Chapter 2.14
Development of a Web-Based Intelligent Spatial Decision Support System (WEBISDSS): A Case Study with Snow Removal Operations

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ABSTRACT

A SDSS combines database storage technologies, geographic information systems (GIS), and decision modeling into tools which can be used to address a wide variety of decision support areas (Eklund, Kirkby, & Pollitt, 1996). Recently, various emerging technologies in computer hardware and software such as speedy microprocessors, gigabit network connections, fast Internet mapping servers along with Web-based technologies like eXtensible Markup Language (XML), Web services, and so forth, provide promising opportunities to take the traditional spatial decision support systems one step further to provide easy-to-use, round-the-clock access to spatial data and decision support over the Web. Traditional DSS and Web-based spatial DSS can be further improved by integrating expert knowledge and utilizing intelligent software components (such as expert systems and intelligent agents) to emulate the human intelligence and decision-making. These kinds of decision support systems are classified as intelligent decision support systems. The objective of this chapter is to discuss the development of an intelligent Web-based spatial decision support system and demonstrate it with a case study for planning snow removal operations.

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INTRODUCTION

Spatial Decision Support Systems

The past decade witnessed an explosive growth of spatial data and various applications that utilize spatial data. Geographic information systems (GIS) have been developed to facilitate storing, retrieving, editing, analyzing, and displaying spatial information. The increasing complexity of spatial data and a need for better modeling requires decision support systems that can handle spatial data. This led to the idea of spatial decision support systems (SDSS). Since the early 1980s, SDSS have been used in several applications that provide spatial functionalities such as routing, allocation modeling, and so forth.

Most of the existing SDSS do not employ any intelligent software components to enhance decision support. Only a very few researchers have explored the possibility of integrating intelligent software components with an SDSS for applications like multi-criteria decision analysis, routing, and weather-based decision-making. Most of the literature reviewed for Intelligent GIS systems deals with architectural as well as implementation issues of GIS-based decision support systems and integrating them with agents. The use of software agents for GIS-based systems is well documented (Odell, Parunak, Fleischer, & Brueckner, 2003; Sengupta, Bennett, & Armstrong, 2000; Shahriari & Tao, 2002; Tsou, 2002). Most of these systems are not Web-based, and they lack the advantages of Web-based systems like ease-of-use, cross platform functionality, low maintenance costs, centralized data storage, and so forth.

Also, recent advances in Web technologies like rich site summary (RSS), XML feeds, and asynchronous JavaScript and XML (AJAX) can help us device a seamless interface by providing real-time access to data over the World Wide Web. Therefore, integrating the process of decision-making with an intelligent component and Web-based technologies proves to be very beneficial. When integrated with encoded human intelligence, the spatial decision support systems can rival a human expert in a particular domain (e.g., snow removal, traffic management, logistics, etc.).

This chapter explores and discusses the development of a Web-based intelligent spatial decision support system for planning snow removal operations. Specifically, this chapter addresses the existing problems with snow removal decision-making in the USA. The SDSS discussed here integrates knowledge from snow removal experts and real-time weather information into a Web-based interface. The system is intended to provide advised decision support for officials at various departments of transportation across the country, and to serve as a guideline for development of a snow removal DSS for the decision-makers and stake-holders around the world.

Background on Snow Removal Operations

Snow removal operations during the winter are of prime importance in avoiding traffic accidents and providing safe travel conditions on the nation's highways and city streets. Quality snow and ice control service is critical for preserving traffic safety, maintaining city commerce, and allowing residents access to schools and medical facilities (Hintz, Kettlewell, Shambarger, & Sweeney, 2001). Department of Transportation (DOT) of each state is responsible for snow removal on all interstates, and primary highways like the U.S. Federal highways and state highways. The city streets are snowplowed by the Street Department of that city, or sometimes by the DOT itself (Iowa Department of Transportation (IDOT), 2005). Snowplowing is done according to a set priority assigned to each road depending upon the annual average daily traffic (AADT). Higher priority roads like the interstates are cleared before the lower priority routes like city streets.

Managing snow removal operations necessitates activities ranging from the preparation of

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