AN ABSTRACTION MODEL FOR IN-SITU SENSOR DATA USING SENSORML

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ABSTRACT:

Context-awareness techniques in ubiquitous computing environment provide various services to users who need to get information via the analysis of collected information from sensors in a spatial area. Context-awareness has been increased in ubiquitous computing and is applied to many different applications such as disaster management system, intelligent robot system, transportation management system, shopping management system, and digital home service. Many researches have recently focused on services that provide the appropriate information, which are collected from Internet by different kinds of sensors, to users according to context of their surrounding environment. In this paper, we propose an abstraction model to manage the large-scale contextual information and their metadata which are collected from different kinds of in-situ sensors in a spatial area and are presented them on the web. This model is composed of the modules expressing functional elements of sensors using sensorML(Sensor Model Language) based on XML language and the modules managing contextual information, which is transmitted from the sensors.

KEY WORDS: Context-Awareness, Meta Data, In-situ Sensor, Sensor Web, sensorML, Abstraction Model

1. INTRODUCTION

Ubiquitous computing is defined as a computing environment which immediately provides service to users who need the appropriate information through connecting all things with functionalities which exist in the real world[1, 2].

In such an environment, context-awareness techniques for providing various services to users who need to take information via the analysis of the collected information from sensors in spatial area are increasingly becoming an important field in ubiquitous computing environment. These techniques can be applied to many application such as disaster management system, intelligent robot system, transportation management system, shopping management system, and digital home service[3, 4].

Especially, we need the techniques to provide appropriate services according to users' context and to observe in real time the information about their surrounding situations collected from different kinds of sensors to cope with the disaster context occurring in outdoor environment such as forest fire, flood, typhoon, earthquake, and air pollution.

Sensor data are mainly monitored from the control center via networks like Internet and provide service, which is suitable to users and surrounding situation. To support this environment, OGC(Open Geospatial consortium) are building a unique and revolutionary framework of open standards for exploiting Web-connected sensors and sensor systems[5].

In this paper, we propose an abstraction model to manage the large-scale contextual information and their metadata which are collected from different kinds of in-situ sensors in spatial area and present them on the web. This model is composed of the modules which express functional elements of sensors using sensorML(Sensor Model Language) based on XML language and the modules which manage contextual information transmitted from the sensors.

The rest of this paper is organized as follows. In section 2 we introduce the concepts of sensor WEB and sensorML. Section 3 presents the abstraction model for sensor data proposed in this paper, the model structure and functions of their modules. Section 4 describes the schema structure of metadata. In section 5, we show an example of sensor data collection. Conclusions and future work are given in section 6.

2. RELATED WORK

2.1 Context-Aware Computing Techniques

Schilit[6] first defined the context as a confirmation of the person who gets proximate things and the changes of these entities. However, this definition was excessively specified to define the context-aware computing. The context has recently been defined by Dey[7] as the appropriate information related to users' activities or the cases of using context in process which provide services to users.

The first attempt for context-awareness was the active badge of Olivetti company[8]. In this research, users find out their locations wearing active badges. Yau[9] introduced a language to define context and proposed the structure of context-aware middleware which checks states constantly from each sensor to be aware of context and then takes actions appropriately according to fixed rules in advance.

IRISA/INRIA[3] proposed the infrastructure based on contextual object to improve service level using users' surrounding environment for user who has a mobility. And the research of the AT&T[4] proposed context-aware application services which are appropriate situational users to detect and trace users' locations indoors.

2.2 Sensor WEB

The Sensor Web defined by SWE(Sensor Web Enablement) in OGC(Open Geospatial Consortium) aims to apply sensors and detecting tools, which are accessible internet through the World Wide Web without any environmental interference, and develops a standards foundation for plug-and-play web-based sensor networks[5].

The Sensor Web visions are to grasp the measured value easily in real time through web and provide standardized web services which control sensor data and their measured values[10]. For these visions, SWE use the schema based on XML(eXtensible Markup Language) to describe features of sensors, locations and their interface on the web according to an unified format.

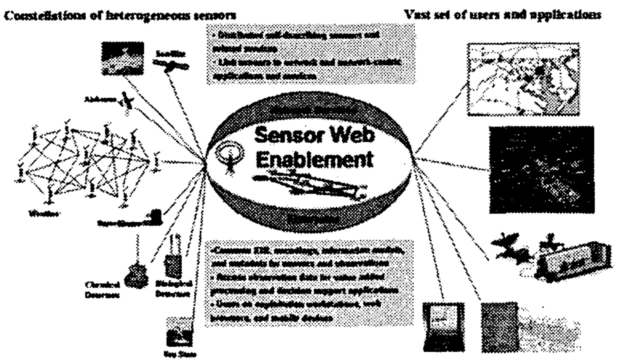

Figure 1. A view of sensor WEBs

Figure 1 illustrates the concept of sensor Webs. Sensor Webs as shown in the figure transmit sensor data collected from various sensors via network and provide them to services in application area such as flood measurement, air pollution monitoring, damage detection of the road and bridge, and so on.

2.3 SensorML

SensorML(Sensor Model Language) is the XML-based language developed by Earth observation scientists to overcome issues which are difficult to match sensor data with geographical information efficiently and combine with various sensors. sensorML was developed by Mike Botts with the support of GMTT(Global Mapping Task Team) affiliated CEOS(international Committee for Earth Observing Satellites) in April, 1998[11].

SensorML provides a model and XML schema to define the measured features from sensors using XML-based language for that describe attributes of dynamic sensors such as geometric, dynamic and radiometric attributes. SensorML supports both remote sensors and in-situ sensors, which are classified according to platform types as shown in Table 1.

Table 1. The classification of sensorML

Sensor \ Platform		Platform Type	
		Static	Dynamic
Sensor Type	Remote	Speed measurement	Satellite weather observation, Airplane weather observation
	in-situ	Chemical smell detection, Thermometer, gravity Measurement	Ozone detection, GPS, Weather detection

sensorML provides the information model and format to be able to detect between sensors and measured values which are registered on web. The schema to support this model is composed of identifiedAs, documentConstrainedBy, attachedTo, hasCRS, locatedUsing, measures, operatedBy, describedBy, documentedBy.

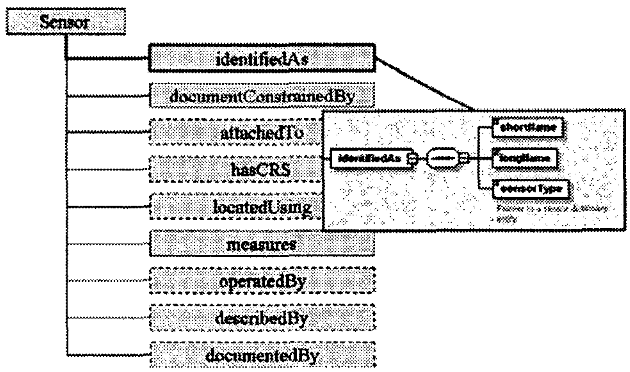

Figure 2. SensorML specification

Figure 2 shows the structure of schema to present on sensorML. Each element presents an attribute describing a feature of sensor. Elements bounded within solid lines in the figure (identifiedAs, documentConstrainedBy, measures) are described basically for sensorML and the rest of parts drawn in dotted line are optional parts possibly omitted.

3. PROPOSED ABSTRACTION MODEL STRUCTURE

The information collected from sensors and their metadata are stored in database and are monitored through a sensor data abstraction model. And then the information in database used to provide appropriate services to users after they are combined with contextual information in knowledgebase.

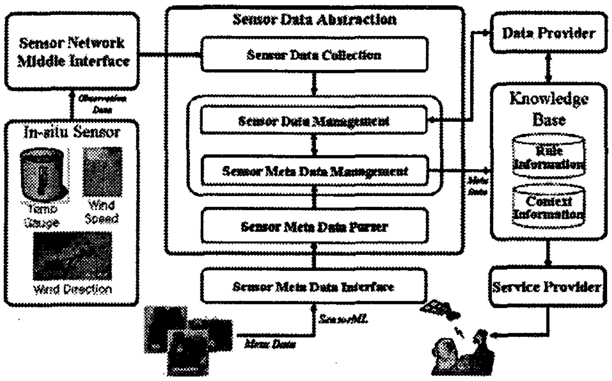

Figure 3. Structure of abstraction model

Figure 3 depicts the whole structure of the proposed abstraction model. As shown in the figure, the data measured from in-situ sensors are transmitted to Sensor Data Collection module via Sensor Network Middle Interface. The measured values are then stored in database via Sensor Data Management module.

On the other hand, metadata of sensors are converted into an XML format file through Sensor Mete Data Interface. Next, metadata are analyzed by Sensor Meta Data Parser module, and then are stored in database through Sensor Meta Data Management module. Finally, the sensor data stored in this way are serviced through Service Provider after being combined with contextual rules in the knowledgebase.

The functions of each module included in the sensor data abstraction model are described as follows.

- **Sensor Data Collection**: This module collects sensor data transmitted from sensors and classifies them into attributes of collected data like sensorID, measuredValue, measuredTime, and so on.

- **Sensor Meta Data Interface**: This module makes out document file according to structure of XML schema suggested by sensorML to present metadata of in-situ sensor.

- **Sensor Meta Data Parser**: This module carries out the analysis of tasks to extract elements and attribute values from metadata file composed in the XML format.

- **Sensor Data Management**: This module performs the tasks of storing the collected sensor data from Sensor Data Collection in database.

- **Sensor Meta Data Management**: This module has the task of storing the elements and attributes extracted from Sensor Meta Data Parser in database.

4. SCHEMA STRUCTURE OF SENSOR DATA

The attributes like sensorID, measuredValue, measuredTime collected from various sensors, make meaningful contextual information that matches the metadata such as the installed location of sensors, measurement unit, sampling interval, and so on.

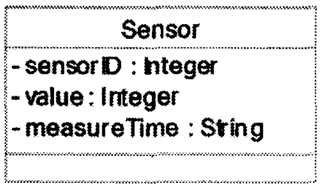

Figure 4. Sensor schema

Figure 4 illustrates a schema structure for sensor information to be stored in database. And also the schema for metadata of sensors to store in database, followed by the schema structure defined by sensorML. Figure 5 is an illustration the entire schema defined by sensorML.

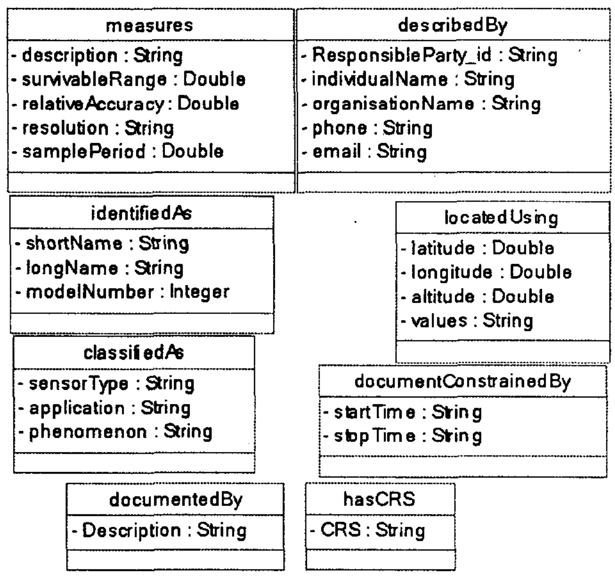

Figure 5. sensorML schema

5. COLLECTION OF THE SENSOR DATA

The information collected from in-situ sensor installed on the spatial area such as temperature, humidity, and intensity of illumination is composed of attributes with sensorID, measuredValue, measuredTime. This information is transmitted to server from sink node of sensor network. And the metadata of these sensors are made out as the document file with XML format according to standards suggested in sensorML.

```xml
<identifiedAs>
    <Identifier type="longName">Davis Anemometer 7911</Identifier>
</identifiedAs>
<identifiedAs>
    <Identifier type="modelNumber">7911</Identifier>
</identifiedAs>
<classifiedAs>
    <Classifier type="sensorType"
            codeSpace="http://vast.uah.edu/SensorML/sensorDictionary.xml">
      anemometer
    </Classifier>
</classifiedAs>
<classifiedAs>
    <Classifier type="application"
            codeSpace="http://vast.uah.edu/SensorML/applicationDictionary.xml">
      weather
    </Classifier>
</classifiedAs>
<classifiedAs>
    <Classifier type="phenomenon"
            codeSpace="http://vast.uah.edu/SensorML/phenomenonDictionary.xml">
      wind speed
    </Classifier>
</classifiedAs>
<classifiedAs>
    <Classifier type="phenomenon"
            codeSpace="http://vast.uah.edu/SensorML/phenomenonDictionary.xml">
      wind direction
    </Classifier>
</classifiedAs>
```

Figure 6. An example of senserML file

Figure 6 shows an example of information about identifiedAs attributes among elements of sensorML. It is seen that identifiedAs is composed of metadata attributes longName, modelNumber, sensorType, and so on.

The remaining elements described in document file are documentConstrainedBy, measures. In these elements, the element of documentConstrainedBy describes valid time of document, security degree, limit, and so on. And measures describe measurement unit, sampling interval, and so on.

6. CONCLUSION AND FUTURE WORK

Context-awareness technique which is considered as an important technique in ubiquitous computing environment is applicable to many applications such as disaster management system, intelligent robot system, transportation management system, shopping management system, and digital home service.

In this paper, we proposed an abstraction model to manage the large-scale contextual information and their metadata that are collected from different kinds of in-situ sensors on spatial area such as temperature, humidity, and intensity of illumination and present them on the web. This model is composed of the modules which express functional elements of sensor using sensorML(Sensor Model Language) based on XML language and the modules which manage contextual information transmitted from the sensors.

Currently, we are implementing our proposed abstraction model. Also we will develop a framework which can provide appropriate service to users' context.

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