Report on Operation of the Technology for Real Time Collection, Summarization, and Sharing of Infrastructure Damage Information

(Study period: FY2014 to FY2019)

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1. Introduction

It is not easy to quickly obtain useful information immediately after the occurrence of an earthquake. In order to build a proper first action system, grasp of damage situation is essential. For quick and accurate collection of information, NILIM has been engaging in technical development for real time collection, summarization, and sharing of infrastructure damage information using spectrum analysis information, existing CCTV cameras, and Synthetic Aperture Radar (SAR), etc. (Refer to the 2019 NILIM Report) This paper introduces the operation of the technology developed in this study with examples of disasters that occurred in FY2019.

2. Distribution of spectrum analysis information

The information analysis / decision support system [1] developed by NILIM under the SIP will create and distribute automatically "spectrum analysis information" immediately after an earthquake.
In the past years, it took about 15 minutes from the occurrence of an earthquake to information distribution and distribution was sometimes interrupted due mainly to system failure. As of January 2020, however, stable distribution of spectrum analysis information is possible in 6 to 7 minutes after the occurrence of an earthquake as a result of the improvement of the information acquisition system through joint study with National Research Institute for Earth Science and Disaster Resilience (NIED).
Fig. 1 shows part of the spectrum analysis information distributed when an earthquake with a maximum seismic intensity 5 lower occurred at the eastern coast of Aomori-ken at 15:21 on December 19, 2019 (distributed at 15:28). It is possible to perceive the extent of damage by comparing the acceleration response spectrum and damage line at top 10 locations of the measured seismic intensity in the observation

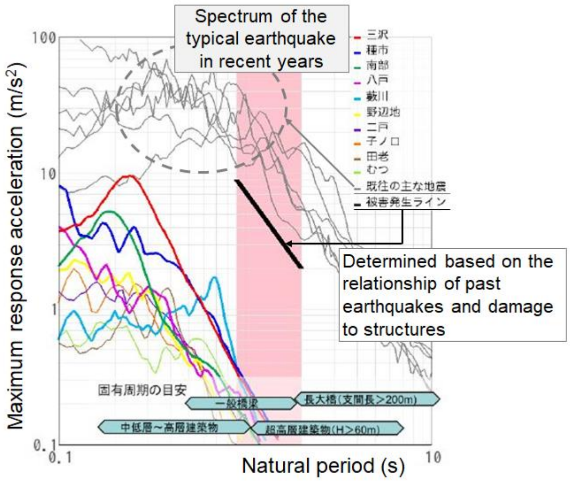


Fig. 1 Spectrum analysis information (extracted in part)

points where strong earthquake record was obtained.
In addition to **Fig. 1**, the spectrum analysis information is distributed in a 3-page PDF describing how to see the seismic intensity distribution map and damage line, characteristics of typical earthquake damages in recent years, etc.
From the current fiscal year, the spectrum analysis information is also distributed to the road management teams, etc. of Regional Development Bureaus for them to study utilization of the information to determine necessity for road inspection after an earthquake.

3. Technology for effective utilization of SAR images

We developed a system for supporting SAR image interpretation with which disaster prevention personnel can efficiently identify collapsed spots etc. using satellite SAR images. Use of satellite SAR in this system enables stable acquisition of wide-area image

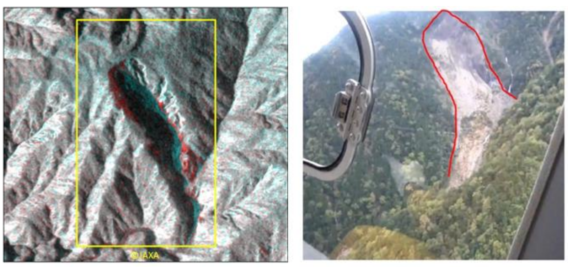
Fig. 3 Panoramic image (Ex.)

information even in a situation where grasp of damage by helicopter etc. is difficult, such as bad weather or night time.

Sabo Department of NILIM implemented emergent SAR image interpretation of areas collapsed in a large scale, etc. immediately after the occurrence of heavy rain disaster or earthquake disaster in wide area, including utilization of this system on a trial basis. Immediately after the heavy rain disaster by Typhoon No. 19 in October 2019 (**Fig. 2**) and the Yamagata Offshore Earthquake in June 2019, etc., we conducted interpretation of collapsed areas with satellite SAR images before field inspection by helicopter etc. Results of this interpretation were provided to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the Regional Development Bureau for use in disaster response.

In addition, we held training seminars, etc. across the country for disaster prevention personnel of Regional Development Bureaus, who are expected to further use this interpretation system, so that they can conduct SAR image interpretation and learn how to utilize and operate the system, and collected opinions about improvement of operability, effectiveness, etc. by actually conducting interpretation in seminars, etc. Further, through joint study with JAXA (Japan Aerospace Exploration Agency), we studied for efficient provision of SAR images etc. in case of an emergency and jointly interrupted SAR images and verified results, etc. As a result, we created a Technical Note of NILIM describing the technical knowledge for interpretation of collapsed areas with SAR images, etc. [2)]

As stated, we are implementing the measures for the effective grasp of disasters in an emergency using satellite SAR images.



SAR image
(Red: Possibility of collapsed area)
Blue: Possibility of deposited area

Result of check by helicopter

Fig. 3 Example for detecting sediment disaster in SAR image interpretation
(Oct. 2019, Typhoon No. 19, etc. (Yamanashi-ken, Hayakawa-cho)

4. Test operation of CCTV cameras

The images of CCTV cameras installed by the MLIT for infrastructure management across the country are also used for grasping damage immediately after disaster occurrence. However, in order to grasp the state of damage, it is necessary to manually operate each camera, which takes much time. Then, we are developing a system equipped with the functions of (a) creating a panoramic image by turning the camera automatically and (b) detecting damage automatically from an enormous amount of image information, immediately after an earthquake, and we implement, in the current fiscal year, test operation and development for full-scale operation in next fiscal year.

(1) Test operation of the system for creating a panoramic image

The information analysis / decision support system organizes the seismic intensity data for each municipality at the occurrence of an earthquake. We are operating on a trial basis a system that detects the CCTV cameras installed in municipalities that were swung due to the seismic intensity of 4 or more and automatically creates panoramic images. From April 2019 to February 2020, an earthquake in which the seismic intensity of 4 or more, at which panoramic views were supposed to be created, was observed by CCTV camera occurred three times and panoramic images were actually created each time. As an example, **Fig. 3** shows a panoramic image created when an earthquake occurred in northern Ibaraki-ken on December 14, 2019, at 10:38.

(2) Development for full-scale operation

For full-scale operation, we are developing a full-scale operation system that includes addition of the cameras for panorama image creation, hardware reinforcement, enhancement of log management function, and addition of e-mail distribution function. Operation of this system is going to start from FY2020 for the cameras of the eight Regional Development Bureaus. We also continue to study for improving the accuracy of damage image detection using AI.

5. Conclusion

The Disaster Prevention and Reduction Research Committee is striving to further disseminate and improve the technologies introduced herein.

☞See the following for details.

1) Information analysis / decision support system
https://www.jstage.jst.go.jp/article/jdr/14/2/14_333/_article/-char/ja

2) Technical Note of NILIM No.1110
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1110.htm