

Development of Earthquake Disaster Restoration Support System of Electric Power Distribution Equipment

Background

In general, since a huge number of electric power distribution equipments are installed in residential areas, it is difficult to accurately monitor and understand those equipment damage conditions during the early stages after a large-scale earthquake. Therefore, highly accurate damage estimation and restoration simulation technologies are desirable to support the emergency restoration work. However, since it is usually difficult to estimate the damage degree and restoration time of the electric power distribution equipment before the occurrence of earthquake, their estimation methods, which effectively apply sequentially updated disaster information just after the earthquake associated with seismic source and power outage, are needed. On the other hand, the highly advanced computer simulation technologies enable us to simulate the detail and emergency restoration process including sequential damage estimation of electric power distribution equipment.

Objectives

This research proposes a damage estimation prototype system for electric power distribution equipment using sequential updated disaster information from the time just after the occurrence of an earthquake to the completion time of the emergency restoration. It also proposes the emergency restoration simulator to estimate the total restoration time

Principal Results

1. Development of a sequential updated seismic intensity evaluation system

A system which evaluates some sequential updated seismic intensity distributions including Peak Ground Acceleration (PGA) and Peak Ground Velocity (PGV) was developed. In order to evaluate them, the developed system used the sequential updated earthquake information such as hypocenters delivered from the Meteorological Agency (Fig.1a).

2. Development of a sequential updated damage estimation system

A seismic damage estimation system for electric power distribution equipment was developed. The developed system applied a Bayesian Network (BE)^{*1} modeling process and enabled us to improve the accuracy of the damage estimation based on some sequential multiple disaster information including power outage distribution lines which can be collected just after an earthquake event (Fig.1b).

3. Development of emergency restoration process simulator

An emergency restoration process simulator, which mounts a database associated with the emergency restoration time estimation for the electric power distribution equipment as a database, was developed (Fig.1c). The developed system can estimate the restoration time based on the Multi Agent Technology (MAT)^{*2}. The MAT can simulate the restorer's actions which are modeled by extracting main work steps of their actual restoration process.

4. Verification of the effectiveness

The developed system was applied to a hypothetical system. As a result, it was illustrated that the sequential updated damage estimation system can more accurately estimate the seismic damage of electric power distribution equipment, compared with an existing model.

Future Developments

The developed three systems will be synchronized as the enhanced emergency restoration support system for electric power distribution equipment to more accurately estimate the seismic damage and its restoration time estimation in actual emergency restoration process.

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References

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* 1 : A Bayesian Network (BE) is a probabilistic graphical model that represents a set of variables and their probabilistic independencies. It could represent the probabilistic relationships between equipment damage and its causes.

* 2 : "Agent" is a software that imitates a restorer who can behave with some autonomy. Moreover, "Multiagent system" is a system of which two or more agents work while causing the interaction each other.

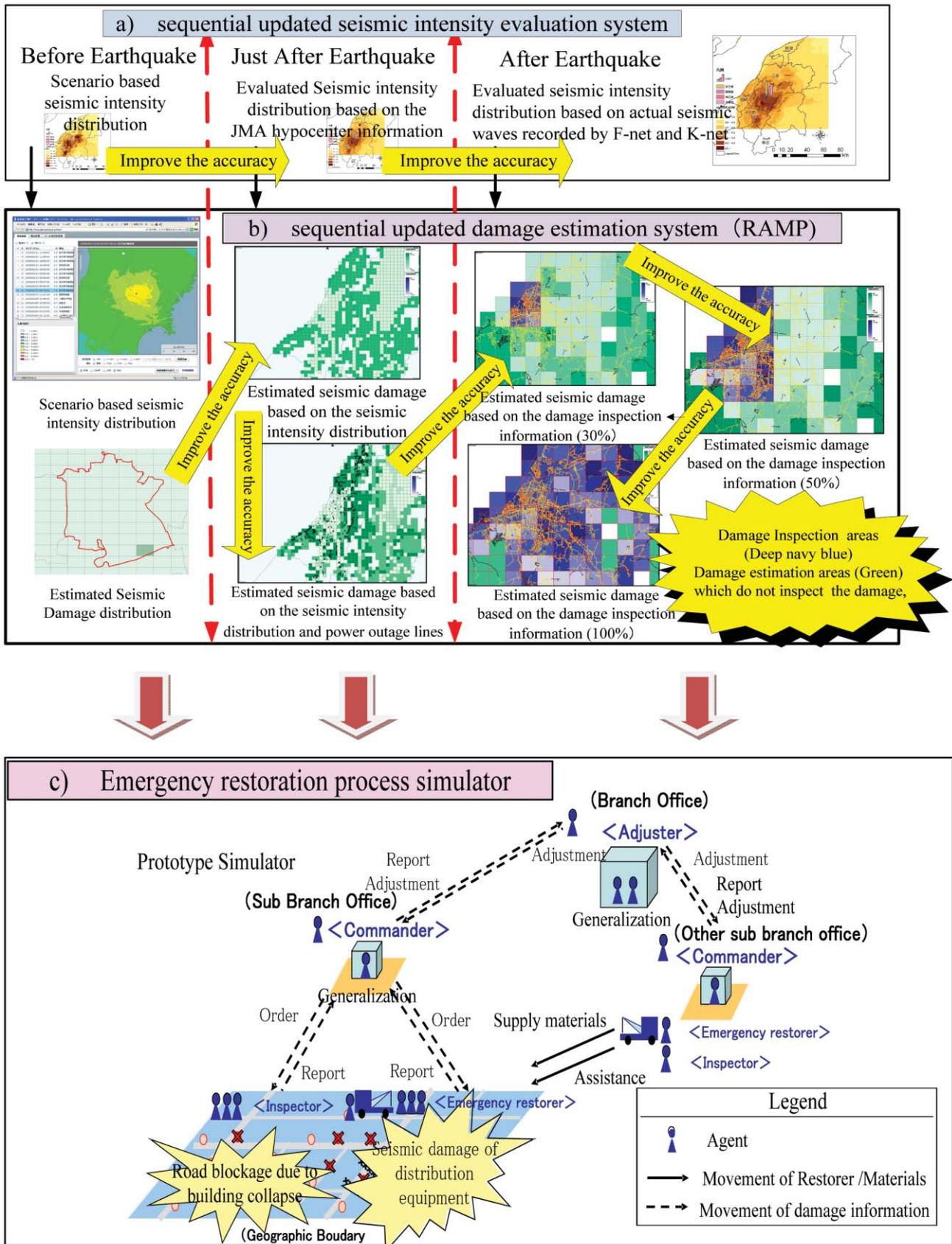


Fig.1 Prototype system of the earthquake disaster restoration support system