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Research on Ontology-Based Tacit Knowledge Mining for Aerospace Enterprise

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Abstract. This paper introduces the traditional methods of the tacit knowledge mining and summarized its existing problems. By combining the features and applications of ontology, an ontology-based tacit knowledge mining model is proposed for aerospace enterprise. Using this model, research is proceeded on ontology library design, mining constraint extraction knowledge mining and knowledge service. In future programs, the tacit knowledge obtained can be reused and improve the R&D efficiency.

1. Introduction
The world has entered the era of knowledge economy now. Knowledge becomes the key factor for enterprises to gain competitive advantage. More and more business managers are aware of the importance of knowledge management (knowledge mining, knowledge sharing, etc.) to enterprise development. In knowledge management, knowledge can be divided into explicit knowledge and tacit knowledge according to the difficulty of knowledge describing [1]. Explicit knowledge refers to the knowledge that can be spread express, perceive, and encode into the computer by language and text [2]. Tacit knowledge is the knowledge that is difficult to clearly expressing, disseminating and sharing, such as the skills, experience, know-how and communication skills of the members [3]. The distinction between explicit knowledge and tacit knowledge is a deeper understanding of human knowledge. Researchers often use the structure of the iceberg to describe explicit knowledge and tacit knowledge: if explicit knowledge is the tip of the iceberg above the water, then tacit knowledge is the majority under the water. Thus, tacit knowledge is more difficult to explore than explicit knowledge and is an important wealth of an enterprise. Therefore, tacit knowledge mining is an important part in the process of knowledge management.

Aerospace enterprises are typical knowledge-based enterprises. A great deal of knowledge is generated and applied in the development of aerospace products. Explicit knowledge can be retained by text, data, and models, which can be easily shared and reused. But the tacit knowledge is usually difficult to dig because of its hidden and exclusive. This paper discusses the effect and existing problems of the traditional tacit knowledge mining methods, and introduces the research on ontology-based tacit knowledge mining technology in the aerospace enterprise.

2. Traditional Tacit Knowledge Mining Methods

2.1. Methods introduction
Tacit knowledge is an important part of enterprise knowledge assets. The purpose of tacit knowledge mining is transforming the tacit important information into explicit, valuable, and applicable
knowledge through a series of methods. There are many researches on tacit knowledge mining methods, such as web2.0-based tacit knowledge externalization [4], case-based tacit knowledge mining [5], construction of expert tacit knowledge map [6], etc. China Academy of Launch Vehicle Technology (CALT) has carried out many relevant works on tacit knowledge mining. The contents are as below:

- **Tutor mode**
  
  An experienced veteran is assigned as a mentor for each new employee. The mentor helps the new employee learn professional knowledge and improve work skills quickly. In this process, the tacit knowledge of the mentor, such as experience, skill, and thinking mode, will affect the new staff imperceptibly, and the tacit knowledge mining is achieving.

- **Expert interview**
  
  CALT has more than 60 years of history. It has developed a variety of space products, and trained a large number of technical experts. Many expert interview groups are established in multiple technical areas to get the tacit knowledge of these experts. The experts are interviewed face-to-face, sharing their experiences on technical research and research management. All the experiences and ideas are recorded and shared in the enterprise.

- **Technical Salon**
  
  To dig the tacit knowledge of ordinary employees, CALT carries out various technical salons regularly. Employees show their research results and share their own experience in the salon. The problems and confusions encountered can also be discussed with others.

2.2. Disadvantages of traditional tacit knowledge mining methods

The traditional methods described above have a certain effect in tacit knowledge mining. But this kind of methods has some limitations since it mainly depends on the experience of the experts.

- **Prone to ambiguity**
  
  Due to the differences on cultural backgrounds and the ability on describing and comprehension, the understanding and description of a certain concept will be different by different people. Therefore the tacit knowledge is difficult to accurately expressed and prone to ambiguity.

- **Lack of uniform conceptual description**
  
  In the process of applying knowledge, different departments may have different knowledge descriptions and definitions in the same field. Some are established by the experts and knowledge managers, some are obtained from the authoritative monographs. The relatively independent describing systems may bring obstacles to the knowledge sharing and spreading.

- **Lack of a uniform knowledge resource format**
  
  In different knowledge describing system, the storing formats in the media may be different a lot. It is difficult for knowledge transfer, integration, and spread.

3. Ontology-Based Tacit Knowledge Mining Model

3.1. Modeling

Ontology is a formal, normative description of a shared conceptual model. It can clearly define the knowledge in the domain and describe the relationship between the knowledge. By constructing the domain ontology, text analysis can be achieved at the semantic level, which means that the machine has some reasoning ability in the process of dealing with the text. The problems in the traditional tacit knowledge mining, such as the nonuniform of concept and form, can be solved by introducing the ontology.

Based on the practice of the traditional tacit knowledge mining method and the analysis of the ontology, this paper proposes a ontology-based tacit knowledge mining model. The model mainly includes 4 modules: target decision, constraint extraction, knowledge mining and knowledge service, as shown in Figure 1.
1) target decision
Target decision mainly defines the target and determines the scope of tacit knowledge mining. The target of the tacit knowledge mining is no longer made by domain experts. By digging the users’ needs using the ontology, the real needs and the potential needs will reveal and become explicit. This work is usually done by the machine.

2) Constraint extraction
According to mining target, the mining constraints are obtained by extracting the concept of the ontology and the concept examples. This process is not dependent on the experts, thus avoiding low quality of the mining results due to the subjectivity and expression differences of each individual.

3) Knowledge mining
Knowledge mining is the process of knowledge search, refining and storage based on the mining target and constraints. The ontology-based knowledge search uses the ontology concept and concept examples as the key words, which ensures the accuracy and high coverage of the search. The ontology-based knowledge storage stores the data by mark and class under the norms and constraints.

4) Knowledge service
Knowledge service refers to providing the necessary knowledge on the demand of users. Knowledge services include the user needs research, knowledge sharing, knowledge trading, user feedback and so on. At the same time, the users’ feedback is also the effective support for improving the domain ontology.

3.2. Characteristics of the Ontology-Based Tacit Knowledge Mining Model
It gives the new features for the tacit knowledge mining by introducing the ontology, which defines the knowledge with uniqueness and certainty.

- Accurate knowledge extraction
  The semantics of the same knowledge in different texts description can be extracted by the ontology instance. This improves the reliability of the knowledge extraction in the process of tacit knowledge mining.

- Increase of the knowledge search coverage
  By introducing the ontology, the text information can be understood at the semantic level. Therefore, the search results will be highly correlated with the retrieval expression through the context analysis. The coverage and the accuracy of the search result can be effectively improved.

- Smoothen of the knowledge sharing process
  The ontology provides the concept definition and association description. It eliminates the express differences of the same semantics and enhance the common understanding of knowledge. The barrier-free communication is achieved and the knowledge sharing and spreading becomes more convenient.

4. Applications in Aerospace Enterprise

4.1. Ontology construction in aerospace domain
The construction of the domain ontology are studies by many researchers [8,9]. The most accepted
five principles on ontology construction are suggested by T.R. Gruber [10]: Clarity, Completeness, Coherence, Extendibility, Minimal Ontological Commitment and Minimal Encoding Bias.

The thesaurus is a collection of vocabularies that express the concept in a particular area. The ontology construction of the theorem should satisfy the five principles above. In this paper, the ontology automatic generation system in aerospace domain is developed using the “Aerospace Scientific and Technical Thesaurus”. As shown in Figure 2, the system transfer the thesaurus to the ontology file automatically using 8 different modules, which are thesaurus analysis module, terminology and relations mapping module, terminology and relations reconstruction module, normative self-test module, ontology file update module, ontology parsing module, ontology deduction module and terminology map construction module. There are 25168 descriptors in the aerospace thesaurus. there are three kinds of reference systems, namely the use of relations (equivalence relations, preferred relations), subordinate relations (subordinate relations, hierarchical relations) and related relations (see relations). The ontology automatic generation system Linking the thesaurus into a semantic web through the thesaurus reference system. Then the aerospace domain ontology library is constructed and is shown in the form of terminology map, as shown in Figure. 3. The users can search knowledge linked in with a certain terminology in the map.

Figure 2: Framework of the ontology automatic generation system
4.2. Ontology-Based Tacit Knowledge Mining

The construction of the ontology library is conducive to the consistency and standardization of the aerospace concept. Embedding the ontology library into a knowledge management system has laid a good foundation for barrier-free communication and knowledge sharing. Based on the ontology-based tacit knowledge mining model introduced in section 3.1, the ontology-based tacit knowledge mining in aerospace domain is carried out.

1) target decision

With the support of the aerospace domain ontology library, the target of the tacit knowledge mining is no longer made by domain experts. The users’ activities in the knowledge management system will be recorded by the system, such as browse, click, search, etc. Then the relative contents will be matched with the terms in the ontology library. The higher the matching amount, the stronger the demand for the relevant knowledge of the terminology. And the system will decide the target of the tacit knowledge mining.

2) Constraint extraction

According to target, the key terminologies are determined as mining constraints. The constraints are generally limited to 3-5 to ensure the accuracy and efficiency of knowledge mining.

3) Knowledge mining

According to the mining constraints, the knowledge management system will generate the hot topics on the home page and encourage users to discuss the topic on-line. This may stimulate the users to express the tacit knowledge in their brain. Based on the mining constraints, the system extracts the content of the online discussion, linked the relevant knowledge to the ontology terminology, and store the results.

In the aerospace product design process, a large number of intermediate process documents are produced. They are ignored after the final design accomplished. But in the knowledge management system, the process document will be treated as an important source of tacit knowledge.

4) Knowledge service

Users can view the associated knowledge in the knowledge map by retrieving the ontology terminologies, or by searching knowledge itself in the system. The system can also dig the users’ needs and push the relevant knowledge to the user's personal center. The users’ activities on the pushed knowledge, such as click, browse or download, will feedback to the system to improve the knowledge mining target and constraints.

5. Conclusions

This paper introduced the traditional methods of the tacit knowledge mining and summarized its existing problems. By combining the features and applications of ontology, an ontology-based tacit knowledge mining model is proposed for aerospace enterprise. Using this model, research is proceeded on ontology library design, mining constraint extraction, knowledge mining and knowledge service. In future programs, the tacit knowledge obtained can be reused and improve the R&D
efficiency.

Ontology-based tacit knowledge mining breaks the limitation of traditional methods, which is helpful to the dissemination and reuse of tacit knowledge. The research can improve the efficiency of tacit knowledge mining effectively. And it is of great significance to improve the ability of rapid design and innovation.

References
[1] Polanyi M. Personal Knowledge[M], the University of Chicago Press, Chicago, 1958.
[2] Zhou C X. The Concepts Discrimination of Tacit Knowledge and Explicit Knowledge[J], Information Studies: Theory & Application, 2004, No. 2, pp 127-129.
[3] Nonaka I. A dynamic theory of organizational knowledge creation[J], Organization Science, 1994, Vol 5, No. 1, pp 14-36.
[4] Lu K. Research on Externalization of Tacit Knowledge Based on Web 2.0[J], Information Science, 2008, Vol 26, No. 2, pp 247-251.
[5] Zhang X Z, Chen B, Fu R. Study on Tactic Knowledge Mining Based on the Cases[J], Information Science, 2006, No. 7, pp 8-9.
[6] Qin T H, Wang Q. On The Construction of Expert Tacit Knowledge Map[J], Journal of the National Library of China, 2007, No. 2, pp 58-62.
[7] Xia L X, Xu C X, Bai H. Research on Knowledge Management of E-government Based on Ontology[J], Information Science, 2009, Vol 27, No. 11, pp 1608.
[8] He L, Hou H Q, Du H P. Research on Semi Automatic Construction of Domain Ontology[J], Library Theory and Practice, 2007, No. 5, pp 26-27, 38.
[9] Yu F. Domain Ontology Construction Method and Empirical Research[M], Publishing House of Wuhan University, Wuhan, 2015.
[10] Thomas R. Gruber. Toward principles for the design of ontologies used for knowledge sharing[J], International Journal of Human-Computer Studies, 1995, Vol 43, No. 5.