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The ontology in description of production processes in the Industry 4.0 item designing company

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Abstract. The task of production organization provision development to solve a practical task to describe of the item designing company manufacturing processes based on ontology is being studied. Ontology is a kind of manufacturing processes semantic description. Ontologies are necessary to link the technological equipment models and manufacturing processes which exist in the level of Internet of Things with their digital twins which exist in the level of Internet of services.

1. Introduction
Generally an ontology is a specification (detailed description) which is used to formally and declaratively define any field of knowledge with a term dictionary for this field and a list of term connections based on the principle of mathematical logic which described the terms relations in the level «part-whole» [1, 2].

The ontology components are: a glossary (the list of terms and their academic definitions), thesaurus (which defines the semantic connection among different terms) and other. Ontology — one of the options how to classify terms (definitions) in the given subject field. A prominent characteristic of an ontology dictionary which can tell the difference between this one and a simple one is a logical classification of the term apparatus being used when they hold the internal unity of the dictionary [3, 4].

Normally an ontology is represented as a tree structure of classes or as a programmed data base or a system of terms which describes: classes (terms, definitions); class examples (terms typical representatives); relations and properties of classes and examples. There are some special program languages and different formats of data structure representation which are used to describe ontologies [5-7]:
- xml-format;
- RDF (Resource Description Framework);
- OWL (Web Ontology Language);
- CycL;
- Ontolingua and others.

2. How to describe manufacturing processes using ontologies
The figure 1 shows the formation schemes of the manufacturing processes description based on ontology in the Industry 4.0 «smart factory» company [8, 9].
Figure 1. The formation scheme of manufacturing processes descriptions based on ontology in the Industry 4.0 «smart factory» company.

The initial data to receive the company digital twin and the item designing component manufacturing technological processes are [10]:
- in the physical level: cyber and physical systems engaged into the technological process
(technological equipment); technological documentation which define the item manufacturing route (technological cards, item manufacturing technological processes description and the sequence of their completion):

- in the level of mathematical abstractions: subject field ontology of the Industry 4.0 «smart factory» company digital manufacturing and ontological dictionary;
- in the level of resources: a set of construction, program and technological documentation; state, interstate, branch and international standards, and some other controlling documents and methodical prescription on the basis of which special methods of test should be created to control the quality of the products being manufactured in the manufacturing company.

Digital models level in the Industry 4.0 production are represented with combinations [11]:

- digital twins of technological equipment;
- digital models of item manufacturing technological operations;
- digital models of the product and its components (which is part of the construction, program and technological documentations);
- digital models of external influential factors which are necessary to organize the virtual test on the product digital model using the technology of the imitation modelling.

3. Ontology in Industry 4.0 company

As an appendix to the Industry 4.0 subject field in the real world cyber and physical systems are the automated one installed in the smart factory production company and in virtual world the information processing technology are cloud technologies and the technology of the industrial Internet of things in the level of services.

The central position of ontology are classes (sets of objects, collections and others) which determines the primary definitions of the subject field being studied. As for production companies of the Industry 4.0 it is logical to study two classes of ontologies [12, 13]:

- classes based on the general notions in the level of cyber world;
- classes based on the real objects in the physical world.

Classes which corresponds to the general notions (abstract classes) which defines the terms to describe information processing methods in the level of abstractions to enable user (plant personnel, program agent of the company control digital system and others) to define the class which corresponds to the real objects.

Classes which corresponds to real objects define terms which are necessary to determine definite objects (processes) of real world (technological equipment examples, technological operations and other) in the Industry 4.0 automatic production systems.

In this view an ontology could be seen in the level of formal model of order set of pluralities of finite sizing: terms; relations among terms (in the level of «part-whole»); interpretation functions of terms and relations.

Interpretation functions given for each term which may unify the language semantics perceived by human being and the language semantics which can be accepted by the machine during the information processing (for example using term apparatus without data). So interpreting function translate some ontology classes terms to machine user requests (plant personnel, program agent of company control digital system) to the data base which can be realized as an abstraction level program option as it is shown in the figure 1.

4. Conclusion

An approach how to describe a subject field of knowledge based on ontology is a form of man-machine interface where the terms from the ontology dictionary can be used by the developer or the automatized system at the same time during the machine data processing. This effect can be reached by representing term of ontology as the formal semantics language which can be processed by the computer and understood by human user. So ontology is a kind of intermediary between the physical world of automatic system and the virtual world of the information processing technology.
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