Research and development of real-time interpretation of flood conditions

*Junko Iwahashi[1], Hiroyuki Ohno[1], Takayuki Nakano[1]

1. GSI of Japan

In recent years, large floods such as the floods caused by Typhoon Hagibis in 2019 have been frequent, and it has become urgent to quickly grasp the inundation areas for disaster response. This research was conducted as an R & D project of Geospatial Information Authority of Japan (GSI) from FY 2017 to FY 2019. This research was carried out as a three-part project: (1) Development of automatic detection system of inundation areas (PIC: Ohno), (2) Establishment of accurate calculation of flood volume (PIC: Iwahashi), (3) Investigation of method to identify inundation areas at night (PIC: Nakano). In this presentation, an overview is introduced.

(1) A system was developed that automatically detects muddy water areas by machine learning (AI), using images transmitted from a helicopter of each regional bureau of MLIT (Ministry of Land, Infrastructure, Transport and Tourism) to GSI. This system is constructed to operate synchronously with helicopter satellite communication systems, of the bureaus, and automatically starts inundation detection processing and extraction of the area as polygon data. Further, the polygon data is orthographically transformed and is merged with the next polygon data to form an inundation area polygon. The system has enabled to detect the inundation areas within 30 seconds after transmission of an image. We have also started to build a practical system and have realized a system construction that updates the latest inundation reach, one after another, at approximately two-minute intervals after the start of transmission.

(2) Various methods for obtaining water volume from the position information of the waterfront of a flood based on aerial images were examined, and the superior procedure was summarized. As the correct answer data, the flood simulation data (MLIT) was used. The method is as follows: first, similar to the aerial images which use position information of the waterfront of a flood, only the point group (perimeter/portion) at the edge of the inundation simulation data was extracted, and the water surface was created using multiple calculation methods. After calculating the flood volume by the difference between the estimated water surface and 5m DEMs, we considered superior method. It was found that in cases where there is a hydrodynamic gradient and the entire inundation area can be grasped with good positional accuracy, interpolation by Natural Neighbor method is appropriate, and in other cases it is appropriate to create a plane with the average elevation of the waterfront points. However, in the case of using planes, it is necessary to divide the area depending on the case, and it has been found that outliers can be identified if a moving average can be obtained.

(3) To gain knowledge for survey of inundation areas at night, possible sensor candidates were investigated. Ultra-high sensitivity cameras and thermal infrared cameras were selected as sensors that can be installed on helicopters. Performance tests from the helicopter and supplementary tests on the ground were conducted, and knowledge on night observation was compiled. As a result, it was found that the ultra-high sensitivity camera is practical for grasping a water area at night, and that the optimum ISO sensitivity is between 51200 and 102400. The thermal infrared camera could identify the water area, but it is susceptible to various conditions, so supplementary use is considered effective. At present the nighttime operation of helicopters is limited.

As described above, this study has established a real-time interpretation of inundation areas in synchronization with the helicopter satellite communication systems, and the method of calculating the amount of water volumes. The automatic detection system of inundation areas is already planned to be used for disaster response through a web-mapping system of MLIT.

Keywords: Flood, AI, Deep learning, Flood volume, Ultra-high sensitivity camera, Helicopter satellite communication system