The roads network, considered as transportation lifeline, has a critical impact on rescue and reconstruction missions after earthquake. Acquiring road damage information makes it possible for decision makers to arrange relief routes.

- **What can remote sensing do?**

Very high resolution(**VHR**) images can be obtained more easily, thanks to the fast development of Unmanned Aerial Vehicle(**UAV**). It provides massive amount of data for post-earthquake information extraction and assessment.

II . Objectives

Many researches have concentrated on using remote sensing images to detect buildings destruction.

When it comes to road damage detection, it becomes a difficulty to improve the efficiency and correctness. Thus, with the assistance of vector road data, a new method is proposed to:

- **Extract road damage information.**
- **Assess road accessibility**.

from post-earthquake UAV images of stricken areas.

III. Methods

❑ General Overview

This method can be divided into **four steps**.(Figure 1.)

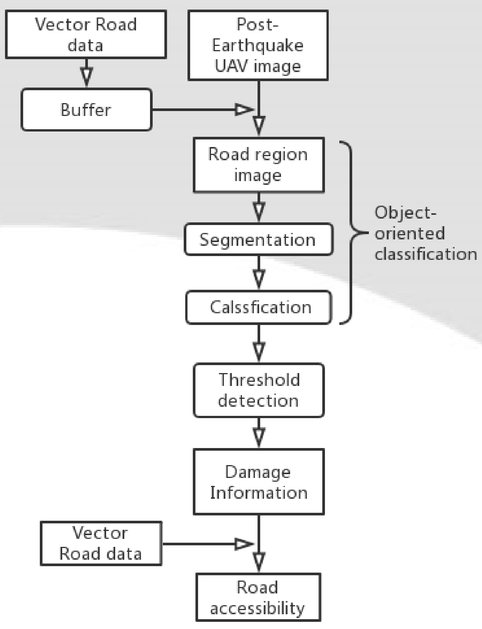


Figure 1. Method Flowchart

❑ Object-Oriented Road Regions Extraction

A large-scale parameter is set to apply **multi-resolution segmentation**. It is assumed that only two categories exist in the image: road (including both damaged and undamaged part) and vegetation. By using textures and brightness of object as constraint, roads and non-roads objects can be distinguished.

❑ Damage detection

A **grey-scale threshold method** is proposed to detect damaged parts and extract their attribute.

- Second-time Segmentation: smaller scale parameter, capture the anomaly of image.
- Brightness, GLCM Contrast, GLCM Standard Deviation and MaxDiff are chosen to be descriptors.
- Draw a boxplot for each feature. The numbers fall out of the boxes are considered as damaged road objects.

❑ Assessment of road accessibility

Road accessibility can be categorized into three categories: **clear**, **partially passable** and **totally blocked**.

- Coefficient ρ is proposed to define whether road is completely damaged or partially blocked.

$$\rho = \frac{W_{damage}}{W_{road}}$$

where W_{damage} and = width of damaged object, W_{road} = width of road.

- If ρ is greater than 0.7, we assume that both lanes of the road are broken, and even small-sized vehicle cannot pass.
- When ρ is between 0.2~0.7, the road is regarded as partially passable.

IV. Experiments and Results

❑ Data

An Ms 7.0 earthquake occurred in Jiuzhaigou, China on 8th August, 2017. The UAV data is acquired on 12th August 2017. It covers most of the heaviest stricken area, with the space resolution of 0.15m.

❑ Processing

- **Buffer radius**: 5m
- **First segmentation**: scale parameter: 60, shape factor: 0.1, compactness factor :0.5.
- **Vegetation remove**:

GLCM Contrast ≥ 390,

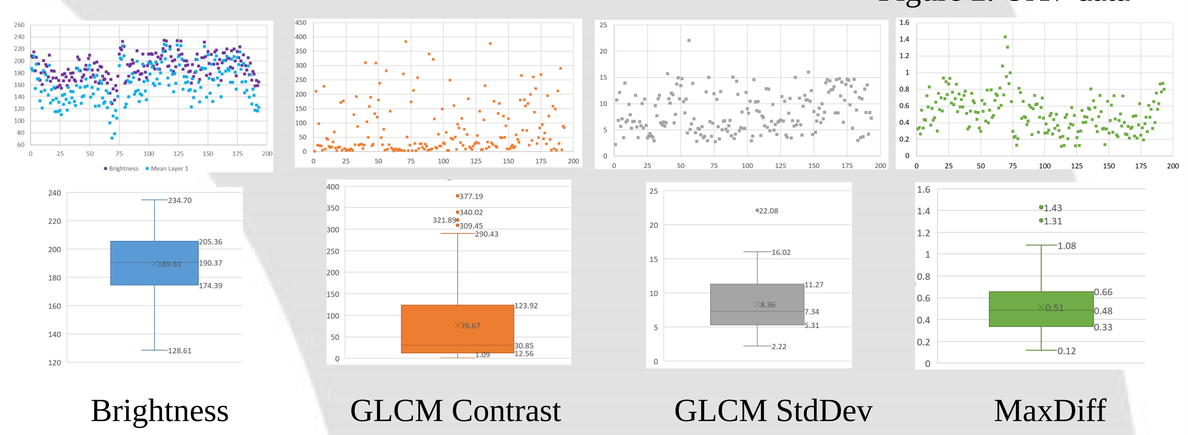
0 < Brightness <180.

- **Second-time segmentation**:

scale parameter : 10, shape: 0.1, compactness : 0.7.

- Export road region objects along with these features:193 objects are achieved, and scatter plots for some features are drew. (Figure 3.)

Figure 2. UAV data



Brightness GLCM Contrast GLCM StdDev MaxDiff

Figure 3. Scatter plots and Boxplots of Road objects

- Given the box boundaries and error factors, we consider objects with brightness greater than 200, or smaller than 120 as road damage class. Exporting the polygon and point feature layer, **damage information extraction result** is clearly displayed in Figure 4. The extraction accuracy is nearly up to 81%.

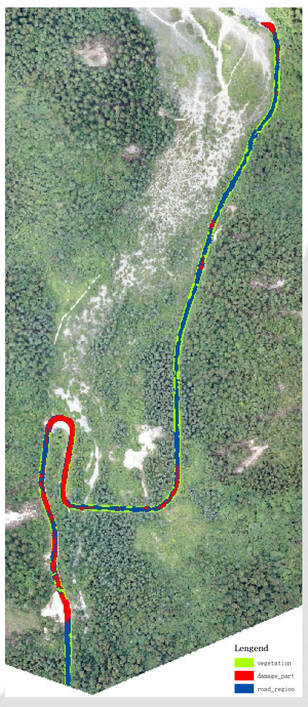
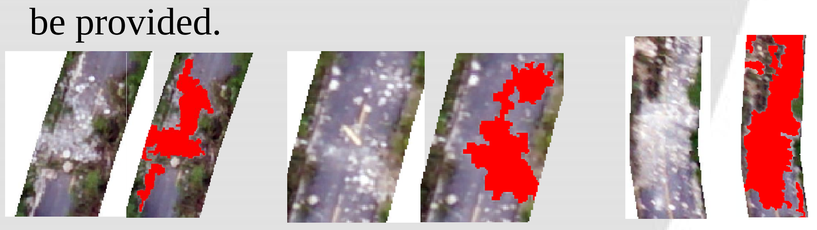


Figure 4. Exported result

- **Damage assessment and road accessibility.** We can get the attribute of restraining mass. Figure 5. shows three groups of road damage. In Figure 5(a) and (c), the dropping rubble stem the road, and ρ value is greater than 0.7, we infer that cars cannot pass these areas. In Figure 5(b), ρ equals 0.44, that means only half of the road surface is affected, small vehicles or experienced drivers can make it through. The most basic traffic capacity can still be provided.



(a) ρ=0.84 (b) ρ=0.44 (c) ρ=0.95

Figure 5. Road Accessibility Assessment

V . Conclusions

- In this paper, threshold detection method is proposed. A method for mono-temporal remote sensing image to extract damage information is applied. With the assistance of vector road data, images and road region can be easily located and the total data size is greatly reduced.
- Admittedly, there remains some unsolved problems. Over bright undamaged road area will influence the final result and center lines confuses the computer for wrongly take them as exceptional spectral value. What's more, the efficiency and parallelization still look for further elevation.