Dynamic Constructing 3D Electronic Technical Manual of Mechanical Products Based on Publishing Rules

Feng Zhao 1, Aijian Wu1, Lijuan Yan1 and Shen Li2,*

1State Key Laboratory of Intelligent Manufacturing of Advanced Construction Machinery, Jiangsu XCMG Construction Machinery Research Institute Ltd., Xuzhou 221000, China
2Key Laboratory of Electronic Equipment Structure Design of Ministry of Education, School of Mechano-electronic Engineering, Xidian Univ., Xi’an 710071, China

*Corresponding author e-mail: sli@xidian.edu.cn

Abstract. In order to solve the different contents of 3D Electronic Technical Manual (3DETM) for classified users in the Process of Publishing Mechanical Products, a method of dynamic constructing 3DETM is presented based on publishing rules. Firstly, the object data of 3DETM was extracted automatically; then the publishing behavior of 3DETM was encapsulated by CAD API method. Finally, the dynamic mapping between different classified users and the publishing contents modes of 3DETM was realized by defining Publishing Rules. Validation in the prototype software developed shows that the 3DETM was constructed dynamically for classified users.

1. Introduction

With the economic globalization and the advent of the information age, the application of advanced information technology in traditional manufacturing industry has become an inevitable way to break through the encirclement. The structure of the mechanical products are more complex, and the use and maintenance are increasingly difficult. Interactive Electronic Technical Manual (IETM) is an important part of equipment information construction. The application of interactive 3D technology enhances the function of IETM and has become the basic support and core of improving enterprise service [1-3]. 3DETM is the key unit of IETM. The 3DETM contents relate to the whole life cycle information of product design, processing, maintenance and so on, different users have different requirements for 3DETM. In order to realize the security of product information and the cost, enterprises need to create various 3DETM for different classified users.

In fact, much work has been carried out on IETM [1-8]. The literature [4, 5] introduced Semantic inference technology in IETM. The literature [4] realized the semantic retrieval of image and text. The literature [5] proposed diagnosis strategies of experience-based manual interpretation, rule-based fuzzy semantic inference and condition-based data fusion. The 3D multi-media object was inserted into the IETM by cross-referencing, and the 3D display platform based on IETM was established by using Active X technology in the literature [6]. The literature [7] proposes a method of IETM information query based on Bayesian network model. The literature [8] proposed the IETM data security control model based on equipment architecture. However, the above literature does not involve classified users to create and publish 3DETM. In practical application, lack of effective methods to create 3DETM for classified users.
The publishing mode of the mechanical products 3DETM is studied in this paper, a multi mode publishing mechanism for classified user 3DETM is proposed based on publishing rules. In the method, dynamic mapping between different classified users and 3DETM content was realized by defining Publishing Rules, dynamic analysis of publishing rules to complete the creation of 3DETM.

2. Overview of the Approach
The 3DETM have different contents for the classified users, the method in this paper process was shown in Fig.1. Firstly, constructing the publish contents lists \( C = \{ C_1, C_2, ..., C_n \} \), based on 3D model of mechanical products, the object data was extracted from model, Filtering data and forming the publish bill of material tree. Secondly, encapsulating the publication behavior lists \( M = \{ M_1, M_2, ..., M_n \} \) by CAD API method. the publishing behaviors includes four kinds: output, hiding, protecting and replacing. Each publishing behavior contains several operations of object data. Thirdly, defining the publishing rules for classified users. The publish rules are the mapping relationship between \( C \) and \( M \), \( PR = \{ PR_1, PR_2, ..., PR_n \} \), \( PR \subseteq C \times M \). Fourthly, defining the classified users \( CU = \{ CU_1, CU_2, ..., CU_n \} \), the rules of \( CU_i \) is a subset of \( PR \). So the different classified users can be mapped to the specific publishing rules. Finally, dynamic publishing 3DETM can be realized through selecting the classified users.

3. Key Technologies

3.1. Constructing the Publishing BOM Tree
In order to implement different 3DETM publishment of the same product for different classified users, firstly, the set of data objects published could be extracted in the product 3D model. Obtaining the published information data in 3D models through the API interface of commercial CAD software. It mainly contains three kinds of information in the model, (1) component information: list of parts and assembly that can be released; (2) feature information: list of geometric features in the part; (3) Functional information: additional information for the special function contained in 3D models, such as, model installation animation, 3D annotation, 3D process information, etc. As shown in Fig.2. The whole product is the root node of the publishing BOM Tree, the tree contains three kinds of sub nodes: Feature Set, Component Set and Function Set. Each component node can be expanded into a subtree.
3.2. Encapsulating 3D Publishing Behavior

Different publishing behaviors result in different contents for 3DETM, in order to simplify the bottom program implementation and the final application, the publishing behavior is encapsulated into four levels, as shown in Fig.3.

Application layer: is the most top-level interface facing ordinary Publishers. Publishing users do not need to care about how to implement the content of the underlying layer, only need to choose the type of classified users, can realize the directional publishing of the content of 3DETM.

Presentation layer: to define publishing rules and package publish logic facing publishing administrator, different classified users reuse rules to improve the efficiency and security of publishing logic.

Logic layer: define the operation logic of publishing content facing publishing administrator.

Implementation layer: implement the operation of publishing content by program developers by encapsulating the API function of commercialized CAD software, such as Creo, Catia and NX.

3.3. 3DETM Dynamic Publishing Technology

According to the requirements of different classified users for publishing the contents of 3DETM, the classified user type database and publishing rule base were constructed. Constructing multi-view user 3DETM by dynamic Selection and driving the publishing rules. The process is shown in Fig.4. Based on the product 3D CAD model, the publishing BOM tree is constructed by extracting publishing content information; At this point, the publishing rules can be obtained in three ways. 1) Selecting classified users from the user type database; 2) Creating classified users dynamically and retrieving rules from publishing rule database to implement rule mapping of newly-created classified users; 3) directly through the dynamic rules generator to complete the rule creation of published objects. The operation logic of the model is obtained by parsing the rules of the model release. According to the mapping CAD API method, the model operation is completed, and the dynamic publishing of 3DETM for classified users is finally realized.
Dynamic rules generator

Analysis of dynamic rules

Driving CAD model with API

Classification of user 3D ETM

Figure 4. 3DETM dynamic publishing process

4. Application

Based on the method in this paper, the 3DETM Publishing software for Mechanical Products was implemented and the main dialogs in the software was shown in Fig.5.a) For the final publishing user, only the type of classified user needs to be selected, and the software can automatically analyze and drive the user type to the publishing rules; b) The dialog can create the models operational logic for publishing administrators. c) Dynamically create publishing rules according to operational logic;d) Complete the dynamic mapping of classified users type and publishing rules.

a) Publish by select classified user

b) Method creation

c) Publishing rule management

d) Classified user management

Figure 5. The dialogs in the prototype software
5. Conclusion
In this paper, we have presented an approach to deal with the construting 3DETM of mechanical products for classified users. User type base and publishing rules base were established in the prototype software. Through dynamic mapping of user types and publishing rules, publishing rules was analysis by CAD API method, then 3DETM dynamic publishing was realized. The publishing efficiency and safety of 3DETM are improved.

Acknowledgments
This research was financially supported by the State Key Laboratory of Intelligent Manufacturing of Advanced Construction Machinery Open Fund Project, China (Grant No. AXE2017001).

References
[1] Liu Qiang, Key Techniques in Three-dimensional Electoronic Manual.Xidian University (2015).
[2] Huang Xiao Yang, Research on Template Customizing for Three-Dimensional Publication System.Xidian University (2015).
[3] Bu Zhaofeng, Du Xiaoming, Liu Bin, Zhang Caihong, Integration and Application of Interactive 3D Technology and IETM.Ordnance Industry Automation. 37(2018).33-38.
[4] Li Kairong, Song Heng, Zhu Junwu, on semantic retrieval oriented to ietm software. Journal of Applied Sciences, 13(12), 2276-2281(2013).
[5] Niu Gang, Li Hao, IETM centered intelligent maintenance system integrating fuzzy semantic inference and data fusion. Microelectronics Reliability, 75(2017) 197-204.
[6] Huang Kui, Zhu Xing Dong, Wang Zheng, Application of virtual technology on aviation equipment IETM. Advanced Materials Research. 846-847(2014) 1443-1447.
[7] Wu Jiaju, Pan ZeYou, Xu YongKang, Yu Rong, The Study on Bayesian Network-based IETM Information Retrieval Technology. Advanced Materials Research. 846-847(2014) 1180-1184.
[8] WU Jiaju, LI Gongliang, CHENG Zheng, Research on IETM data security control based on equipment architecture. Modern Electronics Technique. 40(2017) 22-26.