MONITORING OF COLLAPSED BUILT-UP AREAS WITH HIGH RESOLUTION SAR IMAGES

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When natural hazards happen in built-up areas, there is an urgent need to have a map of all affected parts in real time to allow a responsive intervention. More important is the possibility to fast pinpointing damaged parts as roads (to advise about conditions and alternative road system) and buildings (to promptly save trapped human beings or warn about vital social services no-more available like hospitals).

In case of earthquakes an adequate answer to most of above needs may come from Synthetic Aperture Radar (SAR) imagery and techniques. For example, SAR interferometry is applied to get information about where land movements occurred and measures of displacements in the wavelength order can be given. This kind of information, even if relevant for many aims, it is not useful for a responsive support to civil protection as not able to say how much specific areas have been hit in terms of damaged or collapsed buildings which indeed is probably the most urgent information.

In this paper we deal with the issue of identifying damaged or collapsed buildings in areas hit by earthquakes with one post-event amplitude SAR image. When a pre-event SAR amplitude image of the same area is also available, an algorithm able to detect the target areas is applied exploiting the theory based on the deterministic feature extraction approach [1].

Till now, that theory has been applied in a testing phase to single buildings in areas not affected by hazards for the extraction of geometric [2-3] or electromagnetic [4] building parameters from a single amplitude SAR image. The feature extraction algorithms developed in [1-4] and derived by the direct scattering models in [5] are now applied to an extended area with the aim of producing a map where collapsed or seriously damaged buildings are localized. To achieve this goal one post-event amplitude SAR image is considered, the radiometric content analyzed and compared with that contained in the pre-event amplitude SAR image. The two images need to be obtained in similar conditions, with quite the same radar and orbit parameters.

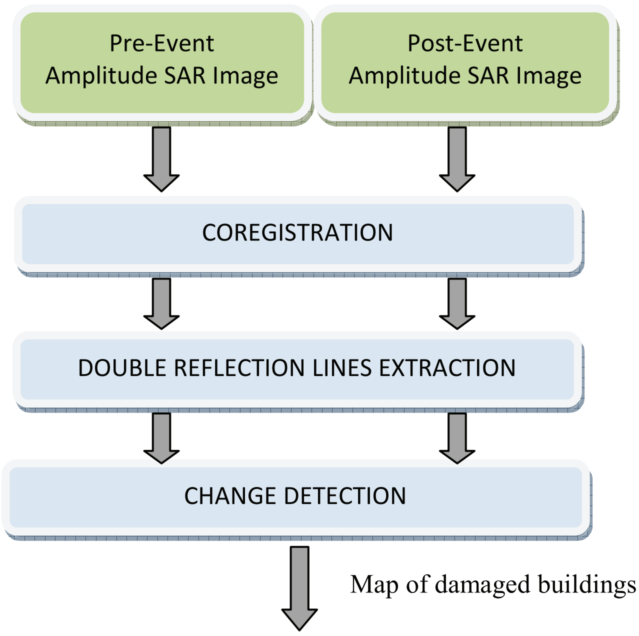

Figure 1

After being co-registered, see the block diagram in Fig.1, they enter the same post-processing block in which double reflection lines of buildings in both images are extracted. This aim is pursued by means of filters for edge detection. Then, for each building in the scene, its pre-event double reflection line is compared with the corresponding post-event one since, according to the scattering theory developed in [5], a change in the dihedral configuration of the building facing the radar (as may happen, for example, when part of a wall collapses) will be reflected in a change in the brightness of the double reflection line appearing in the SAR image. In this way, we now exploit the theory developed in [5] not for feature extraction purposes as done in [2-4] but for proposing new change detection algorithms able to fully exploit the radiometric content in the amplitude SAR image.

As only one image is used some false negative alarms may occur (a collapsed building is not detected) and this may happen when the part of the building affected is not the one facing the radar, see Fig.2. In this case, since other changes will certainly happen in the building appearance in the SAR image (as in the roof backscattering) they will be used as supporting information to limit false negatives. A drawback generally presented by the authors' approach is the high *a-priori* knowledge required in terms of scene parameters. A partial knowledge might affect the precision in the building height retrieval but, in case of earthquake, some errors can be still accepted when the interest relies on the knowledge of building affected more than the precise level of damage.

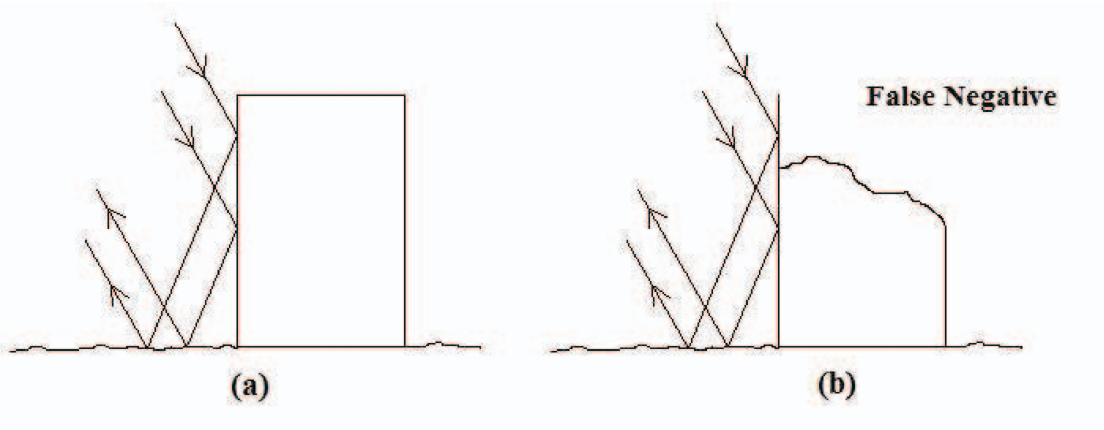

Figure 2

In this paper, the new process described by the block diagrams in Fig.1 is applied to COSMO-SKyMed data provided before and after the earthquake that took place in the area around L'Aquila, Italy, in April 2009. Numerical results obtained on the L'Aquila area will be given and discussed at the conference.

References

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