Development of real-time information collection, investigation, and sharing technology for infrastructure damage. in SIP disaster prevention research

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1. introduction

When a large-scale earthquake occurs, it is necessary to grasp the status of the affected areas immediately from limited information in order to respond appropriately. NILIM is developing technologies to grasp damage immediately by effectively using existing CCTV cameras and satellites. In order to develop and implement these technologies properly, we conducted an information needs survey at the site of the disaster response for the 2016 Kumamoto earthquake, one of the major disasters in recent years, and tried to clarify the information needs and the expected role for each disaster grasping technology.

In this report, based on the results of an information needs survey and technology evaluation, we introduce technological development and social implementation progress as a part of an SIP disaster prevention study.

2. Information needs investigation and technical evaluation for disaster response

Based on research into the 2016 Kumamoto earthquake response, the information needs and expected role for each disaster grasping technology are being clarified. Based on the research results, we arranged the facts as to when and what kind of information was collected on the time axis. From the arrangements, the information blank period and the issues of collecting information that changed with time were organized. With reference to these results, we are developing technology for efficiently using CCTV cameras and satellites during a disaster.

3. Efficient detection of disaster form the image of CCTV cameras

CCTV cameras are installed nationwide for the purpose of monitoring infrastructure. These cameras are also used for grasping damage. However, it requires labor and time to manually turn the cameras one by one and select images that show the status of the disaster from a huge number of cameras in the situation where the number of personnel is limited immediately after a disaster. Therefore, we are developing these two functions: (1) turn the camera automatically and create a panoramic image for grasping the surrounding situation, and (2) detect the disaster from enormous image information (Figure 1).

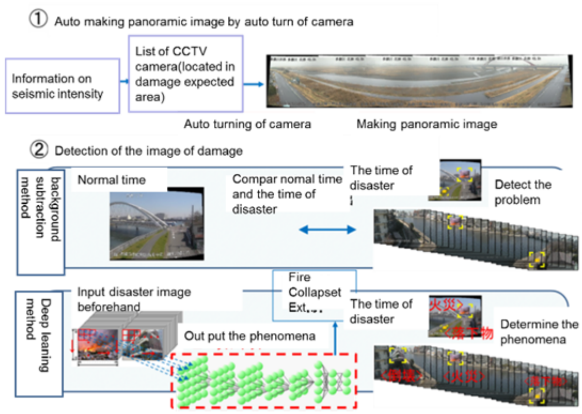


Figure 1 Panoramic image and detection of damage

(1) Auto creation of panoramic image

When earthquakes occur, a list of CCTV cameras in the damage expected area (CCTV camera list) is automatically created based on the information on seismic intensity provided by the Meteorological Agency. Cameras on the list automatically turn and create panoramic images. In 2017, we conducted trial experiments of making panoramic images in an actual environment using the Regional Development Bureau's CCTV cameras.

(2) Auto detection of damage image

We are developing technologies by using two types of methods: the background subtraction method and the deep learning method in order to efficiently detect damage from images. In the background subtraction method, an abnormality is detected by taking the differences in the images between normal time and the time of the disaster, then judging the possibility of a disaster occurring. In the deep learning method, we let the AI system learn the types of damage by using pictures from past disasters provided by Regional Development Bureaus (RDBs).

For more efficient utilization, (1) panoramic images and (2) detected disaster images are planned to be reflected in the DiMAPS (Integrated Disaster Information Map ping System) managed by the Ministry of Land, Infrastructure, Transport and Tourism.

4. Technology for effectively use of satellite

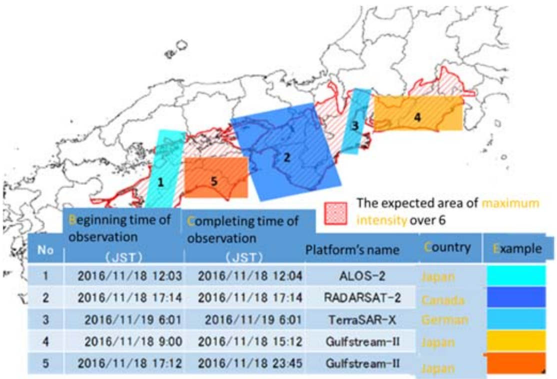
Synthetic Aperture Radar (SAR) loaded on an artificial satellite can observe a wide area even at night or in bad weather. However, there is a case where the disaster area cannot be monitored since the observable range depends on the orbit of the artificial satellite. In addition, SAR images require more skills to read compared to optical images.

(1) Observation planning by combining artificial satellites and airplanes

For observing the affected area quickly, we are developing a technology to support observation planning that efficiently combines platforms, such as satellites, airplanes, and disaster prevention helicopters (Figure 2). The observation plan includes operational conditions and environmental conditions (time weather, available airports, and so on). We have been developing a Web system that supports observation planning followed by system improvement on the basis of trial results at the RDBs.

(2) Support for interpretation of SAR image

In order to support the personnel responsible for responding to disasters, we have developed image processing technology that can improve the readability of SAR images for shortening the work time. In addition to improving visibility, semiautomatic extraction of the priority part of the visual judgment supports interpretation. The readability was verified by actual disasters such as the Kumamoto earthquake in 2016 (Figure 3) the torrential rain in northern Kyushu in 2017. We employed the technology for training interpretation methods for the personnel responsible for responding to a disaster.



No	Beginning time of observation (JST)	Completing time of observation (JST)	Platform's name	Country	Example
1	2016/11/18 12:03	2016/11/18 12:04	ALOS-2	Japan	
2	2016/11/18 17:14	2016/11/18 17:14	RADARSAT-2	Canada	
3	2016/11/19 6:01	2016/11/19 6:01	TerraSAR-X	German	
4	2016/11/18 9:00	2016/11/18 15:12	Gulfstream-II	Japan	
5	2016/11/18 17:12	2016/11/18 23:45	Gulfstream-II	Japan	

Figure 2 Example for observation planning assuming the Nankai Megathrust Earthquake

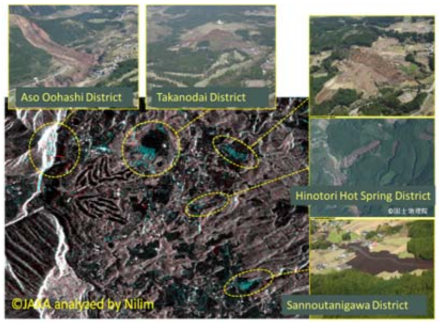


Figure 3 SAR image interpretation in case of the 2016 Kumamoto earthquake

5. Auto distribution of seismic information system

We have developed technologies to provide information within 15 minutes after an earthquake. One is spectrum analysis information that makes it possible to estimate the scale of damage to the infrastructures and the other is the CCTV camera list mentioned in 3. (1). These two sets of information are automatically created when an earthquake with a certain seismic intensity occurs and automatically distributed to the address registered in advance. From April 2017, we started automatic distribution for disaster prevention personnel of the RDBs. It is utilized in disaster prevention drills in the Regional Development Bureau.

6. Conclusion

We are planning to continue social implementation and to upgrade the system based on the information needs toward the final year of the SIP disaster prevention study. In the future, we will consider technical development targets by comparing the information needs and characteristics of various technologies and clarifying the roles required for each technology.

☞more information

1) Research Center for Infrastructure Management's website
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn000.htm

2) Sabo Risk-Management Division's web site
http://www.nilim.go.jp/lab/scg/index.htm

3) Earthquake Disaster Management Division's website
http://www.nilim.go.jp/lab/rdg/division/division.htm