A SENSOR DATA PROCESSING SYSTEM FOR LARGE SCALE CONTEXT AWARENESS

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ABSTRACT:

The advance of wireless telecommunication and observation technologies leads developing sensor and sensor network for serving the context information continuously. Besides, in order to understand and cope with the context awareness based on the sensor network, it is becoming important issue to deal with plentiful data transmitted from various sensors. Therefore, we propose a context awareness system to deal with the plentiful sensor data in a vast area such as the prevention of a forest fire, the warning system for detecting environmental pollution, and the analysis of the traffic information, etc. The proposed system consists of the context acquisition to collect and store various sensor data, the knowledge base to keep context information and context log, the rule manager to process context information depending on user defined rules, and the situation information manager to analysis and recognize the context, etc. The proposed system is implemented for managing renewable energy data management transmitted from a large scale area.

KEY WORDS: Sensor Data Processing, Context Awareness, Event Detection, Location Based Services, Spatiotemporal Database

1. INTRODUCTION

Recently worldwide, various social problems have occurred because the oil value rise and fall. Especially, several nations like Korea, which have no oil resources have difficulty in preserving energy for the future. Because of this reason, renewable energy resources such as biomass, geothermal, solar radiation, and wind energy play an important part for the energy resources of the future. Therefore, the research and development of an energy data management database need to manage renewable energy resources systematically and effectively.

Now at the Europe, America, Japan, and so on, the information systems of the renewable energy resources are actively developed and spread, and these are serviced on the web. Especially, the nations as Korea, which have no oil products, must prepare to the energy problem of the future society by the efficient collection and analysis of renewable energy resources. Therefore, it is very important to research and develop about databases, which manage the renewable energy resources and information service by Internet.

To develop this energy management system, we design the context awareness system to grasp the situation immediately and to monitor the situation of some place at long distance, because of serious environmental pollution according to civilization and enlightenment. It is also useful to prevent disasters such as a storm, an earthquake, flood, the breaking of a tunnel, a bridge, and a building, etc.

2. RELATED WORK

Sensor Web Enablement (SWE) of the Open Geospatial Consortium, Inc. (OGC) builds revolutionary framework of open standards for exploiting Web-connected sensors and sensor systems[1, 2]. In addition, SWE contains some research SensorML[3, 4, 5], Observations & Measurements[6, 7], Sensor Observation Service, Sensor Planning Service, Web Notification Service. SensorML is information model and XML encodings for discovering, querying and controlling web-resident sensors. Observations & Measurements is the information model and encodings for observations and measurements. Sensor Observation Service is the service to fetch observations from a sensor or constellation of sensors. Sensor Planning Service is the service to assist in "collection feasibility plans" and to process collection requests for a sensor or sensor constellation. Web Notification Service executes and manages message dialogue between a client and Web services for long duration asynchronous processes.

The goal of the SWE activity is to allow all types of Web and/or Internet-accessible sensors, instruments, and imaging devices to be accessible and, where applicable, controllable via the World Wide Web. A context-aware application is one which adapts its behaviour to a changing environment[8]. The examples of context-aware applications are 'construction-kit computers' which automatically build themselves by organising a set of proximate components to act as a more complex device. Typically, a context-aware application needs to know the location of users and equipment, and the capabilities of the equipment and networking infrastructure[9].

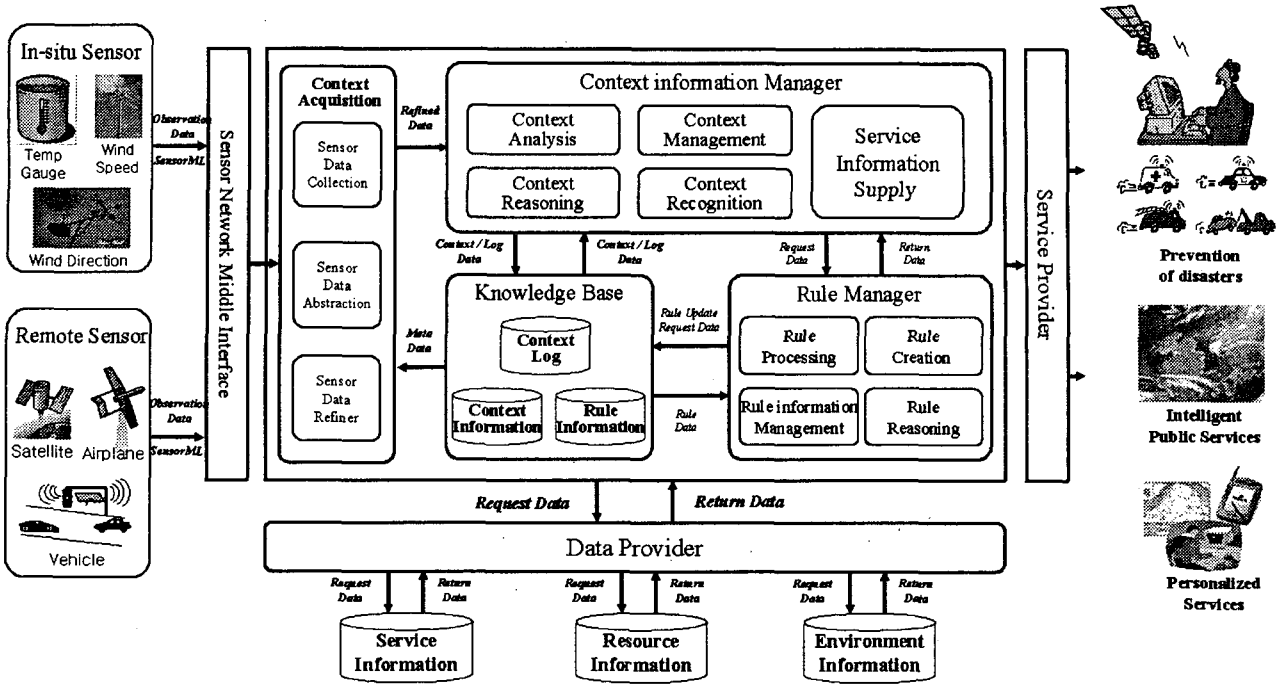

Figure 1. The structure of context awareness system.

3. PROPOSED CONTEXT AWARENESS SYSTEM

3.1 System structure

In order to prevent of disasters, provide intelligent public services and personalized services, the structure of context awareness system for modelling and processing large scale condition information from a variety of sensor data is shown in figure 1.

Data provider serves the environment information, the resource information, and service information. The environment information contains the infrastructure like road network and building, atmospheric phenomena, and geometry information, etc. The resource information has the usable resource catalogue as providing services such as people, vehicles, an aircraft, and so on, because the system has to know material and human resource information in order to find the way to give the alarm and cope with the situation. The service information has a variety of service patterns to give the information about the level and the type of service to the context information manager as the manager decides suitable service according to the understood and predicted situation.

Sensor network middle interface can support to transmit in-situ sensor data such as a wind direction, temp gauge, etc. as well as remote sensor data such as the picture and the atmospheric phenomena information made by satellite and airplane, the location information of vehicles, etc.

In-situ and remote sensor data transmitted from sensor network middle interface are stored into a context information database in knowledge base through converting the data into knowledge with a sensor data collection, a sensor data abstraction, and a sensor data refiner. The context information manager module can understand the situation of the area using sensor in real world through analyzing and reasoning the situation through detecting rules defined in the rule manager. It can also provide the summarized context information to a service provider through utilizing a data provider and the knowledge base.

3.2 System components

The system is consists of a context acquisition, a knowledge base, a rule manager, a context information manager, a data provider, and a service provider.

3.2.1 Context acquisition

- sensor data collection : gathering the data transmitted form various sensors.
- sensor data abstraction : converting gathered sensor data to the information form having a meaning.
- sensor data refiner : in order to store the meaning information created from the abstraction module, integrating and refining the context information through analyzing the relationship between spatial objects and the meaning information.

3.2.2 Knowledge base

- Context information database : having the information of specific situation served from the context acquisition.
- Rule information database : storing the rules for understanding the situation.

- Contest log database : storing the log of analyzed context information as service information. The stored data is utilized to recognize and predict the situation.

3.2.3 Context information manager

- Context management : storing the gathered situation data to the context information database and handling the information with management operators such as SetDangerLevelInPeriod(), GetContextAtTime(), and MaxValue(), etc.
- Context analysis : understanding the situation through checking whether it is satisfied with specific rules about spatial, temporal, spatiotemporal events.
- Context reasoning : in order to grasping the situation and to provide the suitable service according to the condition, this module predict the change of the situation in a specific area.
- Context recognition : examining the current and the predicted situation information extracted from the context analysis and reasoning module.
- Service information supply : to provide the service according to recognized situation, this module serve the information of summarized situation and service types to the service provider and store the information to the context log database.

3.2.4 Rule manager

- Rule management : processing some transaction for handling rule database and keeping consistency.
- Rule creation : generating the rules to understand the situation through utilizing the collected information for the knowledge and data provider.
- Rule reasoning : making new rules from existing rules for predicting spatiotemporal simple or complex events.
- Rule processing : in order to understand the situation, checking the current condition is satisfied with specified rules and giving the results to the context analysis module.

3.3 Spatiotemporal database

The context awareness system deals with data related to solar radiation transmitted from various sensors in this paper. A solar radiation data is a spatiotemporal data, which the observed values are changed by the seasons and regions. Therefore, in order to manage the solar radiation data, it is necessary to use a spatiotemporal database. Spatiotemporal databases store and manage geometries changing over time. That is, they can effectively handle various spatial objects existing in real world as well as history of spatial object changing with time flow. In this research, we look at the mechanisms of spatiotemporal data modelling and the spatiotemporal operators, which were studied in the past. Also, we survey the concept and application areas of GIS used to build a spatiotemporal database.

Table 1. The schema for storing the data of solar radiation data.

Name	Measure Unit	Type	Etc
Year	Year	Int	Not null
Month	Month	Int	Not null
Location	City name	Varchar(20)	Not null
Insolation	Kcal / m^2	Int	
Sunshine rate	0.1 %	Int	
Cloud	1/10	Int	
Insolation rate	%	Int	
Clear day	Day	Int	
Temperature	0.1 `C	Float	
Humidity	1 %	Int	
Wind	0.1 m/s	Int	

Table 1 shows the database schema for storing solar radiation sensing data. This schema is used to analyze and provide the history and current data of renewable energy like solar radiation.

4. IMPLEMENTATION

We design and implement a context awareness system for solar radiation data management by using the solar radiation data observed from domestic twenty cities until now. The context awareness system consists of a client and sever environment. The server is made up of GIS database, spatial object manager, data translator, query execution module, and GIS web server. The client is able to search and query the renewable data resources from the GIS web server using the web browser. Finally, we study on various visualization methods for the results of data search.

4.1 Sensor Management

Sensor Model Language(SensorML) which is an XML schema for defining the geometric, dynamic, and observational characteristics of a sensor is designed to support a wide range of sensors including both dynamic and stationary platforms and including both in-situ and remote sensors.

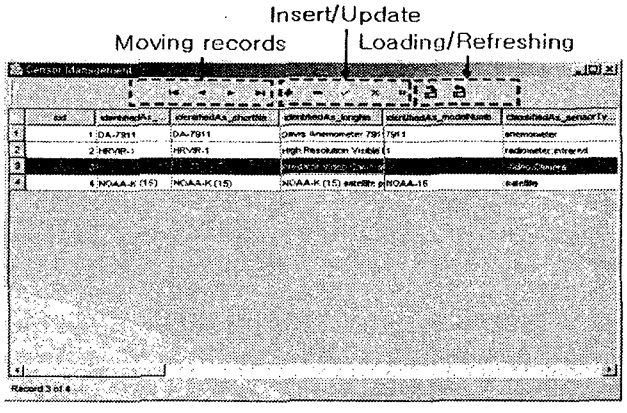

Figure 2. Sensor metadata management.

Figure 2 shows the sensor database management interface for dealing with sensor metadata extracted from the sensorML file. This interface provide some function to user such as insert, update, delete of the records, the moving record pointer to find the record user want to search easily, the sorting in each column, the loading and refreshing of the records, etc.

4.2 Context Awareness for Energy management

This context awareness system which is on going project stores and handle a variety of sensor data through using a spatiotemporal database, GIS tools, and web service, but it can not support to process real time sensor data, now. It is implemented by using ArcView, ArcIMS on windows 2000 server.

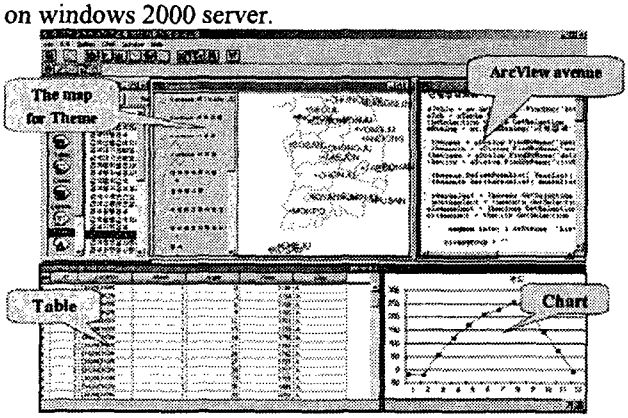

Figure 3. The renewable energy management system.

Figure 3 shows the utilization of renewable energy management system. User can analyze and summarize the energy data gathered for various sensors through using a contour map, chart, aggregate function, and spatiotemporal operators.

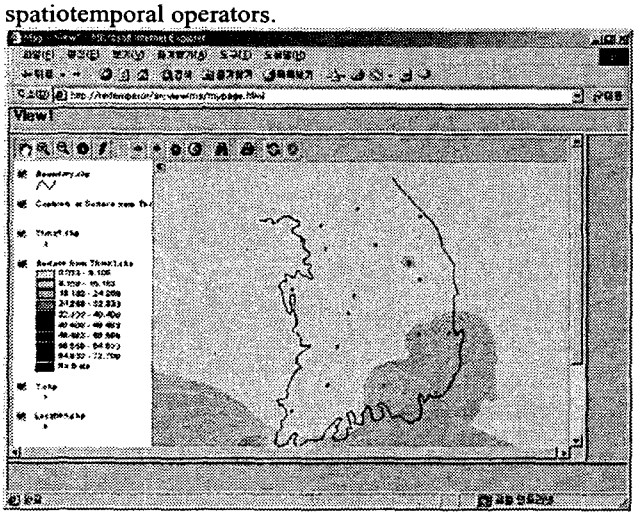

Figure 4. the contour map of temperature.

Figure 4 illustrates the contour map service of temperature in web browser. User can submit some queries and get the results in the web browser such as the average of humidity in winter, 2004, searching a specific data, classification, etc.

Figure 5. the TIN model of temperature for 3D visualization.

In order to study on various visualization methods for the results of data search, the management system can provide a suitable service through TIN model, surface scene, a contour map. TIN model is illustrated in figure 5.

5. CONCLUSION

In this paper, we have proposed a context aware system to manage solar radiation data of domestic twenty cities. The proposed system has been implemented using ArcView GIS tool, and it is capable of data search using various spatiotemporal queries. Also, user can identify the query results such as chart, graph, and counter map. The implemented system supplies Internet web service by ArcIMS. The development technique of context aware system can be applied to the weather, ocean, forest information, and so on. Finally, various related application systems will be affected by the implemented context awareness system for SOLMET data management.

Acknowledgements

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