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Semantic Web of Things for Industry 4.0

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Abstract. Welcome to this special issue of the Semantic Web (SWJ) journal. The special issue compiles four technical contributions that significantly advance the state-of-the-art in Semantic Web of Things for Industry 4.0 including the use of Semantic Web technologies and techniques in Industry 4.0 solutions.

Keywords: Industry 4.0, Semantic Web of Things

1. Introduction

Industry 4.0 refers to the 4th Industrial revolution - the recent trend of automation and data exchange in manufacturing technologies. To fully realize the Industry 4.0 vision, manufacturers need to unlock several capabilities: vertical integration through connected and smart manufacturing assets of a factory; horizontal integration through connecting discrete operational systems of a factory; end-to-end integration through the entire supply chain. In recent technology advancements in Web of Things (WoT) and Semantic Web (Jointly referred as Semantic Web of Things) have a promising role to play to address Industry 4.0 vision. Integration of Semantic Web with WoT technologies enables communications among heterogeneous Industrial assets. Semantic Web can be also used to represent manufacturing knowledge in machine-interpretable way[1]. The semantic modeling of industrial assets and their service produces unambiguous and machine-interpretable descriptions and creates interoperability among assets and their services across domains. Semantic Web is indeed a good fit for a plethora of complex problems related to automated, flexible, and self-configurable systems like Industry 4.0 systems.

Several of such novel systems based on Semantic Web of Things are already being proposed. However, the efforts have not been consolidated to link together, and capitalize on experience in, the major issues related to computational underpinning, multidisciplinary technologies involved, and application domain demands. This special issue builds upon the International Workshop on the same topic[1] held in conjunction with the 15th ESWC 2018. The aim of the special issue is to present the latest advances in the area and further attract attention to these issues from interested communities in these areas.

2. Summary of Contributions

In this section, we present the summary of the papers that were accepted for publication in this special issue.

It is well-known fact that the IoT landscape is characterized by a fragmentation of standards, platforms

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[1] https://swetiworkshop.wordpress.com/

and technologies, often scattered among different vertical domains.Smart Applications REFerence ontology (SAREF) ontology was created in 2015 with the intention to interconnect data, enabling the communication between IoT devices that use different protocols and standards. Consequently, gaps in semantics were identified to represent a number of industry sectors. Roode et al.[2] present SAREF4INMA ontology - an extension of SAREF for describing the Smart Industry and Manufacturing domain. SAREF4INMA is based on several standards and IoT initiatives, as well as on real use cases, and includes classes, properties and instances specifically created to cover the industry and manufacturing domain. Authors describe the approach followed to develop this ontology with a real use case. The ontology is made available from GitHub[2].

Thulva et al.[3] target a popular IoT application development tool Node-RED. Node-RED is often used to develop complex industrial applications as IoT orchestrations. However, NODE-RED like many other similar IoT tools, are only compatible and support devices from specific vendors and ecosystems. Authors present a new semantic extension to Node-RED tool by introducing semantic definitions such as iot.schema.org semantic models into Node-RED. The tool supports rapid application development process by introducing semantic application templates called Recipes in Node-RED. The tool also guides a non-expert in semantic technologies to configure the semantics of a device.

Cao et al.[4] present an approach to predictive maintenance using Semantic web technologies. Their approach is a combination of data mining and semantics, within which chronicle mining is used to predict the future failures of the monitored industrial machinery. A Manufacturing Predictive Maintenance Ontology (MPMO) with its rule-based extension is used to predict temporal constraints of failures and to represent the predictive results formally. One of the main contribution of the work is that chronicles are formally represented with the use of ontologies and the main concepts and relationships for describing chronicles are formalized, then easing the knowledge representation and interpretation of frequent chronicle mining results. Authors carry out reasoning about temporal constraints of future machinery failures with the use of data mining and semantics, which allows the implementation of maintenance actions such as alarm launching.

Ramirez et al.[5] present another ontology, ExtruOnt, for describing a specific type of manufacturing machine that performs an extrusion process (extruder) - in which some material is forced through a series of dies in order to create a desired shape. ExtruOnt contains classes and properties for expressing descriptions about components of an extruder, spatial connections, features, and 3D representations of those components, and finally the sensors used to capture indicators about the performance of this type of machine. The ontology development process has been carried out in close collaboration with domain experts. The process has potential to be applied for another types of manufacturing machines in Industry 4.0 settings.

We hope that the readers will find the articles of this special issue to be informative and useful.

[2]https://github.com/mariapoveda/saref-ext/tree/master/SAREF4INMA

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