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Ontology Development for Heterogeneous Sensor Network

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ABSTRACT

Recent improvements in sensor technology and lower prices change the way how we collect and process massive data in real time. A sensor Network consists of sensors implanted in an environment for collecting & transmitting data regarding changes in the environment based on the requests from controlling device or base station using wireless communication. Sensor networks are used in various applications in several domains for measuring and determining physical phenomena and natural events. Sensors enable machines to capture and observe characteristics of physical objects and features of natural incidents. Sensor network are being used in medical, military and environment monitoring applications. Query dissemination and gathering of information towards central node are important communication paradigms across all application domains. A sensor network is composed of a large number of sensor nodes that are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need not be engineered or predetermined. This allows random deployment in inaccessible terrains or disaster relief operations.

Keywords: Heterogeneous Sensor Network, Control, Communications, Computing, Intelligence, Surveillance, Reconnaissance, Targeting Systems

I. INTRODUCTION

Sensor networks generate immense amount of data which requires advanced analytical processing and interpretation by machines. Most of the current efforts on sensor networks are focused on network technologies and service development for various applications, but less on processing the emerging data (Barnaghi et. al., 2009). Sensor data in a real world application will be an integration of various data obtained from different sensors such as temperature, pressure, and humidity. Processing and interpretation of huge amounts of heterogeneous sensor data and interoperability are important issues in designing scalable sensor network architecture. The lack of integration and communication between these networks, however, often isolates important data streams and intensifies the existing problem of too much data and not enough knowledge. With a view to addressing this problem, the semantic sensor Web (Barnaghi et. al., 2009) (SSW) proposes that sensor data be annotated with semantic metadata that will both increase interoperability and provide contextual information essential for situational knowledge. In particular, the SSW presents an approach for annotating sensor data with spatial, temporal, and thematic semantic metadata. (Sheth Perry,2008)

Most of the research work in sensor networks to date has been focused on device engineering design and communications and networking questions. However, an increasing maturity in that area, including a rapidly developing commercial market, opens up questions that relate to large scale deployment, such as efficient data management and convenient programming models. On the other hand, the semantic web has arrived at a very similar point of maturity from the opposite direction. It is conceived as a very large scale inter-operating network of information and actuation, or at least actuation of information artifacts.(sheth et. al. ,2008).

II. LITERATURE SURVEY

A sensor network is composed of a large number of sensor nodes that are densely deployed either inside the phenomenon or very close to it. The above described features ensure a wide range of applications for sensor networks. (Archana el. al, 2008) Some of the application areas are health, military, and home. In military, for example, the rapid deployment, self-organization, and fault tolerance characteristics of sensor networks make them a very promising sensing technique for military *command*, *control*, *communications*, *computing*, *intelligence*, *surveillance*, *reconnaissance*, and *targeting systems*.

In health, sensor nodes can also be deployed to monitor patients and assist disabled patients. Some other commercial applications include *managing inventory*, *monitoring product quality*, and *monitoring disaster areas*.

The Semantic Sensor Web (SSW) (Barnaghi et. al., 2009) is a framework for providing enhanced meaning for sensor observations in order to enable situation awareness. It is accomplished by adding semantic annotations to the existing standard sensor languages of the Sensor Web Enablement. The semantic annotations provide more meaningful descriptions and enhanced access to sensor data than SWE alone. These annotations act as a linking mechanism to bridge the gap between the primarily syntactic XML-based metadata standards of the SWE and the RDF/OWL-based metadata standards of the Semantic Web. In association with semantic annotation, ontologies and rules play an important role in SSW for interoperability, analysis and reasoning over heterogeneous multi-modal sensor data.

The current Web is a document centric platform for exchanging data amongst the users. The Internet and Web applications in recent years have seen tremendous growth in facilitating data exchange for different applications and purposes. The current networks, however, are limited in sensing and measuring the physical world phenomena and employing them for observing and controlling real world incidents. Sensor networks provide a potential for Internet applications to acquire context data and observe and measure physical incidents. This will support constructing platforms which are aware of physical world incidents. This will enable construction of new services that remove the strict boundary between virtual and physical world. To achieve this, data collected from different types and levels of sensors and sensor networks will be used in different applications. Machines will need to collect and interpret the data provided by various types of sensor devices.

The encodings of observed phenomena by sensors are by nature opaque (often in binary or proprietary formats), therefore metadata play an essential role in managing sensor data. A semantically rich sensor network would provide spatial, temporal, and thematic (STT)(Sheth Perry,2008) information essential for discovery and analysis of sensor data. Spatial metadata provide information regarding the location of sensors and sensor data, in terms of either a geographical reference system (GPS), local reference, or named location. Local reference is especially useful when a sensor is attached to a moving object such as a car or airplane. While the location of the sensor is constantly changing, its location can be statically determined relative to the moving object. In addition, data from remote sensors, such as video and images from cameras and satellites, require complex spatial models to represent the field of view being monitored, which is distinct from the location of the sensor. Temporal metadata provide information regarding the time instant or interval when the sensor data is captured. Thematic metadata describe a real-world state from sensor observations, such as objects or events. Every discipline contains unique domain specific information, such as concepts describing weather phenomena, structural integrity values of buildings, and biomedical events representing patient health status. Thematic metadata can be created or derived by several means, such as sensor data analysis, extraction of textual descriptions, or social tagging.

The following area will be addressed in proposed research work

- Ontologies for sensor networks
- Semantic web services architectures for sensor networks
- Semantic data integration in large-scale heterogeneous sensor networks
- Semantic middleware for active and passive sensor networks

III. Problem Formulations

The proposed research work will be divided in following phase

- Implementation Of sensor network for specific application

- Ontology Development for specific homogeneous sensor network application, if possible propose new ontology standard
- Ontology Development for specific heterogeneous sensor network application, if possible propose new ontology standard.

IV. Research Methodologies

Ontology Preparation

Ontology is a formal representation of a domain, composed of concepts and named relationships. We envision that the SSW will be adopted by a diverse set of domains, and therefore benefit from a collection of ontologies to model each domain. At a broad level, we can classify the ontologies along the three types of semantics associated with sensor data – spatial, temporal, and thematic – in addition to ontological model(s) representing the sensors domain. The more Semantic Web attracts attention, the more importance of ontology increases. Software agents and people can find information about many domains on the web. And, on each domain or several domains, ontology can describe what concepts exist in the target world. Many tools for ontology development have been developed to date. On the other hand, fundamental theories of ontology based on philosophy have been investigated exhaustively. However, not many of the ontology development tools provide higher level of constructs for ontology description compliant with the fundamental theories of ontology. So, it is still difficult to develop a theoretically sound ontology which describes definitions of concepts properly based on ontological theories. (Eiichi et.al., 2009)

V. RESULTS AND DISCUSSION

Implementation of Sensor Network

A sensor network is composed of a large number of sensor nodes that are densely deployed either inside the phenomenon or very close to it. The characteristic of sensor node in the sensor networks are as follows (Archana el. al, 2008)

- Sensor nodes are prone to failures.
- The topology of a sensor network changes very frequently.
- Sensor nodes are limited in power, computational capacities, and memory.

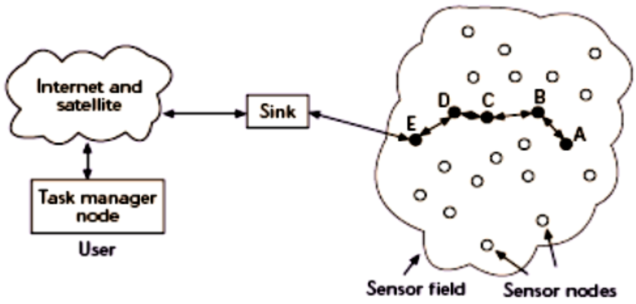

Figure 1 : Sensor Network Communication Architecture [Archana el. al,2008)

The sensor nodes are usually scattered in a *sensor field* as shown in Fig. 1. Each of these scattered sensor nodes has the capabilities to collect data and route data back to the *sink*. Data are routed back to the sink by a multi-hop infrastructure less architecture through the sink as shown in Fig. 1. The sink may communicate with the *task manager node* via Internet or satellite. The design of the sensor network as described by Fig. 1 is influenced by many factors, including *fault tolerance*, *scalability*, *production costs*, *operating environment*, *sensor network topology*, *hardware constraints*, *transmission media*, and *power consumption*.

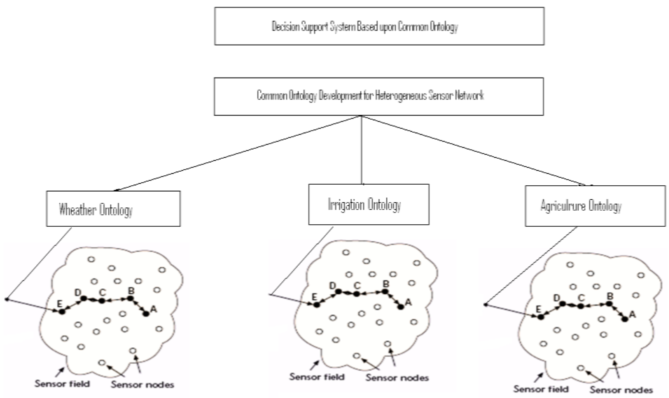

Figure 2: Heterogeneous Sensor Network Architecture

VI. CONCLUSION

In Proposed research work first of all ontology will be developed for specific sensor network thereafter it will be scale up to 3 types of different sensor network(E.g. Whether, Defense, Localize status). The main goal of the propose work is to develop generalize ontology which is based upon these sensor networks. This common ontology will help to take strategic decision in to the authority.

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