Demonstration: Dynamic Sensor Registration and Semantic Processing for ad-hoc MOBile Environments (SemMOB)

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Abstract. SemMOB enables dynamic registration of sensors via mobile devices, search, and near real-time inference over sensor observations in ad-hoc mobile environments (e.g., fire fighting). We demonstrate SemMOB in the context of an emergency response use case that requires automatic and dynamic registrations of sensor devices and annotation of sensor observations, decoding of latitude-longitude information in terms of human sensible names, fusion and abstraction of sensor values using background knowledge, and their visualization using mash-up.

1 Introduction

Mobile devices are pervasive and increasingly becoming powerful (in terms of memory, processing power, on-board sensors). They have access to two sources of sensor information (a) internal sensors (embedded into mobile devices), and (b) external sensors (present in the vicinity of mobile devices), both reporting observations of the physical world. Only way to understand the physical world from observations is to associate semantics with the observations by grounding them in events in the physical world. For example, sensor observations about temperature, CO_2, and wavelength of light can be used to infer a *fire type* event. This can be used by the first responders to decide on the type of extinguisher to be used. SemMOB is a system that embodies such semantic processing of observations from ad-hoc mobile sensors. It extends the capability of the SemSOS [1] for mobile devices while preserving the use of semantics in the form of background knowledge. Our prototype showcases the capabilities of SemMOB using various sensors reporting observations through an Android device.

The rest of paper is organized as follows. In Section 2, we describe the system architecture and review SemSOS and the reasoner. After we describe the nature of queries that can be issued to SemMOB and its visualization capabilities in Section 3, we conclude in Section 4.

2 Architecture

SemMOB has two major components: (a) SemSOS and (b) Reasoning engine, as shown in Figure 1. Mobile devices with an Android client registers with SemSOS using the standard SOS register sensor request. There are internal sensors such as GPS, gyroscope and camera, and external sensors such as activity, temperature, and gaseous sensors, reporting observations to the mobile device via bluetooth. All observations are sent to SemSOS and annotated using the SSN-XG ontology [3, 4] for further reasoning. SemSOS backend also has background knowledge about sensors described in SSN-XG ontology to support reasoning. The reasoner fetches observations and sensor metadata from the knowledge base, reasons over them, and puts back the inferred triples into the knowledge base. The first responders can monitor the sensor observations using the real-time observation monitor or the query interface as shown in Figure 1.

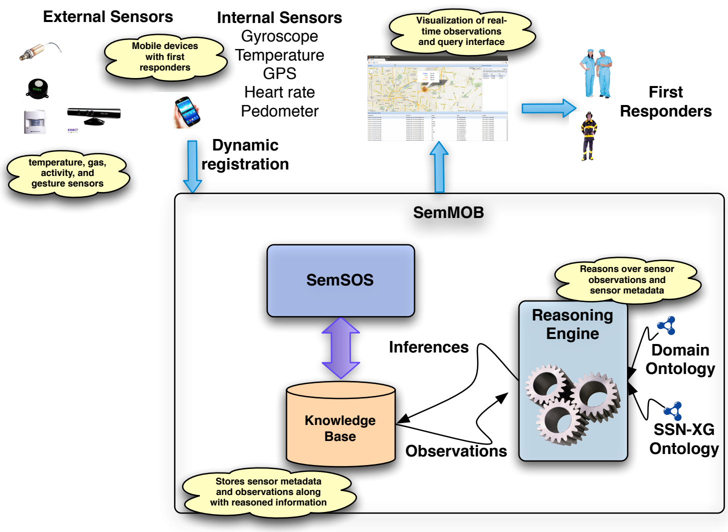

Fig. 1. SemMOB System Architecture

2.1 SemSOS

SemSOS provides a semantic layer over Sensor Observation Service (SOS). SOS is a XML-based standardization of sensor data discovery and access on the web proposed by Semantic Web Enablement (SWE) group of Open Geospatial Consortium (OGC). SemSOS enhances SOS deployments to be semantically rich. SemSOS provides the same interface as SOS while it replaces the backend for processing semantically rich metadata associated with the sensors and observations using a semantic database.

In this work, we have further extended SemSOS to accommodate and integrate diverse mobile devices which enter the sensor network in an ad hoc manner and is required to be integrated. Each mobile device may have different capabilities and different sensors connected to it. SemMOB deals with the sensor network dynamism, sensor diversity, and near real-time reasoning over sensor metadata and its observations.

2.2 Reasoning Engine

The reasoner fetches newly inserted sensor metadata and sensor observations from the knowledge base and inserts inferred triples to the knowledge base so that it can be queried by semantically intelligent clients. Part of the ontology for modeling sensor capability along with its location is shown in Figure 2. Once a sensor registers with SemMOB, the reasoner uses latitude and longitude of the sensor to obtain the named location from GeoNames [2] dataset. The reasoner module can be used to reason about *fire types* using observations such as temperature, CO_2 level, and wavelength of light emitted using approprite background knowledge.

Other reasoning procedures may use knowledge of poisonous gases, fire extinguishers, etc., to decide emergency operation related equipments and chemicals. In the context of fire fighting, we modeled the sensors (e.g., gaseous sensors) by extending the SSN-XG ontology [3, 4].

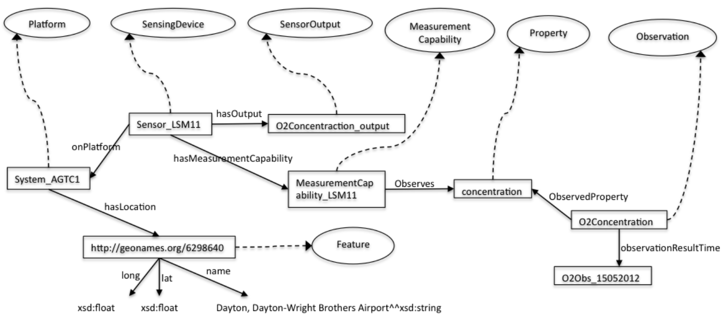

Fig. 2. SSN-XG ontology extension to model gaseous concentration

3 System Capabilities and Visualization

The SemMOB system users can (1) monitor sensor observations in near real-time, and visualized on a map, (2) reason over sensor observations, and (3) query sensor metadata, sensor observations, and inferred knowledge. SemMOB provides unique capability of dynamic registration, search, reasoning, visualization, and querying of ad hoc mobile sensors in a unified framework. SemMOB query interface and the Android application is shown in Figure 3.

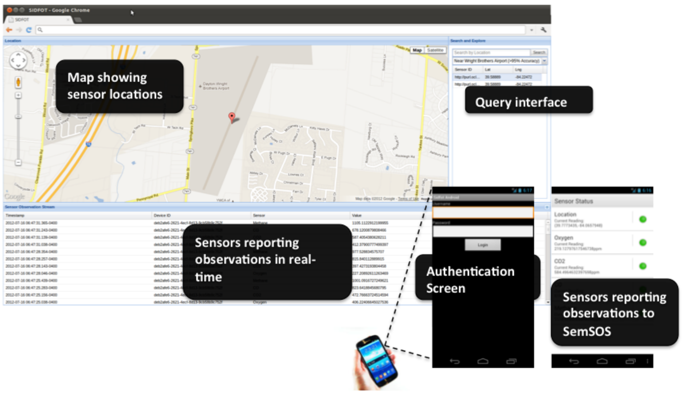

Fig. 3. Visualization of sensor observations and reasoned information along with query interface

4 Conclusions

We demonstrated the functionalities of SemMOB including dynamic registration, querying, reasoning, and visualization of observations from mobile ad-hoc devices and sensors attached to them.

References

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