HIGH RESOLUTION SAR IMAGING EMPLOYING GEOMETRIC FEATURES FOR EXTRACTING SEISMIC DAMAGE OF BUILDINGS

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1. INTRODUCTION

HR optical RS image is widely applied in emergency stage of earthquake, but it is restricted by post-EQ acquiring in cloudy, rainy or foggy weather, only in the daylight. SAR is usable without the above restriction, but difficult to be interpreted (Brett, 2013) directly because of deformed, complicated geometry and significant speckle noise.
The aim of the research is to develop method to detect seismic damage of building suitable for SAR images.

2. GEOMETRIC AND TEXTURE FEATURES OF SEISMIC DAMAGE OF BUILDINGS IN SAR IMAGING

The building imaging is affected by layover, double bounce scattering and shadow etc. on the slant range SAR images. For a building model with uniform surface located in a flat ground, if the aircraft with SAR sensor flights parallel to the direction of building, then there will be three SAR imaging models according to the building height (h), width (w) and the incidence angle of SAR sensor, as shown in Figure 1 &2.

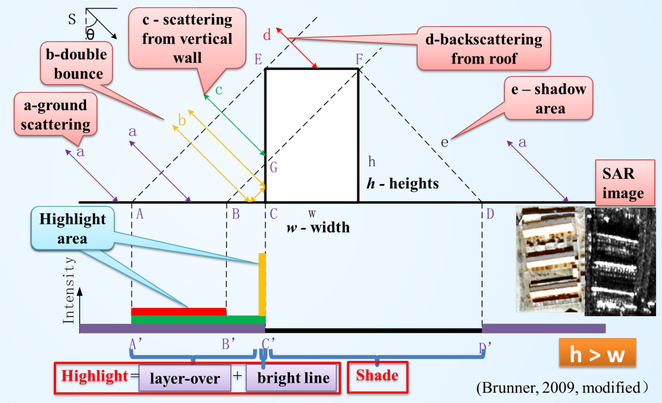


Fig 1 SAR Scattering from a simple flat roof building model

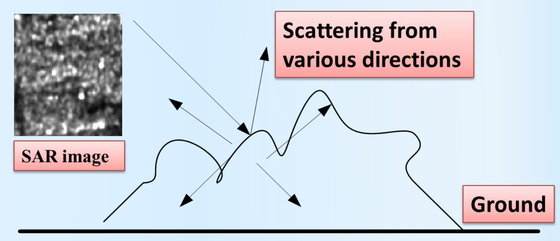


Fig 2 SAR scattering features of collapsed building

3. Texture Features of Seismic Damage of Buildings in SAR Imaging

Cui et al (2016) collected SAR images in shadow area and layerover area of 28 individual un-collapsed buildings, and images in collapsed area of 28 individual collapsed buildings from the post-earthquake airborne SAR image in Jiegu town which is seriously damaged by 2010 Yushu earthquake. The texture features of homogeneity, dissimilarity and entropy combined between shadow area & layerover area for un-collapsed buildings or the collapsed area of collapsed buildings are compared respectively, as shown in Figure 2. The results show that the better separability of collapsed building from un-collapsed building exist by using texture features in combinatorial geometric feature areas in SAR images, which provides a key basis to develop extraction methods of seismic damage of buildings based on high resolution SAR images.

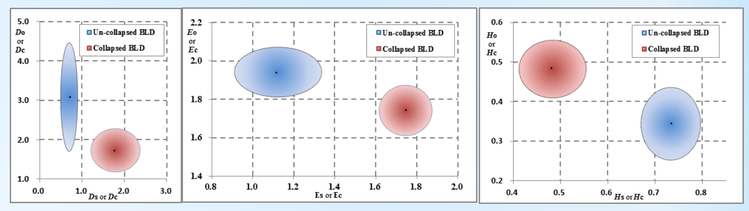
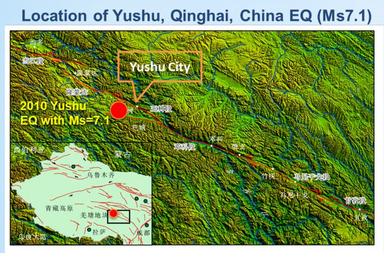


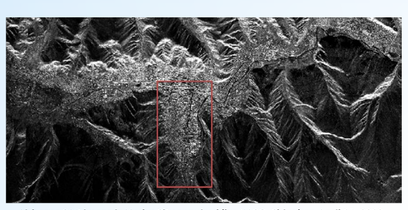
Fig 3. Mean and standard deviation of texture's in layover and shadowing areas of un-collapsed buildings, and the collapsed area of buildings.

4. EXTRACTION TEST OF SEISMIC DAMAGE OF BUILDING FROM SAR IMAGE

Tcollapsed and un-collapsed buildings can be well discriminated according to the geometric features on SAR imaging by the assistance of vector data of buildings prepared before an earthquake occurs, or extracted immediately from pre-earthquake high resolution optical images in post-earthquake emergency stage. While it may be difficult in the case of lack of building vector data before earthquakes. Another corollary according to the above analysis is that, because of the layerover and double bounce scattering, there exist a certain ratio of high bright area to the street block area in SAR images, and such ratio is related to the proportion of building collapse in the block. Therefore, in the case of only post-earthquake SAR images acquired, such ratio is useful to assess quantitatively the distribution of seismic damage in street blocks.

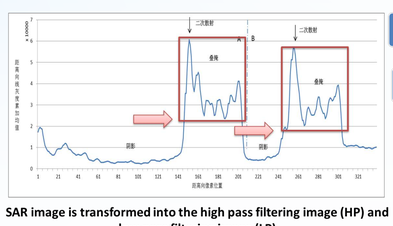


(a) Location of Yushu, Qinghai, China EQ (Ms7.1)



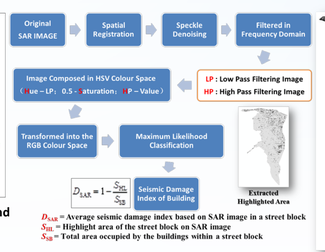
Airborne SAR image in Yushu City acquired (by NASG, China) on April 17, 2010, immediately after Yushu, Qinghai, China earthquake (Ms7.1) on April 14.
The high resolution (0.5m) airborne X-band SAR intensity image

(b) Airborne SAR image in Yushu City

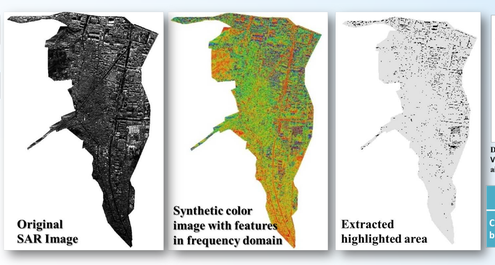


SAR image is transformed into the high pass filtering image (HP) and low pass filtering image (LP)

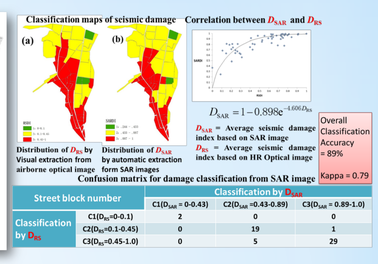
(c) SAR image transformation



(d) Extraction of seismic damage from SAR



(e) Synthetic colour image by features in frequency domain



(f) Seismic Damage Classification

Fig 4. Extraction test of seismic damage of building from sar image

4. CONCLUSION and ACKNOWLEDGEMENT

The results shows that the relative completed and continuous imaging geometry features including layerover, double bounce scattering (highlight line) and shadow for the un-collapsed buildings. Such completeness and continuity will be destroyed for collapsed or partially collapsed buildings. It is shown that the spatial occurrence rate of the highlight area can be used as a good indicator for identification of the seismic damage. Feature extraction method was proposed by using high pass and low pass filtering in frequency domain. A post-earthquake airborne high resolution SAR image in the Jiegu town (Yushu City) was chosen and verified the effectiveness of the method proposed in the paper.

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