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Research on Data Integration Model Technology Based on Ontology Oil Fields

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Abstract: In order to solve the defects of various professional system not alone development to achieve its function in oil exploration and development, research on data theoretical calculations and application based on ontology construction in oil field was proposed. The ontology theoretical construction method is the basis, and it developed and built all business levels in oil exploration and development system. And then it designed the integration model of different frameworks of oil ontology. At last, sound global ontology oil data framework solutions were designed and established. The results showed that the oil ontology framework model can effectively carry out knowledge retrieval in ontology base through the ontology inquiry. Compared to traditional, it can be more effective to get more information about the oil knowledge relationship.

Keywords: Data Integration Model Technology; Ontology Oil Fields; Petro-Onto

1. Introduction

In the oil exploration and development field, with the depth of oil exploring and developing and the development of science and technology, the widely used of Internet makes all relevant information greatly enriched. The increasing of interdisciplinary knowledge and the accelerated update, which bring the complex problem of knowledge constructed in the oil exploration and development field [1].

Oil exploration and development areas include more than twenty professional, like exploring, logging, drilling, mud logging, testing for oil, underground operations, oil production engineering, oil storage and transportation, etc. These majors mutual collaboration comprise all business process of oil exploration and development. However, the prevalence of the question in the professional system developed independently, the simple pursuit of function realization. They are not from the height of the entire oil industry to petroleum exploration and development of application system design. Therefore, in the long term, building the global oil ontology of exploration and development has become an inevitable trend [2-3].

Take China National Petroleum Corporation for example, the information system database of China National Petroleum Corporation has built for ten years, it also has the following problems:

1.1. Coding Principles are not Unified, Basic Data Performance

Earlier each informational module basically has its own basic data by professional vertical. The data is complicated and large. Some of the data is inaccurate and incomplete. At the same time, due to the limitations of time and technology, enterprises in different historical periods have developed application systems which are relatively independent, non-connectivity between systems. The data and code described enterprise information resources are scattered, caliber inconsistent, redundant and non-standard. Sometimes the same data or data index in different systems, different departments with different description and content shown, so that oil resources can not be fully effective sharing.

1.2. Information System and Software have Iterative Developed Phenomenon

At present, China oil for investment and personal of information construction have a certain scale. They developed a number of information system and application software, and obtained a number of research results, in which part of system and software reached more advanced levels. While low-level iterative development is serious. Because before the China's oil industry restructuring, each unit had their own way invest and develop their system. It not only caused a great waste of resources, but also seriously hindered the development of informationization. Therefore, in a long term, building the global oil ontology of exploration and development has become an inevitable trend. In terms of knowledge, exploration and development of oil resources in a unified integrated management and decision-making, building ontology base came into the necessary link for oil company with a competitive advantage.

Ontology theory belongs to the category of artificial intelligence theory, which researches classification, properties and relationship of the object. It provides the describing the terms to domain knowledge. In information field,

"Ontology is a shared conceptual model of the formal specification", which has the characters of conceptual, explicit, formalized and sharing. The objective of ontology is to capture knowledge related areas, to identify common vocabulary recognition in the field, and give a clear definition of the relationship between words and vocabulary of these [4-5]. Hence, one ontology O can be expressed by a triple <D, C, R>, where D is a domain, C is a standardized concepts set of domain D, R is the set of relationships between concepts. Ontology as a knowledge-sharing model provides a great convenience for the exchange and application systems in specific areas. But also because of this, the research and application of ontology quickly extended to knowledge engineering, natural language processing, information retrieval systems, intelligent information integration and knowledge management, information exchange, and software engineering and other fields. How extract, describe and build a suitable domain ontology in different areas has become one of the current research focus on these different areas

Oil exploration and development areas include more than twenty professional, like exploring, logging, drilling, mud logging, testing for oil, underground operations, oil production engineering, oil storage and transportation, etc. For a long time, each professional lacked of a unified information standard, which brought many problems for multi-disciplinary information sharing and application integration. Using a unified method to describe oil field knowledge is the effective way to solve these problems. Through capturing knowledge in related areas, ontology can provide the common understanding of this knowledge area, and identify common recognition of the concept in the field[1]. At present, it has carried out ontology construction and application research in library intelligence, medical, military, e-government in all areas. But there are no oil ontology exploration and development and only few individual professional literatures on oil carried out research local domain ontology. Therefore, this paper is based on ontology theoretical construction method to develop and build all business levels in oil exploration and development system. And then it designed the integration model of different frameworks of oil ontology. At last, sound global ontology oil data framework solutions were designed and established. The results showed that the oil ontology framework model can effectively carried out knowledge retrieval in ontology base through the ontology inquiry. Compared to traditional, it can be more effective to get more information about the oil knowledge relationship.

2. Different Building Integrated Model Frameworks of Oil Ontology

Ontology (Ontology) concept originated in the field of philosophy. The use of computer science can be traced back to the 1980s, eventually Gruber gives a widely accepted concept that the ontology is clear conceptualization standardized instructions.

The key step of establishing the ontology model is to establish a suitable domain framework for ontology model. Oil business model (Busi-ness Model) is a described oil enterprises production process model, which is defined by the logical relationship between the composition of activities and events. It is the basis for the exploration and development data model. Business area is divided by some oil-related themes as a guide on the whole field from the main business. It is neither copying the existed department, nor the clearing up of basic business. It is the general, conclusive division. The division method in business domain is by life cycle as the main line. And then make the professional business domain and method business domain organically connected in series, which is as far as possible in line with custom management practices for oil-gas exploration, development. So different business domain is not repeated and it can guarantee to cover all exploration and development business.

According to above principles and methods, the oil-gas exploration and development business can be divided into "Exploration planning and deployment" , "Geophysical prospecting", "Shaft engineering", "Chemical laboratory analysis", "Integrated research", "Development planning and development program", "Oil-gas production", "Oil-gas gathering and transportation" eight business domain. Special division is shown in Figure 1.

To initiate this activity, in this activities are related to which (Which) object, what is the features of these objects (What). Through this "6W" process to completely extracts related to information involved in certain business activities. 6W core essence is the "Object - Activity - Relevance - Feature", shown in Figure 2.

3. Data Integration Construction of Oil Ontology Framework

As can be seen from the definition of ontology and its concept, ontology has not only atomic concepts, but also has complex concept, universal concepts and individual concepts. The number of ontology concepts may be very large. So it needs a scientific and rational framework to organize these concepts.

In general, the ontology is divided by three layers: the top ontology layer, the domain ontology layer, the application ontology layer. The top ontology layer is used to research the universal concepts, such as space, time, activities, actions, etc. These concepts are independent of the specific areas that they can be shared and reused in different fields. In the second layer of domain ontology is to research vocabulary and terminology of specific areas, modeling for these areas. The domain ontology refers to the top ontology defined vocabulary to describe their vocabulary. In the third layer of application ontology is

to describe the special application. It can refer to specific domain ontology and the concepts of tasks.

The top ontology structure of Petro-Onto as shown in Figure 3. The root node is Petro-Onto. There are four sub-concepts: activity, object, property, meta, which is the top level of Petro-Onto. The concepts of "Petro-Onto" are mean by "in the oil exploration and development field", which is the root of Petro-Onto and the name of these areas. It represents the core business fields of oil, but also represents technical fields.

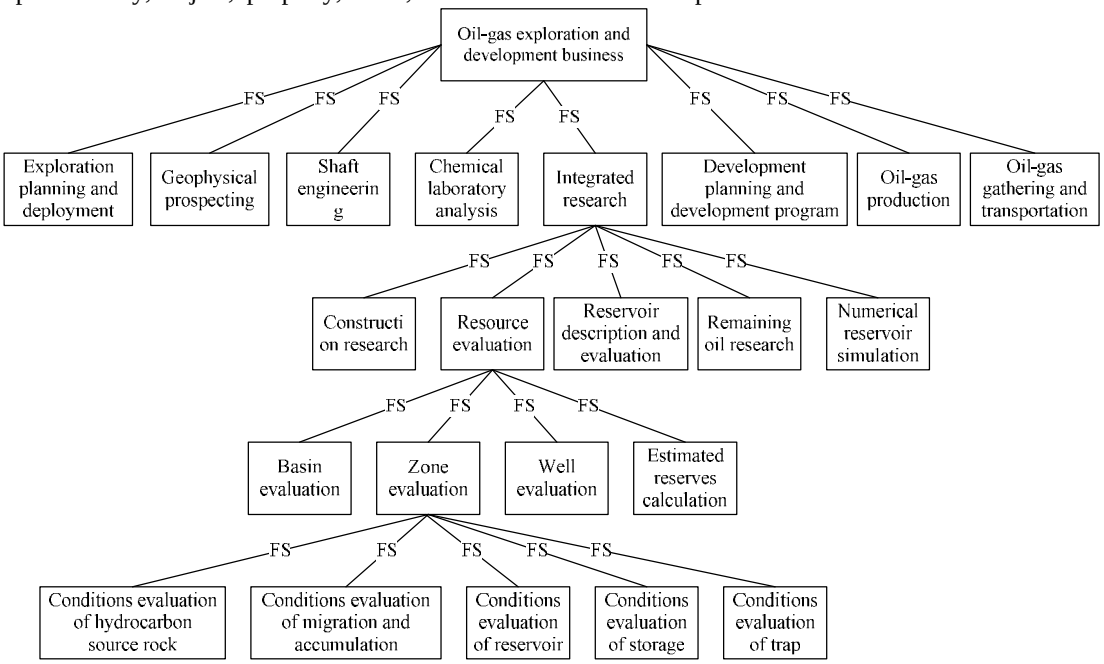

Figure 1. Oil ontology business division

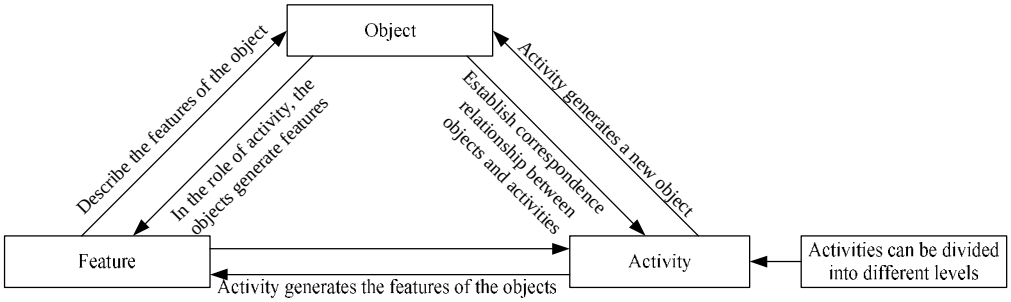

Figure 2. Oil ontology model framework

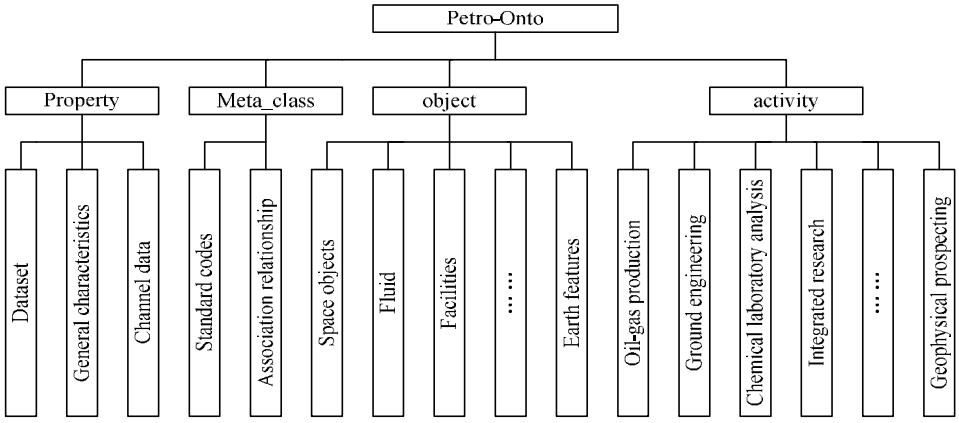

Figure 3. Overall optimization and integration of oil ontology framework

3.1. Oil Data Model

Data model is another implication carrier contained domain knowledge. In oil industry, international community has released PPDM、Epicentre and other integrated data model. In China, it has released exploration and development data structure. Epicentre is a data model faced the objects, which was released by POSC. Its entity can directly transfer into the category of Petro-Onto. PPDM and domestic various data models are both relationship data model. Literature [5] has proposed the method mapping the relational database model into cost structure. The transformational rule includes relational mapping, attribute mapping, association mapping, constraint mapping. This method requests the data model to meet 3NF, while in real application the relational data model can not reach this request. But in semantic, "well location coordinates" refers to the coordinate of wellhead, which is the property of object. However, the object "wellhead" is the part of object "well". Because the "well head" is an important concept in oil production process, it is not ignored. Accurate extraction ontology concepts from data item in relational data model, which needs to analyze the semantics of data items. Semantic description of a data element method is used by semantic data items for analysis. Data element is a data unit described by definition, identification, expression and allowable value. It is considered that it is not subdivided minimum data unit in particular semantic context [4]. Data element is the standard terminology to describe the data in information systems. According to the definition of relational model 1NF, a data item is a data element. By the ISO definition of the data element, the semantic structure of data element is shown in Figure 4.

It is difficult to see from Figure 4 that the semantic analysis of data items can extract the feature word, object word and the relationship between them. And then add these into domain ontology. When the object word of data item and main expression object word is different, we can establish the relationship between the object and the main key word belongs to the object. Compared to traditional semantic query oil library, it is more quickly and accurately on the query and significantly better than traditional oil ontology framework.

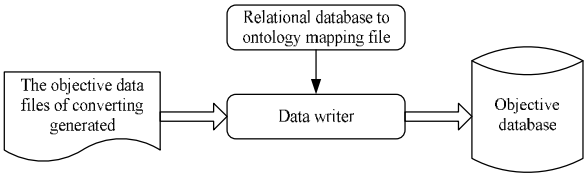

Figure 4. The semantic ontology mappings between datas

3.2. Dynamic Design of Oil Ontology Data

The sequence diagram of data exchange components is shown in Figure 5. This sequence diagram introduced the overall flew of data exchange components. First, the users send data exchange request to access authentication. If authentication is success, then encapsulate data exchange request and get resource data information. At the same time, this information is submitted to data exchange model based on oil ontology to construct related relational model, local ontology and ontology mapping. And then it will form data exchange rules. Second, according to the data exchange rules, it transfers source data into data file conformed objective data source style. Third, through data loading service components, make the generated objective data to transfer to data file conformed objective data source style. At last, load data service components to generate the objective data document is loaded into the objective database.

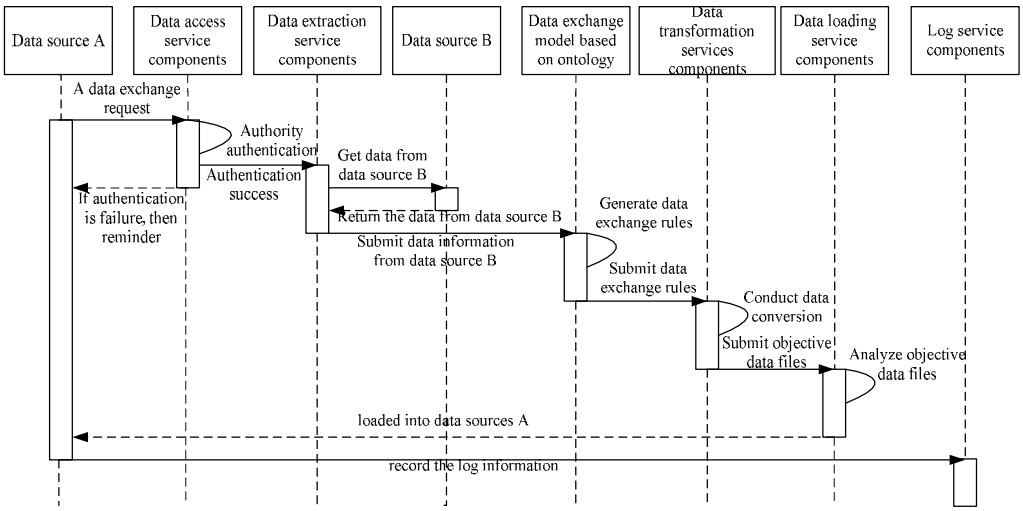

Figure 5. The data integration and loaded of ontology data

4. Conclusion

As the same data or data indicators in different systems, different departments with different description and content for conventional oil ontology framework structure, oil resources can not be fully effective sharing. There is a defect of repetitive development, so it is proposed the model research based on ontology construction theory application in the oil fields. Through the construction of models for different business functions, it established relational integrated system of the semantic query business between oil and data. Compared to conventional oil ontology frame, it has the superiority, fast accuracy and it can be more effective to get more information about the oil knowledge relationship.

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