Research for the Unified Description Mechanism of the 3D model of the Launch Vehicle Based on Ontology

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Abstract. Aiming at the 3D model of the Launch vehicle, the article raises the unified description method based on the ontology and creates the hierarchical ontology model for the launch vehicle. At the end of the paper, an example of the tank which is based on the ontology is verified by the unified description method.

1. Introduction

With the development of the new launch vehicle, the 3D design software is coming into use. But the mainstream 3D design software is the foreign software such as Creo and Catia. There are commercial barriers between different commercial software. It is a serious problem for the existence of the barriers to the users of the software. A number of solutions have been proposed by the foreign users such as STEP. The STEP can be used to data exchange, but the weakness is STEP cannot record the modelling process information and express the modelling feature information. The last but not the least is that the STEP cannot be understood unless the information is processed by the data parser. The character of the launch vehicle in the design process is that the design cycle are too long and the involved institutes are huge. The same 3D model may be expressed by the different 3D software. The research of the describing mechanism is badly in need and it is important to realize the unified expressing as soon as possible.

2. Research for the unified description mechanism based on the ontology

2.1. The basic concept of ontology

Ontology is the logical description of the name, attribute and interaction relationship of the object in the researching field. Ontology describes the semantic information of the objective object which is hided in the real world. The presentation skills of the ontology in object, relationship of the object and system architecture in the domain of the specified knowledge is sufficient. The first step is building the ontology model which is based on the specified domain and application range. The second step is building the correspondence relationship between the concept and attribute. At this point the formalized and unambiguous unified describe for the objective object can be expressed. And now, it is the unified description of the specified domain.

2.2. Tools and methods for creating ontology

Protege is the software developed in java by the University of Stanford, which is used for the ontology editing and knowledge acquisition. The protege provides the class, the relationship and attribute in the
creation of the example, which is a commonly used tool. During the process of creating the ontology by the protege, the most important thing is to be sure the definition of the concept and the fundamental information and classification.

The process of the ontology creation include the following steps, such as determine the overall structure, list the important terms and vocabulary, define the hierarchical relationships between the classes, definite the attribute of the classes \([6][7]\). The flow chart is as the figure 1.

![Figure 1. The flow chart of the ontology model creation](image)

3. The ontology modelling of the 3D model for the launch vehicle

The unified description method for the 3D model of launch vehicle based on the ontology is as follows. Firstly, statistic the characteristics of the launch vehicle and extract the structure information. Secondly, story the component information in hierarchical, the hierarchical structure is just as the figure 2. Divide the launch vehicle 3D model into the target structure layer, the assembly layer, the part layer and the feature layer. The relationship between the target structure layer and the assembly layer is point to point or point to multipoint. The relationship between the assembly layer and the part layer is point to multipoint or multipoint to multipoint. The relationship between the part layer and the feature layer is point to multipoint or multipoint to multipoint. The feature layer is the base layer of the unified description. The feature description is the main body content for the whole work. The hierarchical description from the target structure layer to feature layer is detailed step by step for the specified structure. The method from general description to specific expression and expression from macro to micro solves the unified description of the problem.

![Figure 2. The chart of the hierarchical ontology model for the launch vehicle](image)
4. Example verification

4.1. The example of the unified description for the launch vehicle

The tank structure is one of the typical constituent structures for the launch vehicle. The tank is composed by the flange, the annular connector plate, the melon petal, the short shell, the fork-like ring, the shell. The composition diagram is as the figure 3.

![Figure 3. The composition diagram for the tank structure](image)

Following the steps in the 2 chapter, the hierarchical ontology model of the tank by the protege is as the figure 4(a)(b)(c).

(a) The Hierarchy Figure for the Ontology of the Target Structure Layer for Just Like the Tank

(b) The Hierarchy Figure for the Ontology of the Assembly Layer for Just Like the ForeEllipsoidBottom
4.2. The automatic visualization module for the extracted information

Following the hierarchical ontology model of the tank in the 3.1 chapter, the unified description file of the tank is as the figure 6(a)(b)(c).

(a) The Unified Description File for the Target Structure Layer for Just Like the Tank
4.3. The processing of the unified description file for the instance document
Based on the unified description file of the tank, the article develops the automatic reading module for the visualization. The visualized 3D model of the tank is as follows.

Figure 7. The visualization of the unified description file
5. Conclusion
By ontology modelling and expressing of the launch vehicle, the article builds the hierarchical ontology in the aerospace field, defines the logical relationship between the layers and describes the content in the ontology, realizing the unified description of the launch vehicle. At the end of the article, the effectiveness of the unified description method is verified by the example of the tank, which provides the theoretical basis for the next unified description in the aerospace field.

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