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Computing Perception from Sensor Data

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1. Introduction

This work describes a framework for perception creation from sensory data. Data mining techniques, in particular Symbolic Aggregation Approximation (SAX) [1], are used to analyze and create patterns from sensor data. The created patterns are then linked to semantic descriptions that define thematic, spatial and temporal features, providing highly granular abstract representation of the raw sensor data. This helps to reduce the size of the data that needs to be communicated from the sensor nodes to the gateways or high-level processing components. The energy cost of transmission via wireless radio on sensor nodes is higher than doing an internal process. Therefore, to reduce the volume of data, SAX can be optimally implemented within the sensor nodes. This process can enhance the energy efficiency of wireless sensor nodes that are used for long term observations. We also discuss, implement and evaluate a method that uses abstract patterns created by SAX method and occurrences of different observations in a knowledge-based model to create perceptions from sensor data.

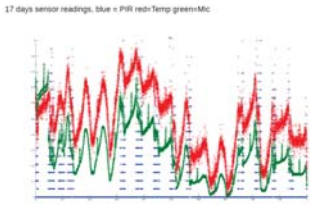

Figure 2. Sensor Observations from the test-bed represented as time series

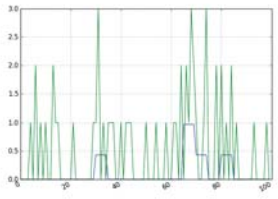

Figure 3. SAX Patterns (blue) with word length of 20 and a vocabulary of 10 symbols and the original sensor data (green)

2. Motivation

Internet connected devices are estimated to grow to 50 billion devices by 2020. Many of these devices will include sensors that can send observation data from the physical world. This will add to a deluge of data that needs to be processed to create meaningful high level abstractions to make this raw data useful for observatory or decision making processes. We present one efficient solution for multi-granularity representation of continuous observations made by sensors, creating abstractions from the raw sensor data by representing them as patterns, and semantically annotating these patterns based on thematic and spatiotemporal features to create high-level perceptions.

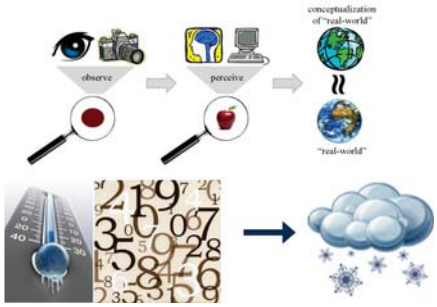

Figure 1. Abstraction and Perception

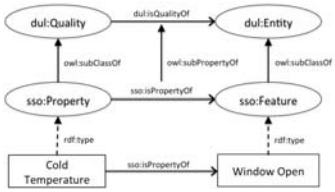

Figure 4. Representation of background domain knowledge in the W3C Semantic Sensor Network Ontology, utilised for creating perceptions of sensor data

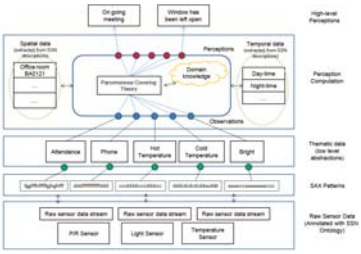

Figure 5. Perception creation using lower-level abstractions (annotated SAX patterns) and the PCT method

3. Results

We have evaluated our approach by collecting data from heterogeneous sensors and running the SAX method on the gateway components on a wireless sensor network test-bed. Results show that the proposed methods can effectively create low-level (i.e. SAX patterns) and high-level (i.e. perceptions) abstractions from the sensor data. Sending SAX patterns that are represented as string "words" also reduces the size of information that is sent from the nodes. The patterns are created based on analyzing observations and measurement as time series data, so it does not require any prior threshold definition or heuristics to set the parameters for pattern creation. The perception creation mechanism uses background knowledge and semantic web technologies to enable combining results of different observations to create high-levels abstractions that can be used by human users or machines to make sense of the observation data.

References

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