CONSTRUCTION OF GLOCAL MONITORING SYSTEM FOR DISASTER MONTORING

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KEY WORDS: disaster, satellite, SNS, global, local

ABSTRACT: In 2016, Tokai University initiated a new project call "Constructing glocal monitoring system for safe and secure society". "glocal" is a coined word of "global" and "local". The main concept of the project is to connect global monitoring system using satellite observation with local monitoring system using SNS for monitoring disasters and environmental changes. The project was selected by the Ministry of Education, Culture, Sports, Science and Technology(MEXT) of Japan as one of the Research Branding Project of Private Universities in Japan supported by NEXT for five years. Tokai University is receiving satellite data such as MODIS, VIIRS and AVHRR data at its ground station in Shonan Campus located in Kanagawa Prefecture, Japan. The data are automatically processed and archived in near real time. The authors are utilizing the data for various purposes including disaster monitoring. On the other hand, the authors has been developing a Twitter-based disaster-related information sharing system which is composed of the following two subsystems; (1) DITS (Disaster Information Tweeting System): a system that inserts both the user's current geo-location information (street address) and the hashtag of the form "#(municipality name) disaster" to a tweet automatically, (2) DIMS (Disaster Information Mapping System): a system that plots tweets posted via DITS on a digital map. The authors are constructing the Glocal Monitoring System by connecting the satellite data system with the twitter-based system.

1. INTRODUCTION

In recent years, many countries in Asia are suffered by severe environmental changes and natural disasters. In April 2016, Kumamoto Prefecture of Japan was seriously struck by a series of quakes including magnitude of 6.2 on 14th and magnitude of 7.0 on 16th. Aso Campus and Kumamoto Campus of Tokai University located in Kumamoto Prefecture were seriously damaged. Several dormitories near Aso Campus were crashed by the earthquake and three students lost their lives. The importance of preparing for disasters and emergencies was strongly recognized in the university.

Tokai University Research & Information Center(TRIC) has been involved in various kinds of research works on image processing mainly focused on remote sensing since 1974. In 1986, Tokai University Space Information Center (TSIC) was set up in Kumamoto Prefecture for receiving remote sensing data from space. Since then, TSIC has received and has been receiving data from various kinds of satellites including MOS-1, JERS-1, Radarsat, ERS-1, NOAA, Terra, Aqua, NPP. Through these experiences, we have been operating a near real time monitoring system with satellite images for years. On the other hand, the authors have been working on utilizing SNS information such as twitter for gathering disaster-related information.

In 2016, the Ministry of Education, Culture, Sports, Science and Technology(MEXT) of Japan called for Research Branding Project of Private Universities. The purpose of the call was to promote the branding of private universities by supporting the unique research project of the private universities. Considering the above experiences at Tokai University, the authors have proposed a project call "Constructing glocal monitoring system for safe and secure society" to the call. "glocal" is the coined word of "global" and "local". The main concept of the project is to connect global monitoring system using satellite observation with local monitoring system using SNS for monitoring disasters and environmental changes (See Figure 2). Total of 198 private universities proposed to the call, and 40 universities including Tokai University were adopted. The authors are proceeding the project under the cooperation with international and local organizations. This paper describes about the concept and initial result of the project.

(a) Destroyed house

(b) Large scale land slide

Figure 1. Damages areas in Kumamoto

Figure 2. Conceptual diagram of Glocal Monitoring System

2. NEAR REAL TIME MONITORING WITH SATELLITE IMAGES

TRIC and TSIC have been operating several types of near real time monitoring system using satellite images for particular purposes as follows.

2.1 Sea Ice Monitoring with MODIS images

Optical sensor MODIS on Terra and Aqua satellite of NASA has 36channels including two channels in visible and near infrared regions with 250m resolution. At Tokai University, the authors have been producing MODIS color composite images of the Sea of Okhotsk in near real time, and has been providing the images to Japan Coast Guard(JCG) during the winter season since 2003. The JCG is using the MODIS images to produce the Sea Ice Charts every day during the winter season. Figure 3 shows the conceptual diagram of the MODIS image dissemination system. Toki University receives the MODIS data at around 11:00 and after extracting the area of the Sea of Okhotsk with color composite, the images are uploaded on our web site at around 14:00. Then the operator of JCG downloads the image and produces the Sea Ice Chart by image interpretation. Finally, the Sea Ice Chart is disseminated to the end users at 17:00.

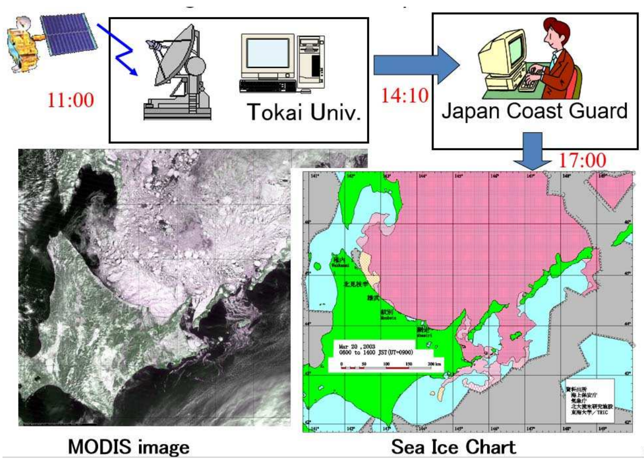

Figure 3. Conceptual diagram of the MODIS image dissemination system for sea ice monitoring.

2.2 Disaster Monitoring with landsat8 images

From 2013 to 2015, TSIC used to receive Landsat8/OLI data under the contract with National Institute of Advanced Industrial Science and Technology (AIST) of Japan. At that time, the authors have developed the near-real time monitoring system using OLS images. Figure 4 shows the conceptual diagram of the system.

A disaster suddenly occurs at some place. In many cases, the area is a part of a satellite image.

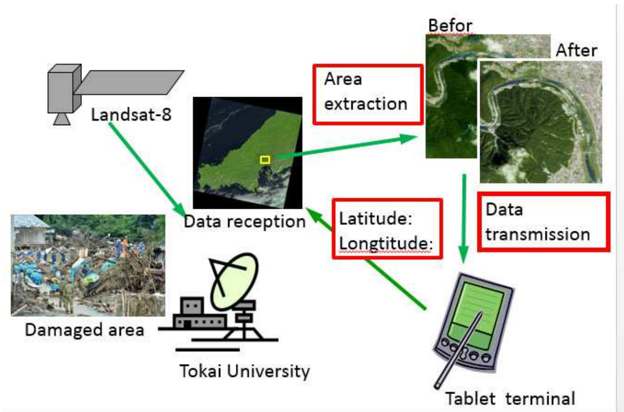

Figure 4. Near-real time disaster monitoring system using OLI images.

So, it is not realistic to send a full scene of a satellite image to the end users. The authors have developed a procedure to specify a particular area of interest from a mobile phone of a end user and remotely extract the area from the time series of OLI images archived in the database including the image taken just after the disaster. Then, the images of the disaster damaged area are transmitted to the mobile phone of the end user. Since the geometric accuracy of OLI is very good, by just extracting the same area from the OLI images taken before and after a disaster, the end user can easily identify the damages of the area without any additional geometric correction.

2.3 Solar Car Race Assistance with Himawari-8 AHI Images

Tokai University has a solar car team which occasionally participates international solar car races. In 2015, the solar car team participated the World Solar Challenge(WSC) 2017 organized in Australia. It is a solar car race travelling 3,000km from Darwin to Adelaide. At that time, TRIC/TSIC has set up a system to provide the optical sensor AHI images of the Himawari-8 satellite of the Australia on near real time to the Tokai University Solar Car Team during the race. The AHI takes the disk image of the earth every 10minutes, and the solar car location information on the WSC2017 homepage are automatically updated also every ten minutes. The authors have developed a procedure to plot the trajectory of our university solar car on the latest AHI image and provide to the team by using ftp command. Figure 5 shows the system diagram and Figure 6 an example of the solar car trajectory plotted on an AHI image. Since solar cars are quite sensitive to clouds, our AHI images were quite useful for the race team to consider the race plan.

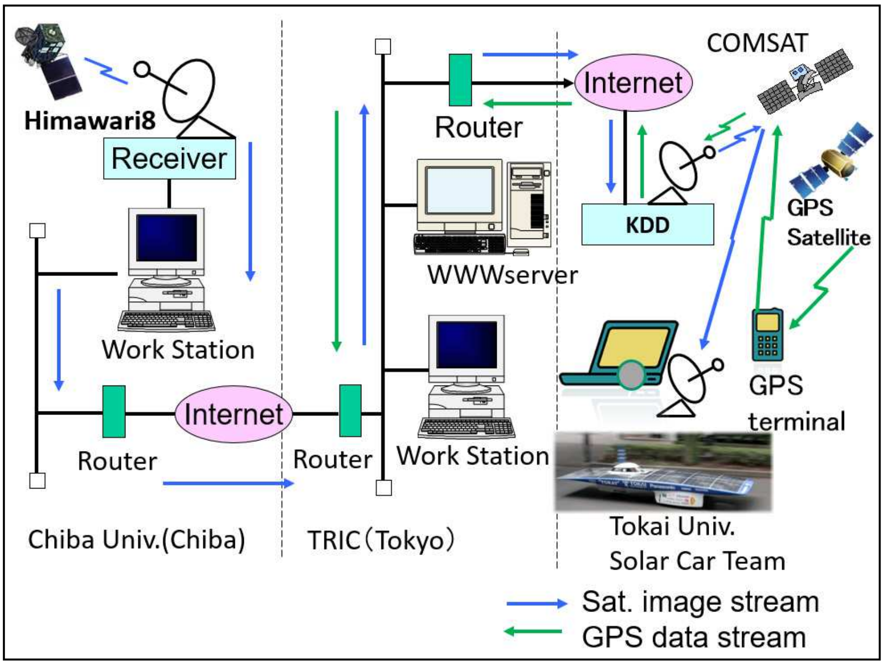

Figure 5. Configuration of Himawari-8 AHI image dissemination system for supporting solar car race.

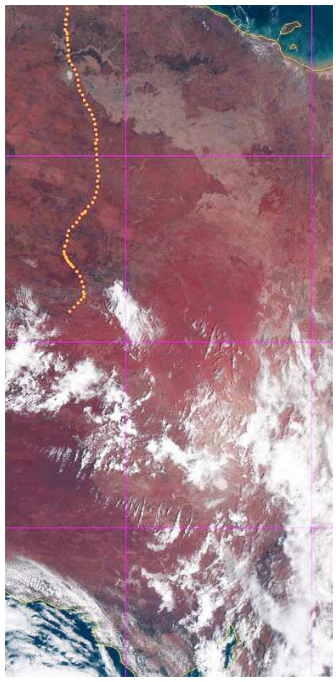

Figure 6. Solar car trajectory overlaid on AHI imagery

3. TWITTER-BASED DISASTER RELATED INFORMATION SHARING SYSTEM

3.1 Concept

To minimize the damage during disasters, collecting and spreading accurate information quickly is crucial. Therefore, making use of Twitter at the time when a disaster occurs has been gaining attention recently. The primary reasons for this are that Twitter is a social media having the characteristics of high immediacy, sharing information is quite easy, and the number of users is large. In recent natural catastrophes, such as the Grate East Japan Earthquake occurred in 2011, Hurricane Sandy which hit the U. S. East Coast in 2012, Typhoon Haiyan which caused severe damage to the islands of Leyte, Philippines in 2013, and 2016 Kumamoto Earthquake in Japan, Twitter was utilized as a communication tool actively. The following text is an example tweet actually posted after the Grate East Japan Earthquake occurred: “Please spread the following information: Information on Satte City, Saitama Pref.: You can’t cross the railroad crossings in the city because all of the crossing bars are down. You should take a devious route such as Route 4.” (original text is Japanese) Such kinds of tweets may be helpful not only for disaster victims but also for governmental agencies to grasp the current situation of the area for various

kinds of decision making. Therefore, lots of Japanese national and local governmental agencies have taken a great deal of utilizing Twitter to gather and distribute disaster-related information in recent years.
By the way, the number of tweets explosively increases immediately after a disaster in general. For instance, about 1.8 times the average daily number of total tweets, were posted in Japan on March 11, 2011, the day of the Great East Japan Earthquake. Then, to effectively utilize Twitter during a disaster, it is desirable that tweets are accessible form in various ways, for example, have geo-related information. However, it is well known that the number of Twitter users who attach geotags to their tweets is exceedingly small.
Based on the backgrounds mentioned above, we implemented a real-time Twitter-based disaster-related information sharing system that supports self-, mutual-, and public-help in the aftermath of a disaster. The system consists of the following two sub-systems: (1) DITS (Disaster Information Tweeting System): a system that inserts both the user's current geo-location information (the address and the MGRS code) and the hashtag of the form "#(municipality name) disaster" to a tweet automatically, and (2) DIMS (Disaster Information Mapping System): a system that plots tweets posted via DITS on a digital map. The system was launched about the middle of Feb., 2015 and generally has been operated well. Many of users expressed their impression that by using DITS they could post tweets with address of their location and the corresponding regional hashtag for disaster reports easily.

3.2 DITS (Disaster Information Tweeting System)

DITS (Disaster Information Tweeting System) is implemented as a web-based application on a Linux server using PHP and JavaScript. This application has the following features:
(a) Tweets are posted as tweets from the user's own Twitter account (Twitter authentication is conducted at the start of the use of the system).
(b) User's current geo-location information (the longitude and latitude coordinates) is acquired by utilizing location specification functions, such as the Global Positioning System (GPS), and based on the acquired location information, the address of the user's current location, the regional hashtag for disaster reports "#(municipality name) disaster", and MGRS code are automatically attached to the tweet as shown on Figure 7.

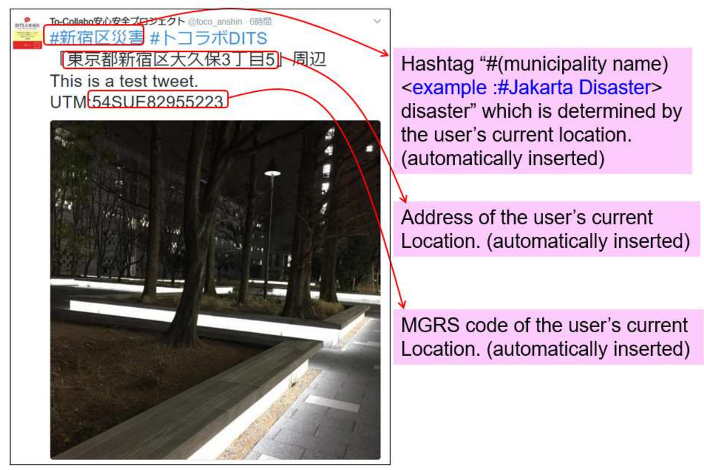

Figure 7. Outlook of DITS Tweet

(c) In the case when the user is in need of rescue, the hashtag "#救助" ("救助" means rescue) is also attached to the tweet.
(d) If the user enables location services on Twitter, a geotag is also attached to the tweet.
(e) An image taken by the user can be attached.
(f) When a tweet is posted, the following information stores in a database; (i) user name, (ii) screen name, (iii) tweet ID, (iv) tweet text, (v) date and time of posting tweet, (vi) latitude, (vii) longitude, (ix) MGRS code, (x) address (in the case where the user is in Japan), (xi) presence of the rescue hashtag ("#救助"), (xii) URL of the attached image (if any).
Both address which is determined by reverse geocoding (Yahoo! Reverse Geocoder API is used as the reverse geocoder; http://developer.yahoo.co.jp/webapi/map/openlocalplatform/v1/reversegeocoder.html) the longitude and latitude information acquired by W3C Geolocation API (http://dev.w3.org/geo/api/specsource.html), and the hashtag for disaster reports are automatically attached to tweets. For example, the acquired location information is that the latitude and longitude are 35.361743 north and 139.273691 east, respectively, the address of the user's current location is determined as "東京都新宿区大久保３丁目 5" (3-5 Ookubo, Shinjuku Area, Tokyo) and the hashtag to be attached is determined as "#新宿区災害" (#Shinjuku Area disaster). The system uses Twitter API (https://dev.twitter.com/) to post tweet texts and images. The maximum file size of the image that can be posted by Twitter API is about 3MB. Therefore, the system shrinks the file size of the image to be posted by decreasing the resolution of it before posting.

3.3 DIMS (Disaster Information Mapping System)

DIMS (Disaster Information Mapping System) is implemented as a web-based application on the Linux server using PHP and JavaScript. This application has the following features:
(a) It is available for a person without any twitter account to use.

(b) It displays the recent 30 tweets posted via DITS within 20 km from the current location of the user on a map by using the information stored in the database.
(c) The center of the map initially displayed is the current position of the user.
(d) The shape and/or color of the icon that is used to indicate the position of the tweet change depending on whether the rescue hashtag (“#救助”) and/or an image is attached or not.
(e) The places of shelters within 2km from the current location of the user are displayed on the map. If user click (tap) a shelter icon, the shortest route from the current location of the user to the shelter is displayed by using Yahoo! Japan route map API (http://developer.yahoo.co.jp/webapi/map/openlocalplatform/v1/routemap.html).
(f) If the municipal government of the current location of the user has an official Twitter account, the latest 10 tweets of the account are possible to browse.
Figure 8 shows an example of screen of DIMS. As shown in this figure, tweets can be viewed on the map. We believe that the system is useful both governmental agencies and disaster victims, that is, supports self-, mutual-, and public-help at the occurrence of a disaster.
Our next target is to overlay the latest satellite imagery in the map as shown on Figure 9.

Figure 8. An example of tweets mapping of DIMS

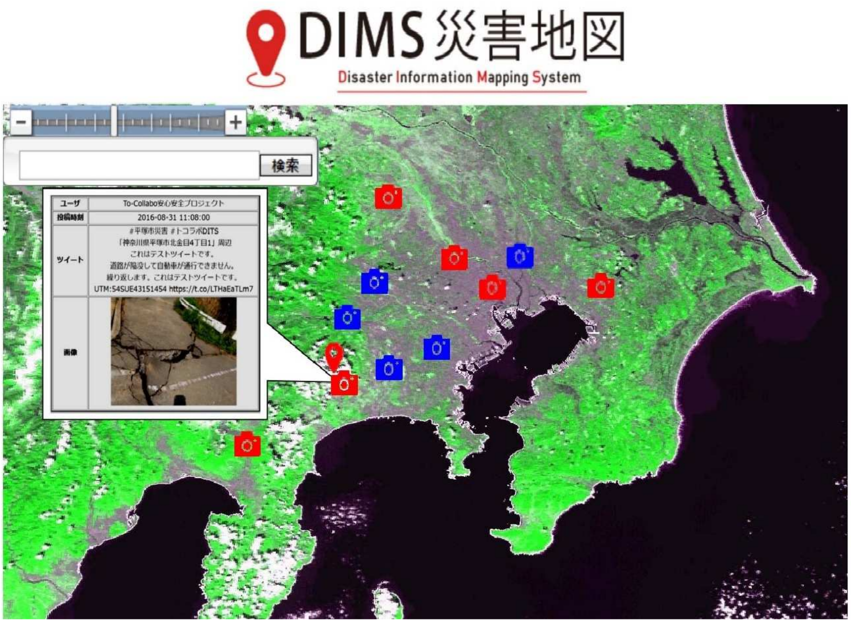

Figure 9. An example of tweets mapping of DIMS overlaid on a satellite image.

4. INTERNATIONAL COOPERATION

The authors are planning to expand the framework of the Glocal Monitoring System under the international cooperation. In December 2016, TRIC exchanged Memorandum of Agreement with the Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of Science to proceed the mutual cooperation including the Glocal Monitoring. On Febrauary 25, 2017, the international workshop on Constructing Glocal Monitoring System for safe and secure society was successfully organized in Tokyo with five invited speakers from overseas and round 100 participants.

5. CONCLUSION

The concept and the initial result of the project "Constructing glocal monitoring system for safe and secure society" initiated by Tokai University was explained in this paper. In 21st Century, we are facing various kinds of disasters and environmental changes. The concept of "glocal", connecting global monitoring system using satellite observation with local monitoring system using SNS, is becoming very important. Since the authors have already constructed a satellite data reception & processing system as well as the Twitter-based disaster-related information sharing system DITS & DIMS, our next step of constructing the Glocal Monitoring System by connecting the satellite data system with the twitter-based system is quite promising. The authors are pleased to cooperate and exchange ideas on glocal monitoring with the international community.

ACKNOWLEDGEMENT

This study was performed under the framework of the Tokai University's branding project "Constructing glocal monitoring system for safe and secure society" supported by MEXT(Ministry of Education, Culture, Sports, Science and Technology). The authors would like to thank them for their kind support.

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