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Development of the Linguistic Ontology Construction Method on the Base of Structured Electronic Encyclopedic Resource

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Abstract

The method for automated formation of the ontological knowledge base software tools construction by converting of the structured encyclopedic resource to the appropriate ontology objects has been presented in the article. The developed method is based on the algorithm and model from the Petri networks theory.

Keywords: linguistic ontology, method, algorithm, Petri networks based model.

1. Introduction

The technical systems complexity grows with the time due to the growing consumers` demands, hard competition conditions and appearance of the new element base.

In such circumstances the existing design methods [Zwicky F., Wilson A.G., 1967, Одрин В.М., 1989, Гліненко Л. К., 2004] do not always have positive results. Therefore, nowadays, the complex objects and systems designing methods based on the ontologies` use are of a great importance [Shamsfard M., Barforoush A., 2004, Литвин В. В., 2010, Клещев А. С., Артемьева И. Л., 2001, Клещев А. С., Артемьева И. Л., 2001].

Ontologies are also widely used for solving problems in medicine [Хашаев З. Х. Et al., 2009], information technologies [Терновой М.Ю., Штогрина Е.С., 2011, Овдій О.М., Проскудіна Г.Ю., 2004] material science [Досин Д.Г., et al., 2008], linguistics [Бондаренко А. В., 2009]. Methods used in the micro electromechanical systems design process [Vasyliuk I., et al., 2011], software development [Musen M. , 1998] and others are also created.

Ontologies` application for solving technical issues can give new relations, hidden dependencies, new technical solutions, etc.

On the other hand, nowadays, we are witnessing the rapid computerization of the modern society, which requires new technologies in the learning process

[Михайлюк А.Ю., et al., 2010], namely: lifelong learning, deep specialization in a particular field, etc. In such circumstances the specialized intelligent software systems, called EI system, are unavoidable [Гришачов В., et al., 2011].
Therefore, specialized EI-systems development with the use of ontologies is the important actual task.

2. The ontology formation algorithm

The ontology formation process can be divided into several main stages of the corresponding algorithm:

Step 1. Preparatory stage.
Step 2. Sensets` database creation stage.
Step 3. Hierarchical relationships construction stage.
Step 4. Associative relations construction stage.
Step 5. Correction phase.

The below figure represents the overall ontology formation algorithm, according to which the process begins with the XML data parsing [Гарольд Э. Минс С. , 2002, Спенсер П., 2001, A. Zelinskyy, et al.,2010] and the according sensets` base formation and ends with the corresponding correction of the formed ontology database in automatic or manual, if needed, modes.
The developed algorithm (see Fig. 1) has the sufficient flexibility of the ontology formation process, in the same way providing the simplicity and reliability of its implementation and further functionality extension by introducing additional methods and models. architecture.

3. Development of the model for linguistic ontology based on colored Petri nets formation

The Petri networks based model was developed for the basic linguistic ontology conditions investigation [Д. Питерсон, 1984].
The below Fig. 2 shows the developed linguistic ontology based on colored Petri nets (CPN) formation model [J. L. Peterson A., 1980, K. Jensen, L. M. Kristensen, 2009, V. Teslyuk, et al., Васильев В.В., Кузьмук В.В., 1990]. The model is developed on the basis of the above described algorithm (see Fig. 1). The basic position of the constructed model and their purposes are described in details in the table 1. Also in table 2 is the detailed description of the developed model transitions and their purposes.

4. System architecture for collaborative design framework

Considering the typical strategy and technology of computer-aided design process, collaborative design framework should allow horizontal, hierarchical and vertical CAD workflows (Fig. 1). The horizontal collaboration emphasizes on allocating a design team from the same discipline to carry out a complex design task simultaneously. The hierarchical collaboration can establish an effective communication channel between upstream and downstream design processes. The vertical design workflow is very rarely included in collaboration activity, but its implementation can significantly improve concurrent engineering.

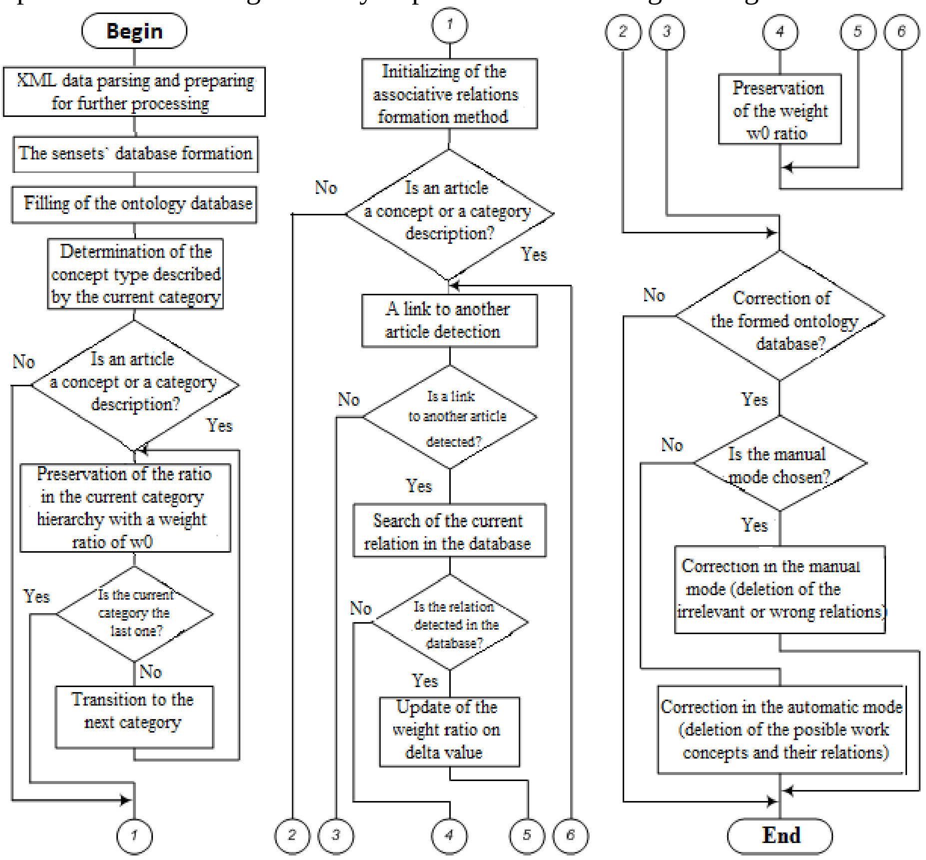

Fig. 1. The ontology formation algorithm

In general, the most common architectural principle that is used in IT systems in practice is tiering. An architecture consisting of multiple tiers is common in many network applications. In Fig. 3 the states reachability graph is introduced [V. Teslyuk, et al., 2010] for the developed model of linguistic ontology formation based on the coloured Petri networks model, which enables exploring the ontology development state.

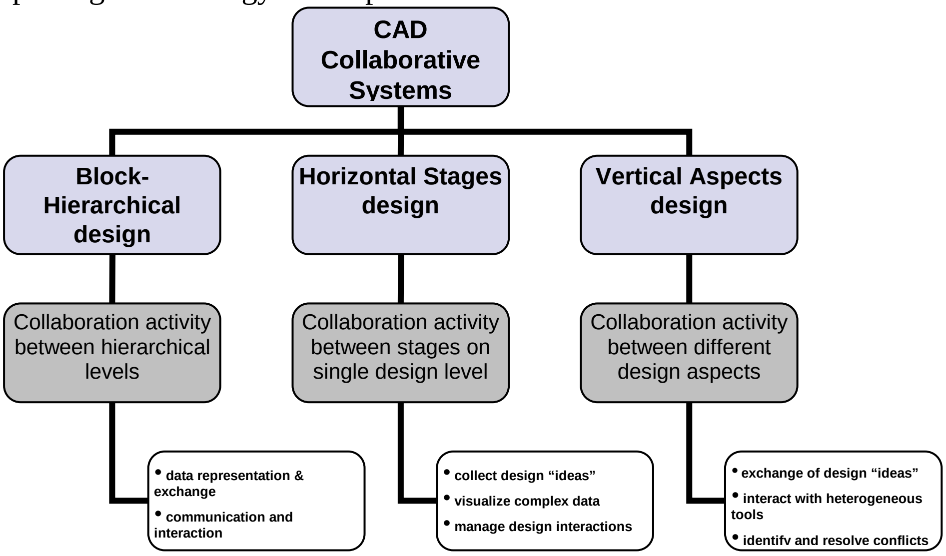

Fig. 1. Main types of collaborative workflows for mechanical CAD systems.

Table 1. The developed models states and their purposes

№	State	Description
S1	Beginning	The model start state
S2	Sensets` database creation stage	The marker in this position testifies transition to the sensets` database creation stage
S3	Hierarchical relations construction stage	The marker in this position testifies transition to the hierarchical relations construction stage
S4	The article is a concept or a category description	This state is responsible for the condition when the discussed article is the concept or category description and also for the data categories number
S5	—	This position acts as a buffer during transition to the next category
S6	—	This position reflects transition to the next category
S7	Associative relations construction stage	The marker in this position testifies transition to the associative relations construction stage
S8	The article is a concept or a category description	This position is responsible for the condition when the discussed article is a concept or a category description
S9	A link to another article detection	Position-indicator revealing a link to another article
S10	A link to another	This position is responsible for the condition when the

	article	viewed article has links to other articles, as well as for the number of such links
S11	Current relation in the database search	This position is responsible for the current relation search in the database
S12	Relation in the database detection	This position is responsible for the condition when the current relation was detected in the database, as well as for the number of the given condition occurrences
S13	—	This position is responsible for the ratio weight updating by the delta value
S14	—	This position reflects transition to the link to another article
S15	—	This position is responsible for the transition to the correction stage
S16	Correction phase	The marker in this position testifies transition to the correction stage
S17	Manual correction	The marker in this position testifies implementation of the manual correction
S18	End	The model shutdown stage

Table 2. Transitions of the developed model and their purposes

Transition	Purpose
t1	XML data parsing and preparing for further processing
t2	The sensets` database formation. Filling of the ontology database.
t3	Determination of the concept type described by the current category
t4	Preservation of the ratio in the current category hierarchy with a weight ratio of w0
t5	Transition to the next category
t6	Initializing of the associative relations formation method
t7	Confirmation of the fact that the article is a concepts or a category description
t8	A link to another article is detected
t9	The ratio is detected in the database
t10	Update of the weight ratio on delta value
t11	Preservation of the weight w0 ratio
t12	Transition to the next iteration of the link to another article detection
t13	A link to another article is NOT detected
t14	The article is not a concept or a category description
t15	Correction implementation in the manual mode
t16	Correction implementation in the automatic mode
t17	The model shutdown

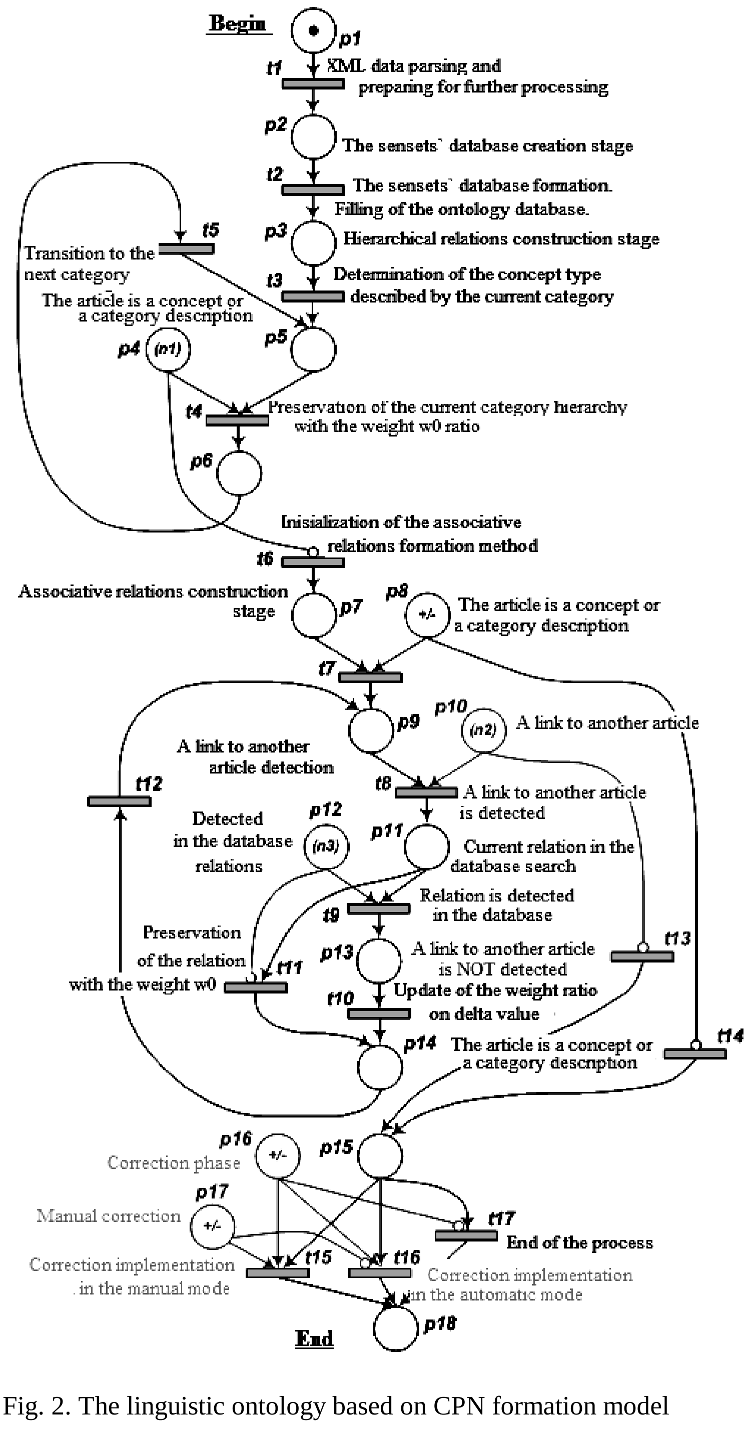

Fig. 2. The linguistic ontology based on CPN formation model

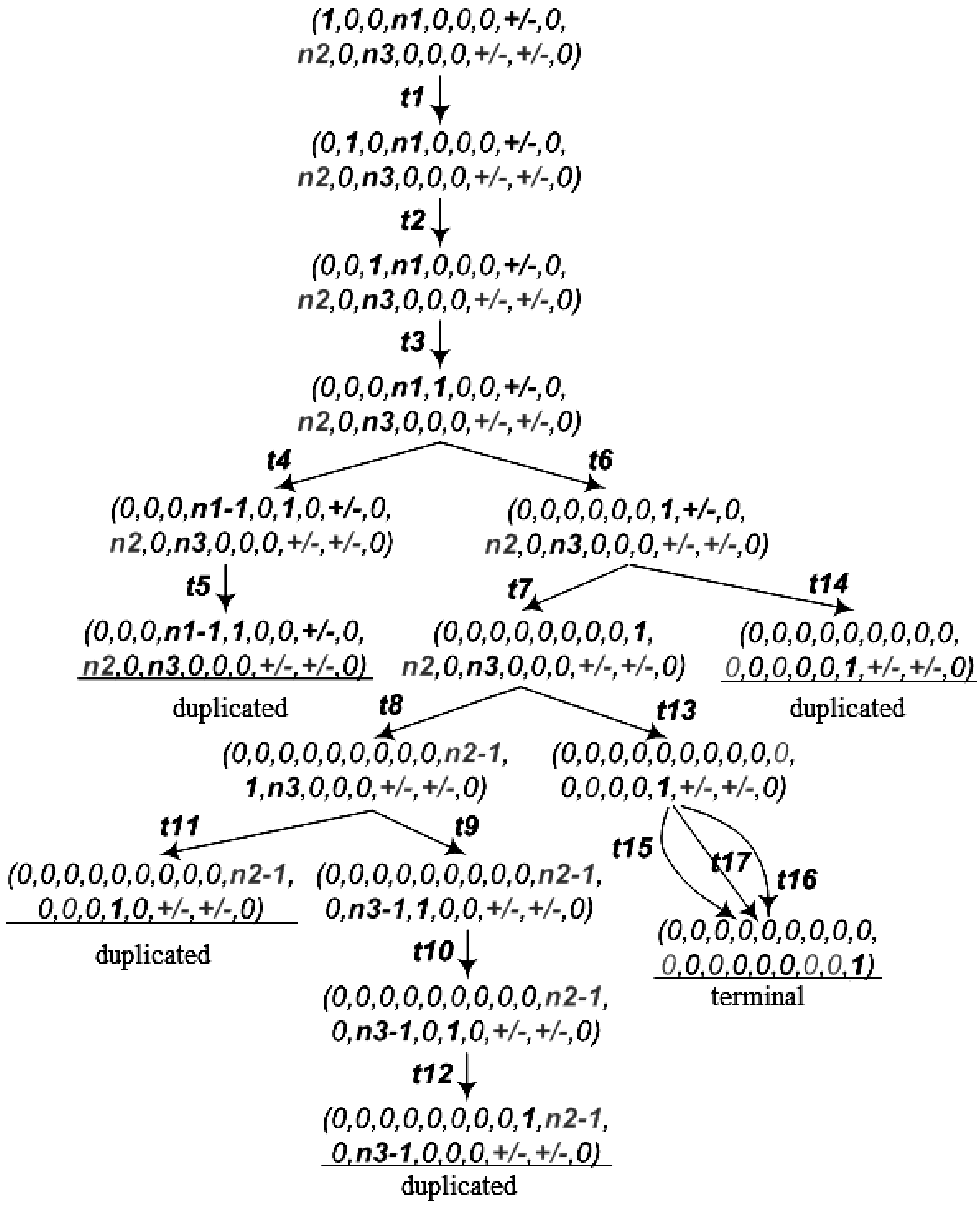

Fig. 3. The states reachability graph of the developed model for the linguistic ontology based on KMP formation

5. Conclusions

The developed algorithm and model based on colored Petri networks enable investigation of the basic states and the dynamics of the linguistic ontology study and construction processes, as well as enable the programmatic implementation of the proposed method, which provides further modification and increase functionality opportunity by introducing additional methods and models.

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