【Grant-in-Aid for Scientific Research (S)】

Broad Section C

Title of Project： Digital twin computing for enhancing resilience of disaster medical system

KOSHIMURA Shunichi

(Tohoku University, International Research Institute of Disaster Science, Professor)

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【Purpose and Background of the Research】

The 2011 Great East Japan earthquake tsunami disaster revealed many problems in Japan's disaster management policies, and these have undergone reforms to promote initiatives for building national resilience. One of the key challenges in the aftermath of tsunami disaster is identifying its impact and prioritizing disaster response and relief activities with the needs of forecast information. Recent advances in high-performance computing and large data sets comprising observations are dramatically improving our understanding of the whole picture of tsunami-affected areas in real-time.

With use of modern computing power and advanced sensing and monitoring capabilities, this research project aims to enhance resilience of disaster medical systems by constructing "Disaster Digital Twin" to support disaster medical assistance team.

【Research Methods】

"Disaster Digital Twin" platform consists of a fusion of real-time simulation for tsunami damage forecast, social sensing to identify exposed population and medical needs, and multi-agent simulation of disaster medical response activities to find optimal allocation of disaster medical services and achieve the enhancement of disaster resilience.

To achieve the goal of innovating digital twin computing for enhancing disaster resilience, four issues are addressed.

(1) Developing nation-wide real-time tsunami inundation and damage forecast system. The priority target for forecasting is the Pacific coast of Japan, a region where Nankai trough earthquake is likely to occur.

(2) Establishing a real-time estimation of the number of affected people in the affected areas and clarifying the relationship between the exposed population and medical demand.

(3) Developing a reinforcement learning-based multi-agent simulation of medical activities in the affected areas with use of damage information, medical demands, and resources in the medical facilities to fid optimal allocation of medical response.

(4) Developing a digital twin computing platform to support disaster medical response activities and find optimal allocation of disaster medical services through what-if analysis of multi-agent simulation.

The concept of disaster digital twin is illustrated in Fig.1.

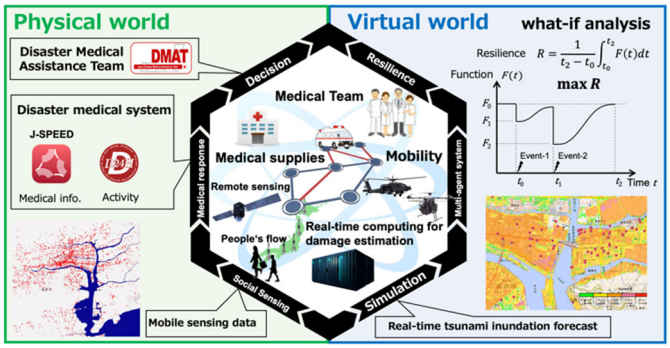

Fig.1 Concept of Disaster Digital Twin

【Expected Research Achievements and Scientific Significance】

"Disaster Digital twin" is the concept of capturing the real physical world from various sensors and simulations, creating a copy (or twin) in the virtual world (on a computer), running simulations with the copied data to find out optimal solutions for enhancing disaster resilience, and feeding back the results to the physical world's decision makers and responders.

The key outcome expected from this project is to create an innovative disaster digital twin computing platform to support disaster medical assistance team and enhance disaster resilience. To accomplish the goal, researchers in the fields of earth science, engineering, and medical science are working together and constructing disaster digital twin to enhance the society's resilience against future catastrophic tsunami disaster.

【Publications Relevant to the Project】

・ Moya, L., Mas, E., Koshimura, S. et al., Disaster Intensity-Based Selection of Training Samples for Remote Sensing Building Damage Classification, IEEE Transactions on Geoscience and Remote Sensing, 1-17, 2021. DOI: 10.1109/TGRS.2020.3046004

・ Koshimura, S., Mas, E., Moya, L., Bai, Y., Tsunami Damage Detection with Remote Sensing: A Review, Geosciences, 10(5), 177, 2020. DOI:10.3390/geosciences10050177

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