Ontology-based Sensor Network Information Sharing

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요 약

The difficulty of “information sharing”, “information reusing” issues happening in Wireless Sensor Network is due to the heterogeneity of the application environment, data processing, communication protocol etc. Based on the introduction of the Ontology theory, though analyzing the sensor characteristic a general type of sensor ontology contains the definition of concept, frame structure and OWL design was proposed from the standpoint of sensor observation. The paper expounded a system framework of the domain ontology through the expansion of knowledge base on the general sensor could achieve the information sharing and reuse by semantic communication between the general sensor ontology and user. The research of this method would bring new idea to the semantic sensor network construction.

키워드

sensor network; semantics; ontology; information sharing

Ⅰ.
Information ‘problem’ in Ubiquitous Sensor Network

The sensor network can monitor, sense and collect all kinds of environment object information through various kinds of integrated micro sensors. In recent years, Internet of things(IoT) promote the development of sensor network, but the current sensor network is applied to the specific field, and the heterogeneity of sensing devices, data processing and communication protocol. The network is difficult to intercommunicate with each other. It is difficult to realize the effective distribution and sharing of resources. It is also difficult to find the effective information in a large number of sensor data, which leads to the island of information.

Ontology

Ontology is originally a philosophical concept, which is used by philosophers to describe the nature of things, and lately is introduced to the field of artificial intelligence, knowledge engineering, computer science and so on. The purpose of Constructing Ontology is to achieve a certain degree of knowledge

sharing, reuse and communication and inter-operate between systems.

The application of Ontology in the network has contributed to the birth of the Semantic Web, which is expected to solve the problem of network information semantic sharing, and realize knowledge sharing and information integration.

Semantic Sensor Web

The Semantic Sensor Web (SSW) is a marriage of sensor and Semantic Web technologies. The encoding of sensor descriptions and sensor observation data with Semantic Web languages enables more expressive representation, advanced access, and formal analysis of sensor resources. The SSW annotates sensor data with spatial, temporal, and thematic semantic meta-data. This technique builds on current standardization efforts within the Open Geospatial Consortium's Sensor Web Enablement and extends them with Semantic Web technologies to provide enhanced descriptions and access to sensor data.

Ontologies and other semantic technologies can be key enabling technologies for sensor networks because they will improve semantic interoperability and integration, as well as facilitate reasoning, classification and other types of assurance and automation not included in the Open Geospatial Consortium (OGC) standards. A semantic sensor network will allow the network, its sensors and the resulting data to be organised, installed and managed, queried, understood and controlled through high-level specifications. Ontologies for sensors provide a framework for describing sensors. These ontologies allow classification and reasoning on the capabilities and measurements of sensors, provenance of measurements and may allow reasoning about individual sensors as well as reasoning about the connection of a number of sensors as a macroinstrument. The sensor ontologies, to some degree, reflect the OGC standards and, given ontologies that can encode sensor descriptions, understanding how to map between the ontologies and OGC models is an important consideration. Semantic annotation of sensor descriptions and services that support sensor data exchange and sensor network management will serve a similar purpose as that espoused by semantic annotation of Web services. This research is conducted through the W3C Semantic Sensor Network Incubator Group (SSN-XG) activity.

Based on the theory of ontology, this paper is based on the characteristics of the sensor and the observation of the sensor, In this paper, the definition, characteristics and structure of the sensor are described. To provide support for the consistency, correctness and completeness of the sensor knowledge, it is possible to provide the knowledge sharing, interoperability and reuse between different or similar knowledge systems.

II. Application of ontology in Sensor Networks

In order to solve the problem of information sharing in sensor networks, a lot of researches have been done research work and achieved many research results. In 2005, the Open Geospatial Consortium (OGC) proposed a new type of sensor Web , Standard sensor Web integration framework(Sensor, Web Enablement SWE). The standard has become the industrial standard in fact. However, this framework is based on the XML model design, lack of semantic sensor data. There is no uniform definition of a shared conceptual model.

In 2009 W3C set up a semantic sensor network incubator working group (Sensor Network Incubator Group SSN-XG, Semantic) The task of the working group is mainly developing to describe the sensor body for the development of a sensor network application service. Semantic markup language and through the sensor found technology applications show the great advantage of the combination of sensor technology and semantic web technology and practical significance.

Currently 《Semantic Sensor Network XG Final Report》 given by SSN-XG group summarizes the existing sensor ontology, such as Michael Compton etc to construct the CSIRO general ontology, by modeling the information of sensors and components, automatic

classification of sensor to achieve the use of semantic. Danh Le Phuoc etc construct onto sensor ontology by building a knowledge base for sensor data to achieve sensor data for knowledge sharing and reuse. RA lGarc, Castro etc proposed based on two layer framework of the body of the sensor to support the retrieval of heterogeneous sensor data. John graybeal builds intelligent software agents that constructs the ontology SWAMO, and Bermudez etc builts ocean sensor equipment construction of MMI Ontology.

According to the above mentioned, we can see that it is difficult to communicate with each other between the two ontology framework because of their limited compatibility.

But now, a centralized framework was introduced for the semantic integration of heterogeneous sensors and their observations into open geospatial consortium Sensor Observation Services (SOSs). An ontology called 1451 ontology was created following IEEE 1451 standards. The 1451 ontology not only describes the sensor properties and observations, but it also specifies the communication interface and protocol. Another ontology called SOS data ontology was also created to represent the feature of interest of the SOS. A matching rule was established to map the two created ontologies with the aim of creating a uniform collaboration of sensors scattered worldwide through the Sensor web.

III. Sensor ontology construction

Sensor Ontology Building

In this paper, we use the language OWL to describe the ontology, and refer to the framework of the ontology. Body (Sensor, Ontology SO) is defined as follows.

Definition

Sensor Ontology=<C, R, M, A, I>. C is a concept set, R is the relationship set, M is the method set, A is the set of axioms, I is the instants of the specific real Cases.

Concept: the sensor, sensor observation, observation property, observation situation and application fields of sensors, sensors quality, deployment process.

In OWL ,they are the class. in the Physical by Object Method, SO, Quality, Process Deployment and other concepts through the set of the set of the set of classification levels.

Relationship: a class of relationships between concepts, such as the concept of a typical relationship between the two IS-A relation, it forms the logical hierarchy of concepts.

Methods: It is a kind of special relationship. It is described by the method name, domain and range and further explain the concept.

Axiom: a formal statement or a rule that is generally accepted as a form of basis to derive other representations.

Instants; An individual object that belongs to a concept or class. Editing the ontology by Protégé4.3 as Figure 1 shows.

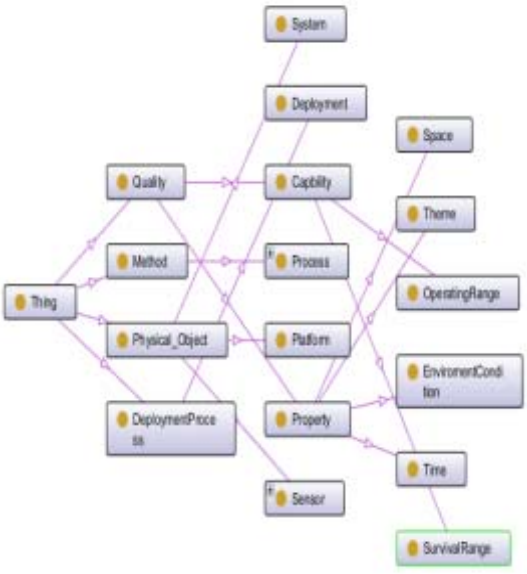

Figure 1 : Sensor Network Ontology Tree Structure

Information sharing based on Ontology

On the basis of the establishment of the sensor ontology, through the expansion of domain knowledge in various fields, the establishment of relevant domain ontology, in order to realize the information representation in different fields.

As the basic ontology in each domain ontology, sensor ontology inter-operates with other system sensor ontology to sharing and reusing the information . So between various systems, it is integrated in different scenarios of the grammar format as Figure 2.

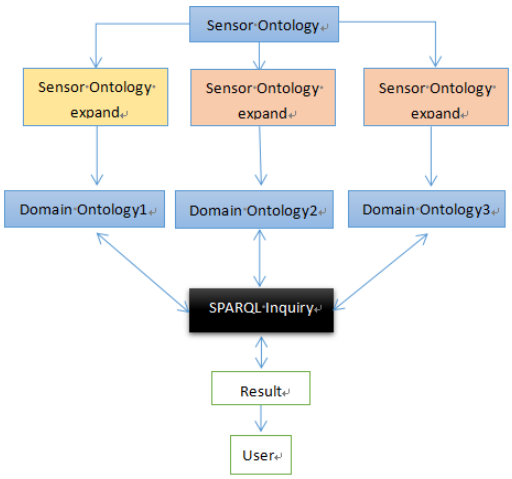

Figure 2 : Ontology-based Information Sharing Framework

Each sensor system is based on the ontology model. Based on their own context and requirements ,they can construct of themselves domain ontology, which makes the system have a common understanding of the basic semantic. Meanwhile using of semantic makes the user-defined needs can be understood in that system, So it can automatically send information to the users who call for services. Therefore the whole system achieve the semantic information sharing and interaction.

Ⅳ. conclusions

Beginning at the sensor network information sharing needs, based on the existing theories this paper does some studies on ontology framework and the sensor ontology construction. The paper also proposed sensor network information sharing method through the sensor ontology domain ontology construction. And the paper research sensor data semantics and sensor information sharing and reuse.

Semantic sensor network will change the localization and heterogeneity of sensor networks fundamentally and achieve the interconnection of sensor network, to achieve a comprehensive perception of the physical world and sensor intelligent service. At present, the research of semantic sensor networks is still in the exploratory stage.There are many issues worthy to be further researched and promising application prospects.

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