Chapter 73
A Component-Based 3D Geographic Simulation Framework and its Integration with a Legacy GIS

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ABSTRACT

There is an increasing demand for 3D geographic simulation systems. Most systems currently available are closed and based on fixed architectures. Some systems allow us to develop and customize a 3D geographic simulation system, but this usually requires the writing of extensive program code. Especially in 3D geo-disaster simulations, for example, we need to dynamically integrate 2D legacy GIS with 3D geographic simulation systems in order to investigate the details about the damaged areas and the consequences of the disasters. The authors propose a component-based application framework for 3D geographic simulation that can integrate a legacy 2D GIS with geographic simulation systems in a 3D visual environment. Their framework provides a set of 3D visual components required for the development of a new interactive 3D visual geographic simulation. In their framework, component integrators can construct 3D geographic simulation systems by composing the 3D visual components. Moreover, the authors' integration framework provides two fundamental integration mechanisms, view integration and query integration mechanisms, to integrate it with legacy 2D systems. The view integration function maps the 2D rendering of a legacy 2D GIS onto the surface of the 3D geography used in a 3D visual geographical simulator, and then dispatches every event on the geographic surface to the original 2D GIS. The query integration automatically converts each 3D simulation result that is shown as a set of highlighted regions on the surface of the geography to the corresponding regional query to the 2D GIS. The proposed framework is based on their 3D meme media architecture in which components are represented as meme media objects, and their interoperation is defined by slot connections between them. As a result, their framework enables users to compose 3D geographic simulation systems and to integrate a legacy 2D GIS with a 3D geographic simulation system simply by composing display objects in a 3D visual environment.

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INTRODUCTION

Various geographic simulation systems have been developed to meet the growing need for 3D geographic simulation of disasters, such as avalanches, floods, and landslides. In general, the development of each has been primarily independent with closed and fixed architectures, it is therefore difficult to introduce existing functions of one existing geographic simulation system to others. Moreover, although the geographic simulation systems generally have strong disaster simulation capability, they often lack the information necessary for analysis and evaluation of the disaster, whereas many legacy geographic information systems (GIS) can provide visual map and region query functions for disaster analysis and evaluation. For this reason, GIS and geographic simulation systems often need to be integrated. However, in general, the development of the 3D geographic simulation systems and legacy GIS have been primarily independent and integrative uses are still at an early stage.

There are many conventional GIS, and simulators have become more advanced. Because these types of software are usually independent, closed systems, they are difficult to customize and to integrate with others. Although some systems, such as GRASS (GRASS) and ArcGIS (ArcGIS), can be customized with library packages, they still require users to write lengthy programs. Other systems, such as GeoVista (Takatsuka, 2002) and AVS (Upson, 1989), provide a visual programming environment for the development or customization of the 3D simulation systems. These systems allow users to interact only with their visual programs; users cannot interact with their visual output to develop a new 3D system or modify their input parameter values. Component object model (COM) is a model for linking software modules. When such a link is established, the modules can communicate with each other through standard communication interfaces. These links require users to be skilled in programming. Open Geospatial Consortium (OGC) standards (OpenGIS) can be used to integrate different Web services through an OGC-standard Web service interface. This integration demands OGC-compliant Web services. However, most of the currently available Web services are not OGC-compliant (Alves, 2006).

This chapter proposes a component-based 3D geographic simulation framework. Our framework provides basic composite components for 3D geographic simulation, and two fundamental legacy GIS integration mechanisms for component integrators. Our framework enables component integrators to easily build 3D geographic simulation systems by visually combining the required components and by defining data flows among the components. The component integrators need to have knowledge about the legacy systems, for example, knowledge about the display and query APIs and their parameters for the legacy GIS, the input and output data formats of the legacy simulators, and the data flows among components. The component integrators also need to know how to combine the required components together. The end users of this framework only need to replace some component with another of the same functionality, by mouse manipulation, to carry out 3D geographic simulations integrated with a legacy GIS.

The component-based 3D geographic simulation framework presented here incorporates the basic components of 3D geographic simulation systems and two legacy GIS integration mechanisms into an integrated environment. This framework provides a set of 3D visual basic components required for the development of a new interactive system that can integrate legacy 2D GIS and legacy geographical simulators to make 3D geographic simulation systems. In the integration framework, construction of a new 3D geographic simulation system only requires combining the necessary 3D visual components. To support this framework of integrating a legacy GIS, we also propose two fundamental integration mechanisms: view inte-

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