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Chapter 1 : Semantic Sensor Web | calendrierdelascience.com

Introduction. So far, we have seen how to augment the maps representing environments with semantic information. This additional information was obtained by classifying the laser range data obtained by a mobile robot into some of the classes that represent the different places in the environment.

Published online Feb This article has been cited by other articles in PMC. Abstract Current mobile phones come with several sensors and powerful video cameras. These video cameras can be used to capture good quality scenes, which can be complemented with the information gathered by the sensors also embedded in the phones. For example, the surroundings of a beach recorded by the camera of the mobile phone, jointly with the temperature of the site can let users know via the Internet if the weather is nice enough to swim. In this paper, we present a system that tags the video frames of the video recorded from mobile phones with the data collected by the embedded sensors. The tagged video is uploaded to a video server, which is placed on the Internet and is accessible by any user. The proposed system uses a semantic approach with the stored information in order to make easy and efficient video searches. Our experimental results show that it is possible to tag video frames in real time and send the tagged video to the server with very low packet delay variations. As far as we know there is not any other application developed as the one presented in this paper. Sensor networks will play a crucial role in the Internet of Things [2]. The physical values obtained by the sensors will be accessible from the Web [3 , 4]. Mobile and wireless communication has also grown dramatically in recent years. Nowadays there is a considerable amount of standardized wireless access options that allow the devices to access Internet resources massively [5]. Mainly because of the appearance of new admission control algorithms that guarantee QoS [6] for each user. Next generation of mobile Wireless networks 4G [7] and 5G [8] will increase the massive use of Internet resources. With a WSN a lot of sensors are easily and at low cost deployed in a geographical area to monitor its physical properties. The spectacular growth of mobile phones sold in the last ten years has no similar precedent in the history of the business, and in some countries the number of mobile phones by person is greater than one [9]. These terminals are equipped with a powered hardware and software that allow the mobile user to practically use universal services to manage heterogeneous information and access Internet using different wireless and mobile technologies. The most prominent services are video and audio content multimedia content. These users usually access podcasting, vodcasting and broadcatching services in Internet. The management of video based services is complex. A lot of information is generated and it is hard to transport this big amount of communication in the network. Recently, the hardware of video and audio is produced at low cost. This has fostered an increasing interest in multimedia WSN [12]. In [13] an excellent state of the art in Multimedia WSNs is presented. The algorithms, protocols, hardware, applications and multimedia sensors implementation are reviewed in depth. They use three different strategies: In both cases in the Central Server there is an entity having to process the multimedia information; c The sensor nodes retrieve audio and video streams ubiquitously from a determined environment. In [16], an energy-aware scheduling for video surveillance using Multimedia WSNs is presented. They propose an efficient scheduling of the activation and sleeping of sensor nodes in order to save energy. The authors show the problem of coverage understanding coverage as the efficient detection of visual properties of the environment analyzing the Field of View and Depth of View of the video sensors. They also present the need to make distributed video signal processing in the sensor nodes in order to reduce the big information volume that must be communicated in the WSN. The big amount of information produced by multimedia WSN demands the usage of semantic technologies in order to be efficiently processed. In [18] is presented a surveillance sensor application in which video sensors are connected to an Ethernet network in order to allow the efficient transport of video streams to the supervisor. The sensors use semantic information to establish direct communication among themselves. In a semantic sensor web, as defined by Henson in [19], sensor data are annotated with semantic metadata to increase interoperability as well as to provide contextual information essential for situational knowledge. With this contextual information the raw data are enriched in order to reduce the amount of information to be stored [20

]. Data from video sensors video cameras are complex to annotate when spatial tags are used. With these kinds of tags it is possible to position videos in geographical services like Google Maps or Google Earth or Panoramio. In [19] a proof of concept that consists in processing temporal semantic tags of videos stored in YouTube and situated the in Google Maps service, to seek videos using a time restriction is presented. This can be done implementing temporal tagging that allows the user to specify queries of concepts like within, contains or overlap [21]. In [22], Henson imagined that a mobile Android phone could capture a video and annotate it with semantic data. That mobile video could be annotated with time, place and thematic information submitted by the mobile user. Such metadata could be used to query for similar videos. From to now the evolution of mobile phones has been very important. Current smart mobile phones are provided with sensors and powerful video cameras in some cases more than one video camera. This makes possible to realize the vision of Henson in In this paper we present a sensor-based video tagging system that allows a mobile phone to record videos and tag them with some extra information taken from the embedded sensors. Later, the tagged video is placed on an Internet server, so it can be viewed by other users jointly with the sensed data in order to appreciate better the environment when the video was recorded. Moreover, we have added a semantic approach in the server in order to provide easy and efficient video searches. Experimental results show that videos can be tagged in real time and with a good grade of precision, and the transactions with the Web server can be done with low delays. This facilitates to implement a real time query system directly on the mobile phones in real time. The remainder of the paper is as follows: The architecture of the semantic system, the ontologies and the semantic system operation are presented in Section 3. Section 4 is devoted to the analytical model presentation. Section 5 shows the experimental evaluation of our semantic system. Finally, in Section 6, we draw our main conclusions and future work. Related Work Traditionally, several formats for video tagging have been used related to different specific purposes. Moreover, the video content can be analyzed using ontology. In [23] soccer domain ontology is designed to analyze soccer videos. They use Web Ontology Language to define the ontology and temporal logic to describe the semantic events and reasoning. In [24], an original work on semantic video annotation is presented. In this work some interesting thoughts about this topic are discussed. Concretely, MPEG7 the formally called Multimedia Contend Description Interface helps describe video content and thus enables the user to easily perform many tasks such as find, store and locate a video [25]. It has the ability to describe the low level, semantic and structural aspects of the video. We are interested in augmenting the expressivity of a video with other information sensed by other sensors. In this way, the video information can be interpreted taking into account this information. For example, different parts of a video of a beach, tagged with temperature values provided by a sensor, could enrich the video allowing the user to interpret the scene. In [26], a very interesting survey about the state of the art in MPEG7 based ontologies is presented. In this work, the two main annotation dimensions prevailing in the literature content structure descriptions and linking with domain ontologies are compared. In addition to MPEG7 a framework must be used in order to fill the gap between semantic and reasoning. In [27], the application of semantic Web technologies to semantic video retrieval is presented. Semantic video indexing is the first step towards automatic video browsing, retrieval and personalization. It consists of two sub-processes: The objective of this segmentation is to extract video semantic units that can be associated with clear semantic meanings. In well structured videos like TV Programs it is possible automatically generate this semantic video indexing [28]. A not considered challenge is to take into account the MPEG7 annotation of videos in order to allow Peer-to-Peer communication among them as explained in [29]. Similar comments could be done for the MPEG21 standard. It is very appropriate to specify the interchange of information among users and the entire multimedia distribution chain [30]; but it is not well appropriated for our purposes. A semantic modeling of video contents retrieval is presented in [31]. In this paper some basic ideas and concepts of semantic modeling of video formal definition of semantic unit and association in videos are explained. It also discusses about Query language and graphical conceptual model for video contents. This work is previous to MPEG7 standard and presents interesting basic concepts and ideas of video semantics. In [32] a very interesting survey about automatic video annotation and ontologies for retrieving video from large data bases is presented. The authors also present challenges and applications. In [33] a dense and good survey of video semantics is presented. This work presents models that are classified into annotation-based models and rich semantic models. The authors evaluate these two models and present twenty one rules which cover the whole process of model based video application development. There are several ways to include semantic information from sensors. The first step is to consider a set of tags that can describe the values that the sensors provide, and the second step is to implement an ontology that can allow the extraction of knowledge. A good introduction of the reasons for and benefits of annotating the information retrieved from sensors is done in [34]. The authors of this paper explored the benefits of augmenting sensor data with semantics; they describe the domain specific and spatio-temporal problems to be addressed. The role of knowledge representation and reasoning Semantic Web technology , and standardization efforts underway to make sensor-related data and sensor observations widely available are shown. In [35] the authors presented a good survey of 14 ontologies. They concluded their work saying that a combination of OntoSensor and the CSIRO ontologies represents the current limit of expressive capability for semantic sensors. But, neither current ontology nor a combination of the available ontologies is able to express all the properties required for the capabilities. So, it is needed more work in order to improve this expressivity. Moreover, the early work presented in [36] shows that it is possible the support for browsing service ontologies and the cooperative discovery of services based on an intuitive preference model, on mobile devices.

Chapter 2 : Semantic Sensor Web | S Karthik - calendrierdelascience.com

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.

Joining Us Semantic Sensor Web Millions of sensors around the globe currently collect avalanches of data about our environment. The rapid development and deployment of sensor technology involves many different types of sensors, both remote and in situ, with such diverse capabilities as range, modality, and maneuverability. It is possible today to utilize networks with multiple sensors to detect and identify objects of interest up close or from a great distance. The lack of integration and communication between these networks, however, often leaves this avalanche of data stovepiped and intensifies the existing problem of too much data and not enough knowledge. With a view to alleviating this glut, we propose that sensor data be annotated with semantic metadata to provide contextual information essential for situational awareness. In particular, we present an approach to annotating sensor data with spatial, temporal, and thematic semantic metadata. This technique builds on current standardization efforts within the W3C and Open Geospatial Consortium OGC and extends them with semantic Web technologies to provide enhanced descriptions and access to sensor data. Research Topics Semantic Modeling and Annotation of Sensor Data Ontologies and other semantic technologies can be key enabling technologies for sensor networks because they will improve semantic interoperability and intergration, as well as facilitate reasoning, classification and other types of assurance and automation not included in the 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 will provide a framework for describing sensors. These ontologies will 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 will, 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 standard goes a long way in providing interoperability between repositories of heterogeneous sensor data and applications that use this data. Many of these applications, however, are ill equipped at handling raw sensor data as provided by SOS and require actionable knowledge of the environment in order to be practically useful. There are two approaches to deal with this obstacle, make the applications smarter or make the data smarter. We propose the latter option and accomplish this by leveraging semantic technologies in order to provide and apply more meaningful representation of sensor data. More specifically, we are modeling the domain of sensors and sensor observations in a suite of ontologies, adding semantic annotations to the sensor data, using the ontology models to reason over sensor observations, and extending an open source SOS implementation with our semantic knowledge base. This semantically enabled SOS, or SemSOS, provides the ability to query high-level knowledge of the environment as well as low-level raw sensor data. Perception and Analysis of Sensor Data Currently, there are many sensors collecting information about our environment, leading to an overwhelming number of observations that must be analyzed and explained in order to achieve situation awareness. As perceptual beings, we are also constantly inundated with sensory data; yet we are able to make sense out of our environment with relative ease. This is due, in part, to the bi-directional information flow between our sensory organs and analytical brain. Drawing inspiration from cognitive models of perception, we can improve machine perception by allowing communication from processes that analyze observations to processes that generate observations. Such a perceptual system provides effective utilization of resources by decreasing the cost and number of observations needed for achieving situation awareness. Trust on Semantic Sensor Web Trust and confidence are becoming key issues in diverse applications such as ecommerce, social networks, semantic sensor web, semantic web information retrieval systems, etc. Both humans and machines use some form of trust to make informed and reliable decisions before acting. In this work, we briefly review existing work on trust networks, pointing out some of its drawbacks. We then propose a local framework to explore two different kinds of trust among agents called referral trust and functional trust, that are modelled using local partial orders, to enable qualitative trust personalization. The proposed approach formalizes reasoning with trust, distinguishing between direct and inferred trust. It is also capable of dealing with general trust networks with cycles. Analysis of Streaming Sensor Data Sensors are increasingly being deployed for continuous monitoring of physical phenomena, resulting in avalanche of sensor data. Current sensor data streams provide summaries e. Feature-streams, on the other hand, provide a higher-level of abstraction over the sensor data and provide actionable knowledge useful to the decision maker. This work presents an approach to generate feature-streams in real-time. This is accomplished through the application of ontological domain knowledge in order to integrate multiple, multimodal, heterogeneous low-level sensor data streams and infer the existence of real-world events like Blizzard, RainStorm etc.

Chapter 3 : Internet of Things Tutorial: IoT Devices and the Semantic Sensor Web

notating sensor data, such as RDFa, ple, the semantics of a query about XLink, and SAWSDL (Semantic Anno- weather information at a particular Semantic Sensor Web tations for WSDL and XML Schema). time and place.

Research Topics Semantic Modeling and Annotation of Sensor Data Ontologies and other semantic technologies can be key enabling technologies for sensor networks because they will improve semantic interoperability and intergration, as well as facilitate reasoning, classification and other types of assurance and automation not included in the 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 will provide a framework for describing sensors. These ontologies will 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 will, 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 standard goes a long way in providing interoperability between repositories of heterogeneous sensor data and applications that use this data. Many of these applications, however, are ill equipped at handling raw sensor data as provided by SOS and require actionable knowledge of the environment in order to be practically useful. There are two approaches to deal with this obstacle, make the applications smarter or make the data smarter. We propose the latter option and accomplish this by leveraging semantic technologies in order to provide and apply more meaningful representation of sensor data. More specifically, we are modeling the domain of sensors and sensor observations in a suite of ontologies, adding semantic annotations to the sensor data, using the ontology models to reason over sensor observations, and extending an open source SOS implementation with our semantic knowledge base. This semantically enabled SOS, or SemSOS, provides the ability to query high-level knowledge of the environment as well as low-level raw sensor data. Perception and Analysis of Sensor Data Currently, there are many sensors collecting information about our environment, leading to an overwhelming number of observations that must be analyzed and explained in order to achieve situation awareness. As perceptual beings, we are also constantly inundated with sensory data; yet we are able to make sense out of our environment with relative ease. This is due, in part, to the bi-directional information flow between our sensory organs and analytical brain. Drawing inspiration from cognitive models of perception, we can improve machine perception by allowing communication from processes that analyze observations to processes that generate observations. Such a perceptual system provides effective utilization of resources by decreasing the cost and number of observations needed for achieving situation awareness. Trust on Semantic Sensor Web Trust and confidence are becoming key issues in diverse applications such as ecommerce, social networks, semantic sensor web, semantic web information retrieval systems, etc. Both humans and machines use some form of trust to make informed and reliable decisions before acting. In this work, we briefly review existing work on trust networks, pointing out some of its drawbacks. We then propose a local framework to explore two different kinds of trust among agents called referral trust and functional trust, that are modelled using local partial orders, to enable qualitative trust personalization. The proposed approach formalizes reasoning with trust, distinguishing between direct and inferred trust. It is also capable of dealing with general trust networks with cycles. Analysis of Streaming Sensor Data Sensors are increasingly being deployed for continuous monitoring of physical phenomena, resulting in avalanche of sensor data. Current sensor data streams provide summaries e. Feature-streams, on the other hand, provide a higher-level of abstraction over the sensor data and provide actionable knowledge useful to the decision maker. This work presents an approach to generate feature-streams in real-time. This is accomplished through the application of ontological domain knowledge in order to integrate multiple, multimodal, heterogeneous low-level sensor data streams and infer the existence of real-world events like Blizzard, RainStorm etc.

Chapter 4 : Sensor - Semantic Scholar

The Semantic BMS describes only the data point - the address in the BMS that contains data from the particular sensor or actuator (i.e. Address XY provides a current temperature in the Room when queried).

Residents of to complex events and situations. The lack of Valley Park, a small town along the Meramec integration and communication between these River, Missouri, had to decide whether to rely networks, however, often isolates important data on a newly constructed levee or abandon their streams and intensifies the existing problem of homes for higher ground. Had pres- contextual information essential for situational sure sensors been embedded in the levee, they knowledge. In particular, this involves annotat- might have provided accurate real-time infor- ing sensor data with spatial, temporal, and the- mation that let residents make informed deci- matic semantic metadata. This scenario demonstrates the Background increasingly critical role of sensors that collect The SSW approach presented here leverages and distribute observations of our world in our current standardization efforts of the Open everyday lives. Geospatial Consortium OGC; www. The rapid development and deployment eling, storing, retrieving, sharing, manipulat- of sensor technology involves many different ing, analyzing, and visualizing information types of sensors, both remote and in situ, with about sensors and sensor observations of phe- diverse capabilities such as range, modality, nomena. A se- sor networks and archived sensor en acquisitions and observations. This Spatial metadata provide infor- applications using sensor technolo- is the standard Web service inter- mation regarding the sensor loca- gies to attain actionable situation face for publishing and subscrib- tion and data, in terms of either a awareness. Lack of standardization, ing to alerts from sensors. This is the standard Web service ure 1. Local reference is especially The OGC recently established interface for asynchronous deliv- useful when a sensor is attached to Sensor Web Enablement SWE to ad- ery of messages or alerts from SAS a moving object such as a car or air- dress this aim by developing a suite and SPS Web services and other plane. In addition, be accessible and controllable via the W3C Semantic Web data from remote sensors, such as Web. These are standard models and XML schema for encoding ar- chived and real-time observations The semantic sensor Web enables and measurements from a sensor. Web is formally defined. The principal tech- vations, such as objects or events. RDF data representation model and as concepts describing weather phe- This is the standard Web service the ontology representation lan- nomena, structural integrity values interface for requesting, filter- guages RDF Schema and Web Ontol- of buildings, and biomedical events ing, and retrieving observations ogy Language OWL. Within ated or derived by several means, tween a client and an observa- Space, Time, and Theme such as sensor data analysis, ex- tion repository or near real-time Sensors encoding of observed phe- traction of textual descriptions, or sensor channel. Progression from natural phenomena to raw sensor data to semantic annotation of Sensor Web Enablement to ontological knowledge of space, time, and theme. Whereas the languages provided ta necessary to answer the queries Web. In association with seman- by the OGC SWE provide annota- listed requires knowledge of the tic annotation, ontologies and rules tions for simple spatial and temporal situation the sensors observe. Such play an important role in SSW for in- concepts such as spatial coordinate knowledge can be represented in on- teroperability, analysis, and reason- and time stamp, more abstract con- tologies and used to annotate and ing over heterogeneous multimodal cepts, such as spatial region, tempo- reason over sensor data to answer sensor data. Consider, for exam- data within the sensors domain. It enhances meaning markup language that enables the one, such as a tsunami. These annotations pro- provides a set of attributes that can tial region within a bounding-box, vide more meaningful descriptions represent semantic metadata with- or a named location such as a park and enhanced access to sensor data in an XML language from which or school. The semantics of the time than SWE alone, and they act as a we can extract RDF triples using a interval specified by the query could linking mechanism to bridge the simple mapping. The core subset of be about weather conditions that fall gap between the primarily syntac- RDFa attributes http: Specifically, a temporal, geospatial, sensor, and property for the content of an el- weather ontology. OWL- tently, coherently, and accurately. At ports defining interval queries such Instant here, time is the namespace a broad level, we can classify on- as within, contains, and overlaps.

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Do- for an OWL-Time ontology: Figure 2 shows a sub- triples. Instant subject is op a common sensor ontology based modeling the weather domain. Several ef- use rules. Rule languages and rule- is xs: We collected and stored such data for one month at sec- SSW Application ond reading intervals. A semantic mashup with encoded in SensorML and semanti- with spatial, temporal, and weather ability to show videos that capture cally annotated with concepts from ontological concepts. Figure 4 shows events from police cruiser cameras an OWL-Time ontology. State Patrol in-dash cameras that notations, we can fluently execute contain temporal information with- complex queries over simple weather in the video frames. More specifically, suppose the ontological assertions from known Using this semantic metadata, we query requests information about instances. The W3C has proposed can retrieve videos by using seman- freezing or blizzard conditions. Its pri- onto a Google Map and play them from a freezing condition. The blizzard mary advantage is that it seamless- within an information window. Figure query, on the other hand, requires ly incorporates rules into an OWL 3 shows a screenshot of the interface three sensor types â€" temperature, ontology schema while provid- for this SSW prototype application. We the freezing condition, high-winds group of sensors explicitly provides refer to this type of service as a Se- condition, and snowing condition. As described earlier, SOS the situational awareness enabled by rules, we can specify possible road is a service for requesting, filter- semantic annotation and reasoning conditions. The following rule states ing, and retrieving observations and over sensor data. Blizzard Condition with then the roads are potentially icy. Our winds, and snow Rule: Our appli- cation collects and uses data includ- ing temperatures of the air, surface, B y incorporating OGC and W3C standardization efforts into a SSW, we can provide an environ- 82 www. This skin is already being stitched together. It consists of millions Figure 4. Contact sphere, our ships, highways and fleets him at satya knoesis. His research We share this vision and wish to interests include the Semantic Web and provide meaning to this new world. Sheth has a PhD in computer 1. His research interests include b Mike Botts et al. Overview and High Level Ar- data and manage situational awareness. Semantic Web through Space, Time, and wright. Sahoo is a PhD student at the 5. His research interests include Workshop, ; www. Developing a Hu- in biomedical and sensor Web domains.

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Chapter 5 : Semantic Sensor Web - Wikipedia

Semantic Sensor Information Description and Processing Abstract: Wireless sensor networks (WSN) generate large volumes of raw data which possess natural heterogeneity. WSNs are normally application specific with no sharing or reusability of sensor data among applications.

Agriculture[edit] Monitoring various environmental attributes is critical to the growth of plants. Environmental attributes that are critical for growers are mainly temperature , moisture, pH , electric conductivity EC , and more. Real-time monitoring in addition to setting alerts for the mentioned sensors was never possible. With the creation of SSW, growers can now track their plant growing conditions in real-time. The architecture of this research project consists of personal integration needs, Semantic web , and more in addition to semantic data integration , i. SSW allows for getting notified of water leaks, controlling apartment temperature via smartphone , and more. Laboratory management[edit] Managing laboratory tests can be quite challenging, especially if tests take place over a long time, across multiple locations, or in infrastructures where many tests occur. Such tests include creep tests for a material, reaction tests of a certain chemical or wireless transmission tests of a circuit. Advancements in SSW allow for real-time monitoring of laboratory variables via sensors. Such sensors can take more than one factor into consideration before alerting. Notable contributions[edit] Standardization is a lengthy and difficult process, as players in a field that have existing solutions would see any standardization as an additional cost to their activities. Open Geospatial Consortium OGC , an international voluntary consensus standards organization that was founded in , is making efforts to enhance and accelerate the growth of the SSW community and standardize sensor information across web. The goal of OGC is to provide enhancements in description and meaning of sensor data. OGC is in charge of creating open geospatial standards. Current challenges[edit] Current challenges in the SSW field include a lack of standardization, which slows down the growth rate of sensors created to measure things. For the semantic sensor web to be meaningful, the languages, tags, and labels across various applications, developed by various developers, must be the same. Unfortunately, due to scattered development of various architectures, such standardization is not possible. This problem is called vastness. There is also the problem of inconsistency, such that when changing the architecture of an existing solution, the system logic will no longer hold. In order to resolve this problem, there is a need for an extensive amount of resources depending on the size and complexity of system. For example, many existing systems use twelve bits to transfer temperature data to a local computer. However, in a SSW 16 bits of data is acceptable. This inconsistency results in higher data traffic with no additional accuracy improvement. In order for the old system to improve, there is a need of allocating extra bits and changing the buffer requirements, which is costly. Assuming the resources required to make the tag requirement are available, there is still the existence of unnecessary data that requires additional storage space in addition to creating confusion for other SSW members. The only solution remaining is changing the hardware requirements, which requires a lot of resources.

Chapter 6 : SSN Applications - Semantic Sensor Networks Community Group

8 Semantic Information in Sensor Data Fig. Typical range readings from legs of people. As can be seen, the appearance can change drastically, also because the legs cannot always be separated.

Chapter 7 : SSW - Knoesis wiki

The ability to learn such semantic categories from sensor data enables a mobile robot to extend the representation of the environment facilitating interaction with humans. As an example, natural language terms like "corridor" or "room" can be used to communicate the position of the robot in a map in a more intuitive way.

Chapter 8 : "Semantic Information and Sensor Networks" by Krishnaprasad Thirunarayan

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Trust on Semantic Sensor Web. Trust and confidence are becoming key issues in diverse applications such as ecommerce, social networks, semantic sensor web, semantic web information retrieval systems, etc. Both humans and machines use some form of trust to make informed and reliable decisions before acting.