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学位論文名	Development of Web Service for Distributed Geoprocessing and Real-Time Sensor Observation using Free and Open Source Software フリーオープンソースソフトウェアを用いた分散型の空間解析およびリアルタイムセンサーオブザベーションのためのウェブサービス
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論　文　内　容　の　要　旨

Geoinformatics has played a key role at all levels of communities; especially since vast amounts of valuable geospatial data have become available. The near real-time utilization of geospatial data has been widely utilized in environmental monitoring, security management, disaster mitigation and so on. In order to fully utilize the available spatial data efficiently and time effectively, GIS has to play a critical role in not only disseminating the spatial data, but also by providing information and offering value-added service to potential users so as to support spatial decision making needs. Nowadays, the Web-GIS has very extensively developed and is being widely used as scores of Internet users are gaining exposure to spatial data for day-to-day needs. For most advanced usage, Web-GIS should include spatial analysis and spatial modeling capabilities for an on-demand GIS mapping. However, the essential data for accurate and up-to-date modeling of environmental situations also needs to be efficiently gathered. Real-time data acquisition and management is becoming more necessary to fulfill such needs. The present study proposes a comprehensive web-based GIS system enabled with spatial analysis functionality and coupled with real-time observation from remote field sites based on various open standards of OGC specifications. A distributed geoprocessing framework based on Web Processing Service (WPS) using real-time data as input parameters from Sensor Observation Service (SOS) has been newly implemented. Here, several different remote acquisition systems were successfully tested for compliance with standard web service framework. A prototype system for environmental monitoring for water quality has been developed to demonstrate the efficacy of integrating of several Open Web Services to develop a distributed data access and geospatial analysis system. Further, on-demand computation using Remote Sensing data has been demonstrated by implementing WPS for calculation of Sea Surface Temperature and Turbidity index map from ASTER image. The Remote Sensing data can be requested from distributed Web Coverage Services (WCS) following OGC compliant specification.

Further, in order to promote easy understanding of analytical results, 3D geospatial data visualization within a web browser was implemented. In this research, the implemented system provide a novel solution offering a “browser-only” solution, wherein not only the existing static data; for example, the developed prototype system for 3D geologic modeling, can be visualized but also dynamic results offered through WPS can be accessed. The system is implemented under the multi-layer distributed web service architecture, which is based on a clearly demarcated Service Oriented Architecture (SOA) workflow.

The present study will contribute to development of comprehensive analytical web-mapping application using a variety OGC services and facilitate gathering and processing real-time data from sensor networks with minimum human interaction. In addition, the prototype systems developed in this research are scalable, robust and well suited for distributed geospatial

modeling. Apart from simple WPS implementation, the Web-GIS functionality could be enhanced based on service chaining and orchestration and execution of complex geoprocessing workflows using BPEL (Business Process Execution Language) engines. However, the actual implementation of service chaining would require development of middleware services due to existing incompatibilities between OGC web service and W3C standard web service. Such enhanced Web-GIS capabilities offer new opportunities for geoscientists to build applications for multi-layered dataset such as lifeline infrastructure, geological borehole data, geological maps, soil profiles, marine and atmospheric data.

論 文 審 査 の 結 果 の 要 旨

This thesis presents a new concept for Web-GIS using Open Standards and Open Geospatial Consortium Web Services (OWS). Based on this concept, a comprehensive Web-GIS framework for seamless sharing, distributed processing and visualization of both archived geospatial data as well as near real-time measurements derived from field sensors is proposed. The thesis also describes practical implementation of prototype Web-GIS systems that offer high degree of scalability, interoperability and customizability to cater to a variety of user needs. The prototype systems provide a clear demonstration on the efficacy of Free and Open Source Software (FOSS4G) to provide a framework to enable wider access and broader utilization of geospatial data. The proposed Web-GIS system is especially suitable for urban applications where information sharing and near real-time data processing is required for monitoring as well as decision making needs.

Chapter 1 provides an overview of Web-GIS technology and presents the research objectives emerging needs for standardized geospatial services.
Chapter 2 proposes an integrated OWS framework, enabling geospatial Data Sharing, Geo-processing and Visualization in distributed computing environment
Chapter 3 outlines the implementation of service oriented Web-GIS environment using FOSS4G software stack and independently developed software solutions.
Chapter 4 presents three prototype systems based on a clearly demarcated workflow comprising of data access, geo-processing and visualization services for on-demand spatial modeling using near real-time data from heterogeneous sensor network.
Chapter 5 discusses the suitability of OWS based Web-GIS framework for environmental monitoring. It also proposes further enhancement such as mapping of geo-processing workflows as service chains.
Chapter 6 summarizes the main conclusions of the research.

The thesis defines a new Web-GIS framework based on careful evaluation of limitations in existing systems. Further, the results demonstrates a deep understanding of the underlying Open GIS Standards and expertise in implementing Open Source GIS Software solutions that have enabled the integration of several novel features within Web-GIS framework.

The Web-GIS framework presented in the thesis offers a basis for building more complex applications using the emerging trends of service chaining and Web Service Orchestration. Further, innovative software development carried out, as a part of this research is an invaluable feedback to the FOSS4G community.

In light of the above, the present thesis is evaluated to be of high caliber and as a significant contribution to Spatial Information Science as well as Environmental Science. Therefore, this the author of the thesis is conferred the degree of Doctor (Creative Cities).