R&D Item

5． System integration for emergency surveys of river channel blockages

Progress until FY2024

1. Outline of the project

This project aims to enable infrastructure construction in diverse environments using a collaborative AI robot system, with a focus on applications at natural disaster sites involving river channel blockages. To this end, we are advancing R&D in three areas: (1) System integration for emergency surveys of river channel blockages, (2) System integration for emergency restoration work of river channel blockages, and (3) Technologies for responding to river blockages. In (1), Rapid situational assessment is crucial for emergency surveys, requiring not only image data but also water levels, terrain, and ground strength. Since these sites are often in mountainous areas, manual data collection is difficult. We are therefore developing remote data collection technologies—centered on drones—and an integrated system to aggregate this data. Figure 3 provides an overview of the technologies and system, followed by a summary of key outcomes from the 2024 efforts in emergency survey system integration.

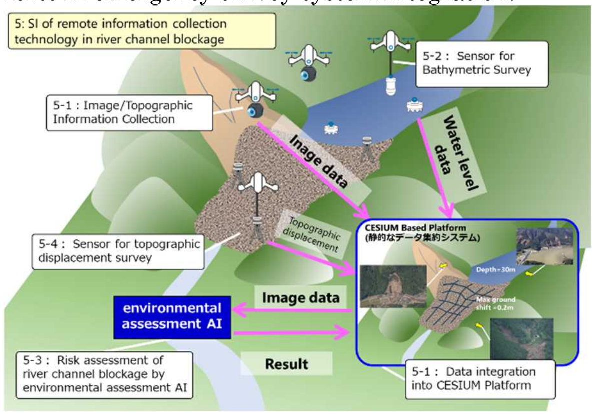

Figure 3: Emergency Survey Technologies.

2. Outcome so far

In fiscal year 2024, this research project developed an integrated emergency survey system for disaster response scenario in Figure 1. We also conducted field tests to acquire data in a real environment. The system consists of multiple components: (1) Aerial imagery and 3D terrain mapping using drones, (2) Remote deployment of water depth sensors in flooded areas via drone, (3) Remote deployment of sensors for detecting terrain displacement, and (4) Risk assessment of river blockage collapse areas. The collected data and assessment results are integrated into an information-sharing platform built on Cesium (The Platform for 3D Geospatial, by Cesium GS, Inc.). To validate the system, field experiments were conducted in October 2024 at the Imokawa River in the Chuetsu region. These included drone-based aerial surveys, sensor deployment, and data acquisition. Notably, the water level sensor was transported over 400 meters by drone, autonomously deployed in water, anchored in place, and used to transmit data—achieving Technical Readiness Level 5 (TRL5), indicating proven functionality in a simulated environment (see Figure 4). The collected data were then visualized using the platform. Figure 5 shows an example of time-series data from the water level sensor overlaid on the 3D terrain model of the Imokawa site.

Figure 4: Drone takeoff/landing site (left), the drone carrying the sensor device (center), the device just before water landing during autonomous transport (right).

Figure 5: The Information-Sharing Platform

We also developed a system that analyzes aerial imagery captured by drones and uses AI to assess the collapse risk of targeted river blockage sites. The system qualitatively estimates the likelihood and type of potential secondary disasters, and is integrated into the information-sharing platform. In general, AI-based systems require large volumes of training data. However, for slope failure analysis—the focus of this project—the task requires expert knowledge, and suitable datasets are limited. To address this, we created a new dataset specifically designed for learning about slope failure risks, and developed a novel AI system capable of efficiently learning from limited data and incorporating expert knowledge to assess collapse risk. The system demonstrated superior performance in identifying disaster types, causes, and potential future risks compared to conventional methods.

3. Future plans

The intermediate target for 2025 is to demonstrate this capability in a simulated natural disaster environment.

To achieve this, we plan to complete system integration by 2025 and conduct a demonstration in the simulated river channel blockage environment at Kyushu Univ. in the summer, and achieve Technical Readiness Level 5.