

Disaster Relief with Satellite based Synthetic Aperture Radar: SAR

Shogo Kajiki¹

¹Faculty of Science and Engineering
Saga University
Saga City, Japan

Hiroshi Okumura²

²Graduate School of Science and
Engineering
Saga University
Saga City, Japan

Kohei Arai²

²Graduate School of Science and
Engineering
Saga University
Saga City, Japan

Abstract—Disaster relief with satellite based 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.

GMTSAR

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GMT Hawaii

An InSAR processing system based on GMT

David Sandwell - Scripps Institution of Oceanography
Xiaohua (Eric) Xu - Scripps Institution of Oceanography
Rob Mellors - San Diego State University
Xiaopeng Tong - Scripps Institution of Oceanography
Meng Wei - Scripps Institution of Oceanography
Paul Wessel - University of Hawaii
Looking for volunteers to develop scripts

GMTSAR is an open source (GNU General Public License) InSAR processing system designed for users familiar with Generic Mapping Tools (GMT). The code is written in C and will compile on any computer where GMT and NETCDF are installed. The system has three main components:

1. a preprocessor for each satellite data type (ERS-1/2, Envisat, ALOS-1, TerraSAR-X, COSMOS-SkyMed, Radarsat-2, Sentinel-1A/B, and ALOS-2) to convert the native format and orbital information into a generic format;
2. an InSAR processor to focus and align stacks of images, map topography into phase, and form the complex interferogram;
3. a postprocessor, mostly based on GMT, to filter the interferogram and construct interferometric products of phase, coherence, phase gradient, and line-of sight displacement in both radar and geographic coordinates;

GMT is used to display all the products as postscript files and KML images for Google Earth. A set of C-shell scripts has been developed for standard 2-pass processing as well as image alignment for stacking and time series. ScanSAR processing is also possible but requires a knowledgeable user. Users are welcome to contribute to this effort. In particular contributions using other scripting languages such as Perl and Python are desired.

CITATION: Sandwell, D. ., R. Mellors, X. Tong, M. Wei, and P. Wessel (2011), Open radar interferometry software for mapping surface deformation, Eos Trans. AGU, 92(28), doi:10.1029/2011EO280002.

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Fig. 1. Specific feature of GMTSAR.

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Open Hub API Hub S-2B PreOps Hub S-3 PreOps Hub

Fig. 2. Copernicus open access hub site.

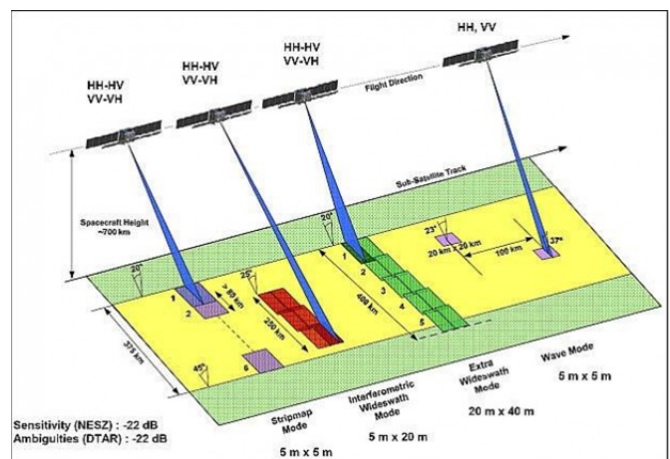


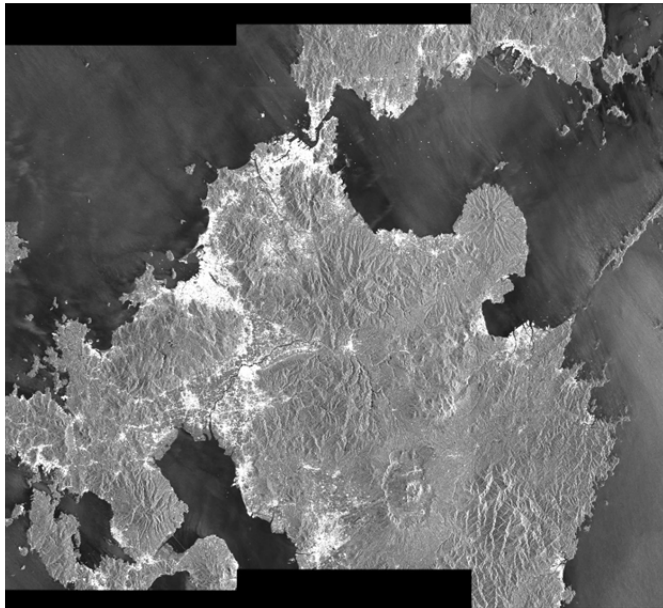
Fig. 3. Operation modes of the Sentinel-1A.

III. EXPERIMENTS

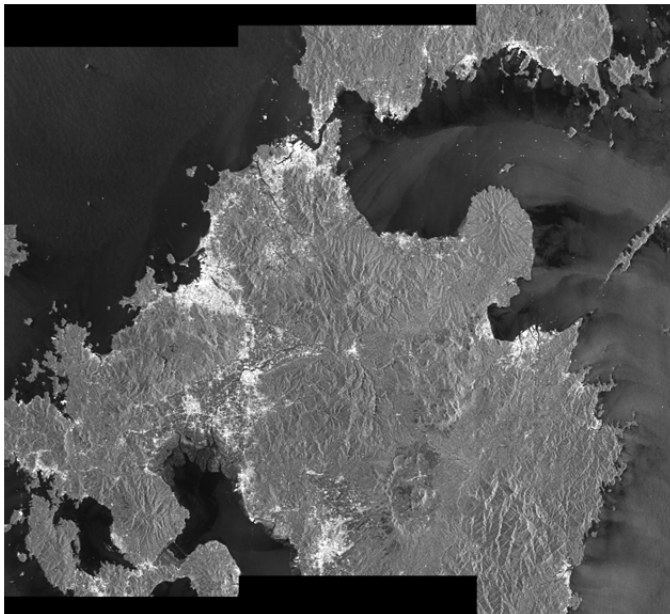
A. Experiment-1: Kumamoto Earthquake

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.

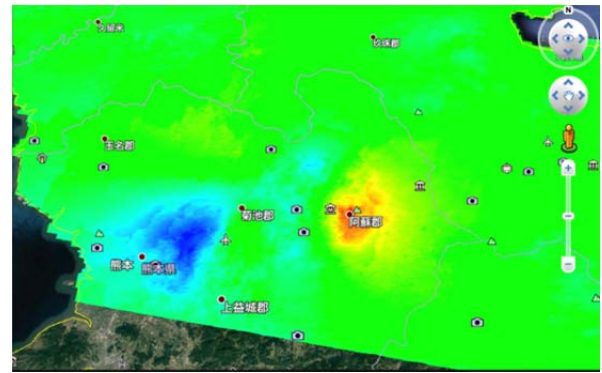


Fig. 5. Interferogram using two SAR imagery data (Fig.4).

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.

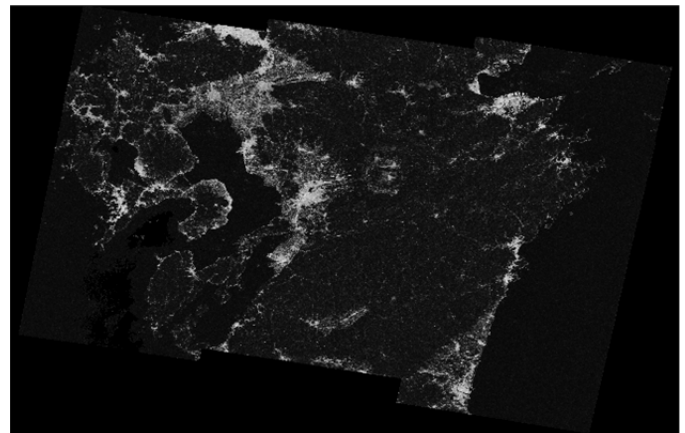


Fig. 6. Coherence image of the Northern Kyushu on July 9, 2017,

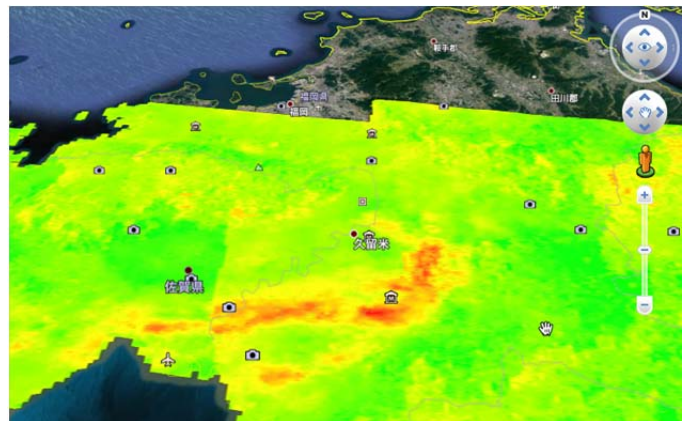


Fig. 7. Interferogram of the Northern Kyushu derived with two SAR imagery data.

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.

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AUTHORS PROFILE

Kohei Arai: He received BS, MS and PhD degrees in 1972, 1974 and 1982, respectively. He was with The Institute for Industrial Science and Technology of the University of Tokyo from April 1974 to December 1978 also was with National Space Development Agency of Japan from January 1979 to March 1990. During from 1985 to 1987, he was with Canada Centre for Remote Sensing as a Post Doctoral Fellow of National Science and Engineering Research Council of Canada. He moved to Saga University as a Professor in Department of Information Science on April 1990. He was a councilor for the Aeronautics and Space related to the Technology Committee of the Ministry of Science and Technology during from 1998 to 2000. He was a councilor of Saga University for 2002 and 2003. He also was an executive councilor for the Remote Sensing Society of Japan for 2003 to 2005. He is an Adjunct Professor of University of Arizona, USA since 1998. He also is Vice Chairman of the Science Commission "A" of ICSU/COSPAR since 2008 and now he is awarded as a committee member of ICSU/COSPAR. He wrote 37 books and published 570 journal papers. He received 30 awards including ICSU/COSPAR Vikram Sarabhai Medal in 2016, and Science award of Ministry of Mister of Education of Japan in 2015. He is now Editor-in-Chief of IJACSA and IJISA <<http://teagis.ip.is.saga-u.ac.jp/index.htm>>.