Large-Scale Computer Modeling and Simulation as a Planning and Design Tool

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A number of natural disasters occur annually in various parts of the world. Especially, the number of natural disasters in cities, such as floods, wind disasters, and air pollution, increase in accordance with the development of cities. In order to estimate the extent of a disaster quantitatively, it is necessary to estimate the behavior of natural phenomena that cause the natural disaster. In practical computations of this type of problem, the computational domain is large and the computations need to be carried out over long durations. Therefore, this type of problem becomes quite large-scale, and it is essential to use methods that are as efficient and fast as the available hardware allows.

In recent years, massively parallel finite element computations have been successfully applied to several large-scale simulations for natural phenomena. These computations demonstrated the availability of a new level of computational capability to solve practical problems. However, in order to compute natural phenomena accurately, it is necessary to prepare an accurate shape model for landforms, buildings, and civil structures. Furthermore, a good finite element mesh of quality must be prepared for the complicated spatial analytical domain. In this presentation, a large-scale computer modeling and simulation method is discussed. GIS data was used for the preparation of the shape model and an automatic mesh generation method was developed. Parallel finite element methods were employed for the numerical simulation of natural phenomena. The present method is shown to be a useful planning and design tool for natural disasters.

Keywords:
Large-scale simulation: Simulation with a large number of degrees of freedom. Normally, parallel computer is used for the simulation.

GIS data: GIS is an abbreviation for geographic information system. GIS can handle and process various types of digital maps and data related to geographic information. GIS data is the digital data of landforms, shape of buildings, and civil structures.

Parallel finite element method: Finite element methods designed for the use of parallel computers. The finite element method is a numerical method for solving partial differential equations.

Mesh generation method: The method to divide the spatial analytical domain into a large number of elements. Normally, finite element simulations require this method.