협업 스마트 공장의 웹 오브젝트 기반 데이터 상호운용성 제공 기능 모델

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Web of Objects based Functional Model of Data Interoperability for Federate Smart Factories

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요 약

Federated smart manufacturing (FSM) is applied to the improvement in manufacturing operations new business creation through integration of systems, linking of physical and cyber capabilities, and taking advantage of AI capabilities including distributed manufacturing data. The paper describes the WoO based functional model to support data interoperability in distributed manufacturing factories. Its adoption will encourage to occur unevenly across Businesses, thus there is an opportunity to look to other manufacturing to develop its business market and to enhance.

Ⅰ. Introduction

Federate smart manufacturing (FSM) is applied to the improvement in manufacturing operations of cooperative factories with linking of physical and cyber capabilities, federated learning and automations. Considering different FSM platforms with different data model, it delivers the data interoperability issues in semantic, syntactic and object abstraction level to exchange data among cooperative SM platforms. This paper describes the Web of Objects(WoO) [1] based functional model to support data interoperability mechanism across cooperative SM platforms.

Ⅱ. Data Interoperability Provisioning Model

One of the major challenges that various platforms are facing is the heterogeneity of data and resources which hinders the interoperable sharing and reuse. Existing system suffer from many obstacles to completely achieve interoperability at data level. The proposed Functional Model of Data Interoperability (FMDI) supports the interoperability provision in three ways that are the semantic level, syntactic level and object abstraction level. Based on the three level interoperability procedure, FMDI generalizes the mechanisms to support interoperability among different domains.

Semantic mediation function offers the mechanisms for semantic translation and linking of the data from different platform, which involves semantic vocab description maintenance, semantic translation and annotation, and semantic alignment and validation functionalities. Syntactic mediation function provides a syntax level translation of different data formats, schemas and interfaces, it provides interpretation and parsing methods to deal with different data formats and their validation and maintenance syntactical description repositories. Interoperable object abstraction function consists of the mechanisms that provide the heterogeneous objects data abstractions at semantic and syntactic level. Figure 1 shows diagram of Functional Model of Data Interoperability.

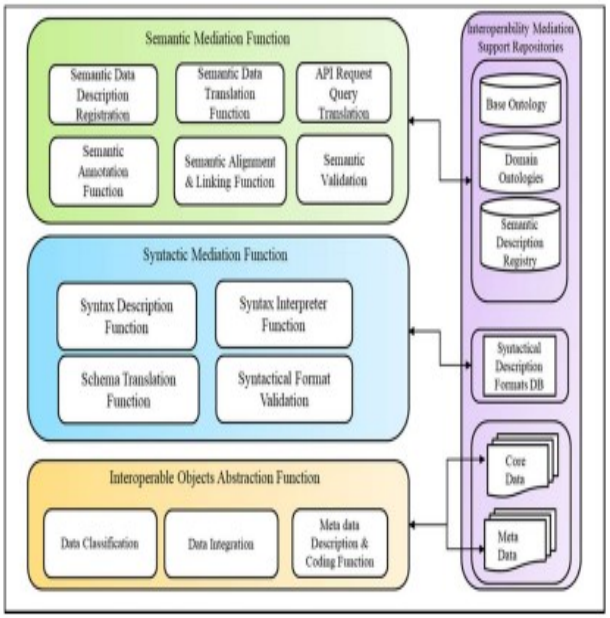

Figure 1. Functional Model of Data Interoperability (FMDI)

A. Semantic Data Interoperability Provisioning Model [1,2]

Semantic interoperability enables systems to share information and resources in such a way that their meaning can be uniformly understood in diverse systems. However, existing system suffer from the diverse semantic models used in the deployed systems. We propose the semantic alignment and linking functional features (as shown in the following illustration) to support the semantic sharing of information in an efficient way. To provision the semantic interoperability with mechanism of generalized alignment within source and target ontology models the functional components are developed using CVOs and microservices based on the following functions as shown in Figure 2.

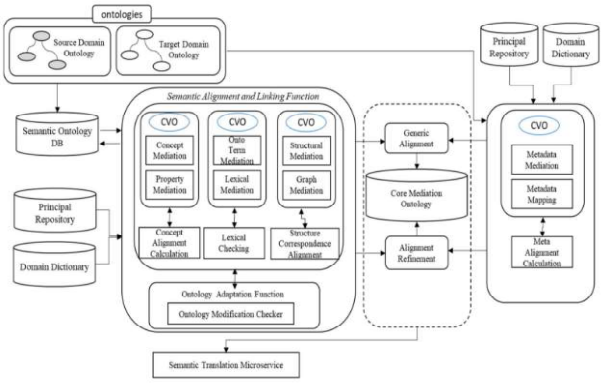

Figure 2. Semantic Alignment and Linking Functional Features interaction in accordance with WoO

B. Syntactic Data Interoperability Provisioning Model [2,3]

The component based interaction of the syntactic mediation functional unit has been shown in the following illustration. To provide syntactical interoperability a syntax translation microservices generates the conversion schema through the syntax interpreter service. The main goal of SIS is to generate the syntactical alignment based on the syntax that is chosen for the subject alignment. The syntax description and management services throughout the syntax translation perform three major tasks that includes the discovery of syntax template from the template repository, the syntax registration once a conversion has been performed successfully, and syntactical metadata management to support additional syntax level checking. To provide the verification of syntactical conversion SFV test the generated translation schema against a pre-validated test case in order to insure the integrity of mediation process. Figure 3 shows the syntactic mediation functions interaction.

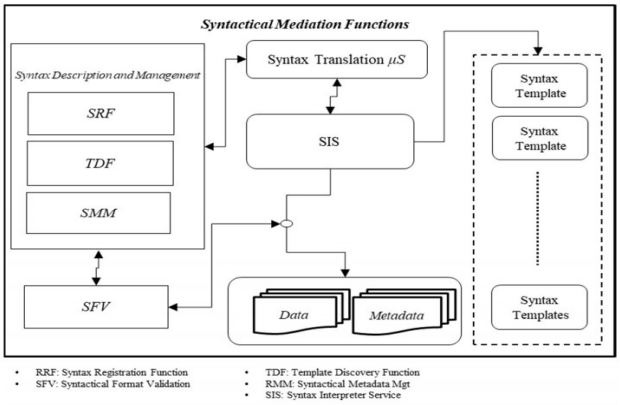

Figure 3. Syntactic Mediation Functions Interaction

C. Interoperable Object Abstraction Model [2]

To provide data interoperability, Interoperable Object Abstraction Model (IOAM) provides the shared representation of data through core data and metadata descriptions and coding. In semantic interoperability provisioning process common representation of data is generated so that it can be understood by several heterogeneous applications which provides highly useful way to support integration and sharing of information. The ability to generalize well on different data models and scale with increasing number of population are key requirement to develop an IOAM. Following figure illustrates the IOAM and the supported functions. IOAM also supported with CVO based functionalities to provide classification and integration of heterogeneous data from multiple sources as shown in Figure 4.

D. Common Data Model [2,3]

Transformation to interoperable shared data model is done by extracting the entities from the domain specific data model with their metadata description and translation from the concepts of a domain to the generic entities of ISDM. An example of this transformation is shown in Figure 5, given below. Such translation involves a core schema to transform the concept of the domain and a Meta schema to transform the related metadata of the domain.

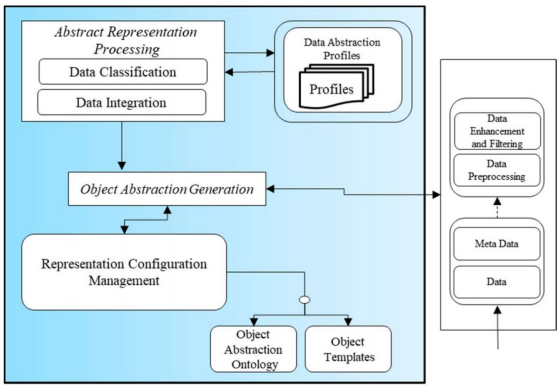

Figure 4. Interoperable Object Abstraction Functions Interactions

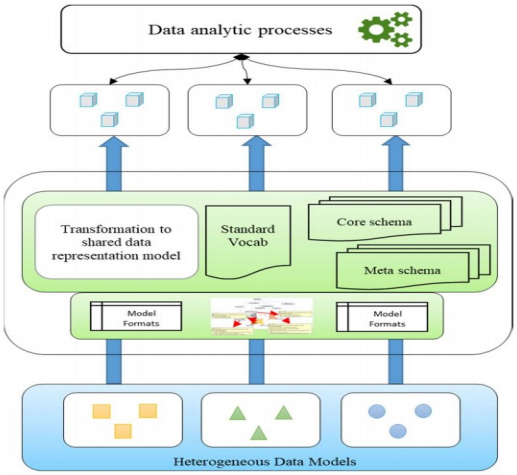

Figure 5. A model of CDM as Interoperable Shared Data Model

Ⅲ. Conclusion

This paper presents a data interoperability framework and provides a WoO based Functional Model of Data Interoperability for the cooperative business in federated smart factories. The proposed FMDI provides the semantic, syntactic and object abstraction level interoperability mechanisms in accordance with CDM (Common dadata Model) and provides the details on the interactions in the functional components for data interoperability provisioning. The paper also provides a common data model to support interoperability provision in the face of heterogeneous data models.

ACKNOWLEDGMENT

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