Disaster Relief with Satellite based Synthetic Aperture Radar: SAR

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***Abstract*—Disaster relief with satellite bases Synthetic Aperture Radar (SAR) is conducted. SAR can be used for disaster relief. Interferometric SAR (IN-SAR) allows elevation estimation. Therefore, it is applicable to estimate seismic changes, elevation changes due to earthquake, land slide, slope collapse, etc. Experiments are conducted for the earthquake disaster which occurs in Kumamoto, Japan and for the river flooding due to typhoon heavy rain which occurs in Oita, Japan. Sentinel-1 of SAR imagery data shows an enormous potential of disaster relief.**

Keywords—Synthetic Aperture Radar (SAR); interferometry; disaster relief; earthquake; water flooding

I. Introduction

Synthetic Aperture Radar (SAR) onboard remote sensing satellites are widely used for a variety of application fields. Geometric fidelity of SAR imagery data is not good. Therefore, some geometric corrections are required before data analysis. Ground Control Point (GCP) is used for the correction. In order to get good quality of GCP, Digital Elevation Model (DEM) is useful [1], [2]. Other than that speckle noise should be removed for SAR imagery data. Speckle noise reduction method based on Chi-Square test is proposed [3], [4]. Thus, SAR imagery data can be used for a wide variety of application fields.

One of the specific SAR imagery data applications is Polarimetric SAR analysis. Not only receiving power signal of SAR, but also polarization signal can be used for analysis by using surface and SAR electric magnetic wave interaction characteristics. SAR imagery data classification and sea ice classification are good example of polarization characteristics [5]-[8].

In the paper, Interferometric SAR (IN-SAR) is featured for disaster relief purposes. IN-SAR allows elevation estimation. Therefore, it is applicable to estimate seismic changes, elevation changes due to earthquake, land slide, slope collapse, etc. Experiments are conducted for the earthquake disaster which occurs in Kumamoto, Japan and for the river flooding due to typhoon heavy rain which occurs in Oita, Japan. Sentinel-1 of SAR imagery data shows an enormous potential of disaster relief.

The following section describes the proposed method for disaster relief followed by some experiments. Then conclusions are described together with some discussions and future research works.

II. Proposed Method

A. Software Tools Used

There are two major commercially available software tools:

1) GAMMA SAR (it requires ISP, Diff&Geo software packages):
It can be operable under Linux/MacOSX/Windows OS. JERS-1 SAR, ENVISAT, ERS-1/2, X-TerraSAR, RADARSAT-1/2, ALOS/PALSAR, ALOS2/PALSAR-2, Cosmo-Skymed, RISAT, Sentinel-1、 KOMPSTAT-5 are supported.

2) ENVI SARscape
It requires Basic & InSAR License. Other than these, there are two open source software:

- Doris InSAR Processor
- GMTSAR

Specific feature of GMTSAR is shown in Fig. 1.

B. Data Used

Open hub of Sentinel-1A of SAR data is used. Sentinel-1A SAR data is available at:

https://scihub.copernicus.eu/

It is a comprehensive site to access and download the Sentinel-1A SAR data as shown in Fig. 2. Fig. 3 shows operation modes of the Sentinel-1A. In order to get IN-SAR data, two SAR imagery data are required.

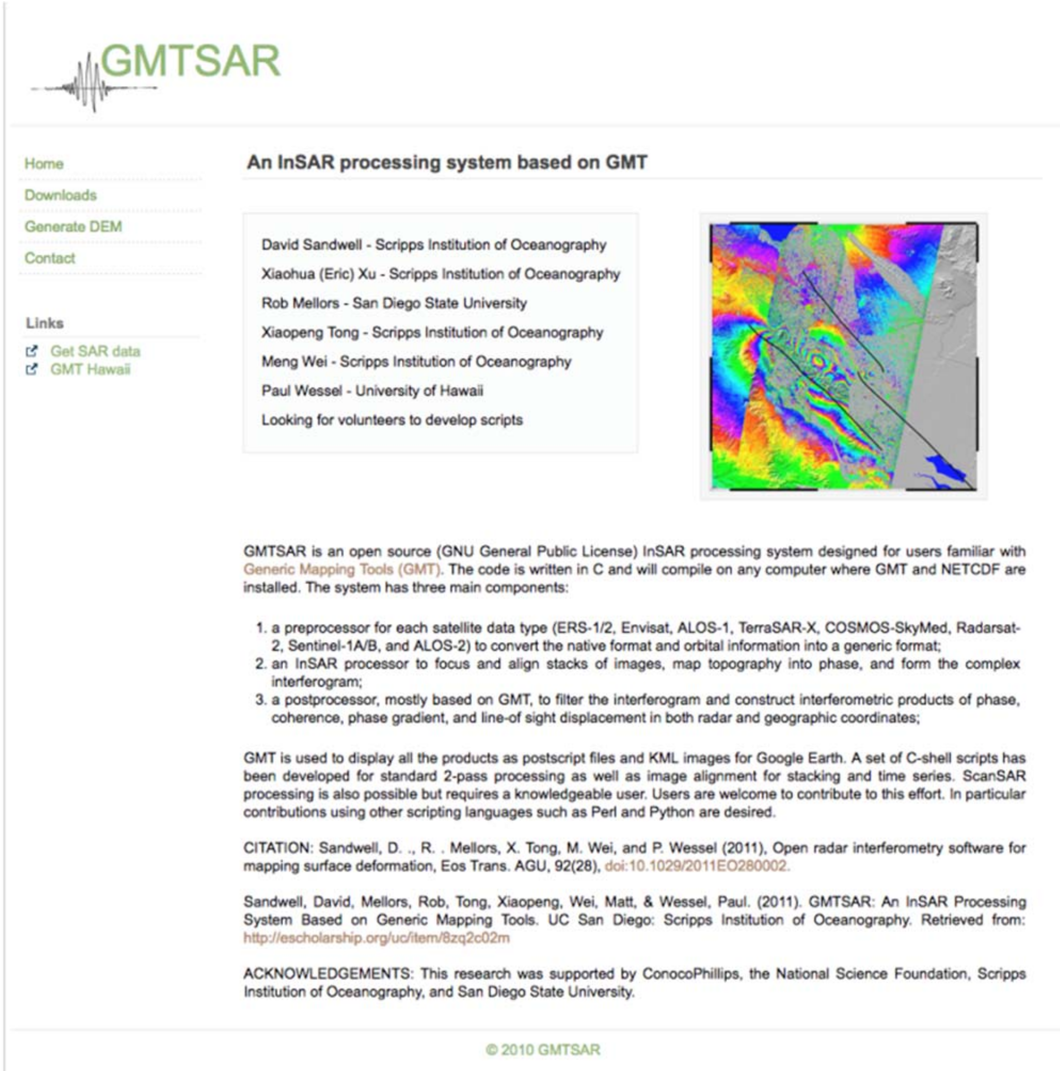


Fig. 1. Specific feature of GMTSAR.

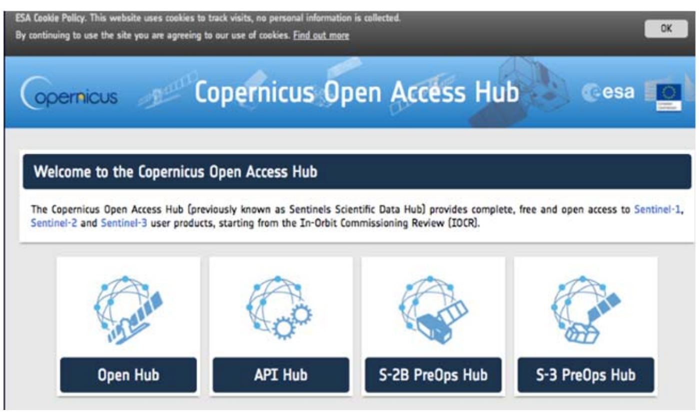


Fig. 2. Copernicus open access hub site.

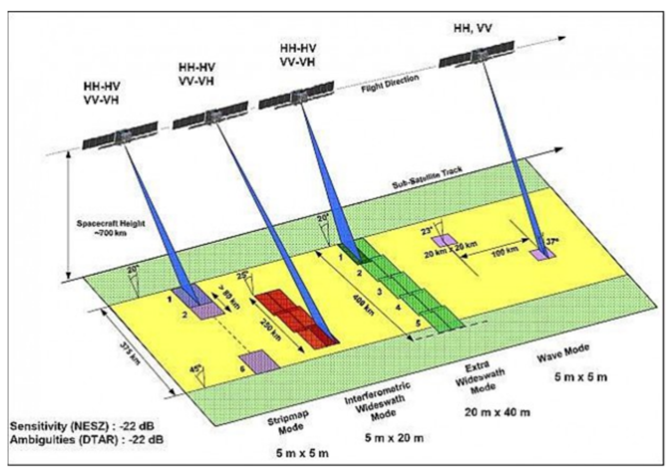


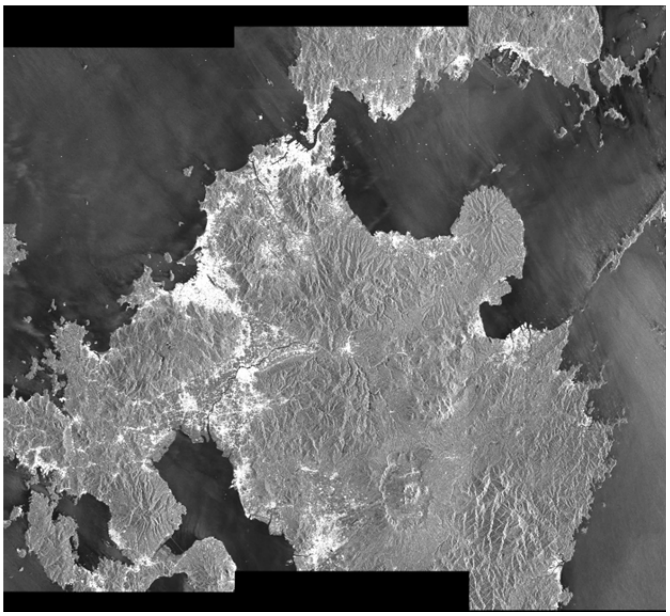
Fig. 3. Operation modes of the Sentinel-1A.

III. EXPERIMENTS

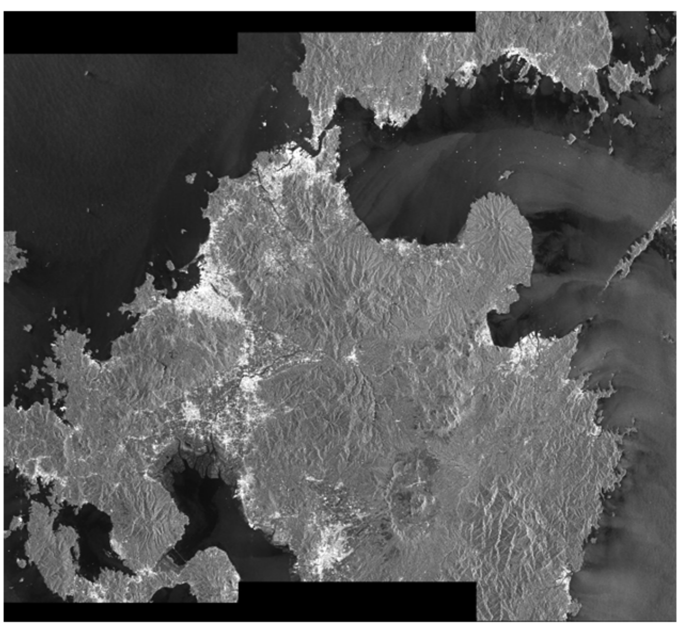
A. Experiment-1: Kumamoto Earthquake

Big earthquake was occurred in Kumamoto prefecture, Japan on 14, 15, and 16 April 2016. Kumamoto data of Sentinel-1A of 27 March 2016 and of 20 April 2016 are acquired. Interferogram is generated with these two data as shown in Fig. 4.

The resultant image of interferometry using these two SAR imagery data is shown in Fig. 5. It is found that land surface raises about 50.8 cm (red) around Mt. Aso while land surface sinks about 37.9 cm in Kumamoto-city (blue).



(a) March 27



(b) April 20

Fig. 4. Original SAR imagery data.

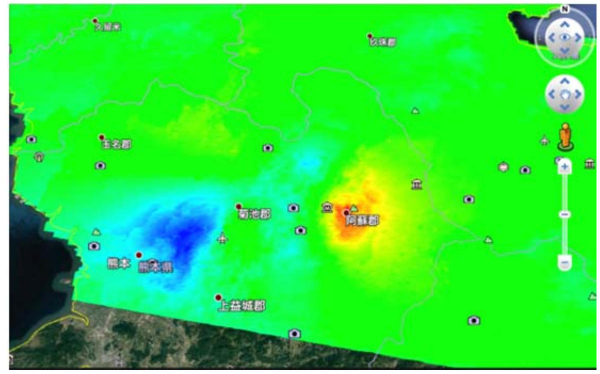


Fig. 5. Interferogram using two SAR imagery data (Fig.4).

B. Experiment-2: Northern Kyushu Flooding (June 27 and July 9 2017)

Typhoon hit the northern Kyushu, Japan on July 5 and 6, 2017. Using two Sentinel-1A SAR data, interferogram is created.

The coherence imagery data which is derived from the SAR imagery data acquired on July 9, 2017 is shown in Fig. 6. Also, the resultant image of the interferogram using two SAR imagery data is shown in Fig. 7. The result shows land surface raises about 30.2 cm due to water level raise and muddy soil deposition while land surface sinks about 17.2 cm.

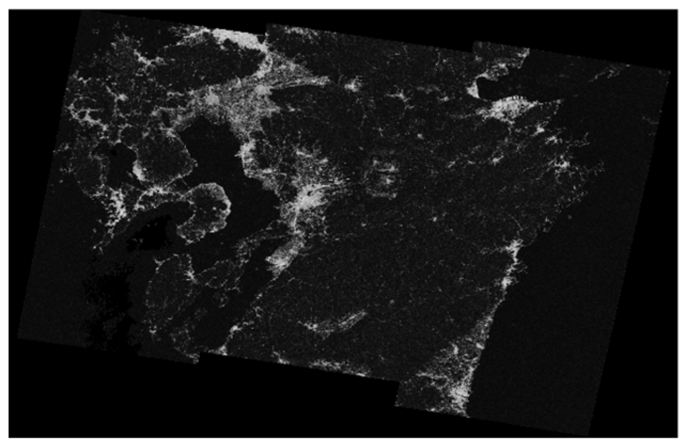


Fig. 6. Coherence image of the Northern Kyushu on July 9, 2017,

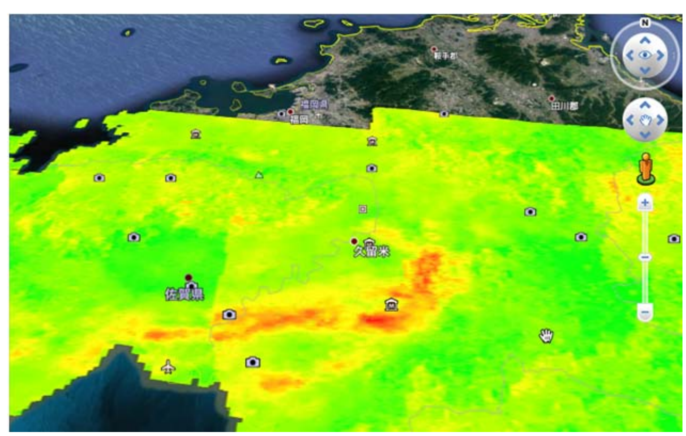


Fig. 7. Interferogram of the Northern Kyushu derived with two SAR imagery data.

IV. Conclusion

Through experiments, it is found that the Interferometric SAR (IN-SAR) is quite useful for earthquake disaster relief and water flooding disaster. SAR onboard Sentinel-1A shows a satisfactory performance in disaster relief.

It is also found that the GMT-SAR of the open source software for SAR data processing and analysis is very useful and easy to use for manipulation of SAR imagery data including IN-SAR processing.

Further investigation is required for other disaster types of relief. This is required for simultaneous estimation of cornea curvature center and cornea radius, and noise removal of the depth image.

Acknowledgment

The authors would like to thank the fourth group members of the Department of Information Science, Saga University for their contribution to the experiments.

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Authors Profile

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