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A fact-oriented ontological approach to SAO-based function modeling of patents for implementing Function-based Technology Database

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ABSTRACT

Function-Oriented Search (FOS) has been proposed as a tool for use in searching patent databases to find existing solutions to new problems. To implement FOS effectively, a well-structured Function-based Technology Database (FTDB) is required. An FTDB is a data repository of technology information represented as "function". To implement an FTDB, four features should be addressed: continual data updating, limited area searching, function generalization, and semantics handling. In this paper, we consider these features to suggest a fact-oriented ontological approach to implementing an FTDB by Subject–Action–Object (SAO)-based function modeling of patents. The proposed approach uses fact-oriented ontology modeling of SAO structures extracted from patent documents, and implements an FTDB, which is an SAO-based patent retrieval system to support FOS. We also verify the feasibility of the proposed approach to by using it to conduct case studies of patent retrieval.

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1. Introduction

The Theory of Inventive Problem Solving (Russian acronym: TRIZ) was developed by generalizing technologies after extensive analysis of 40,000 patents (Altshuller, 1984). Altshuller noted that technology has followed certain patterns and rules in creating new and inventive patentable ideas (Salamatov & Souchkov, 1999). TRIZ is a useful tool for analyzing technology; it has been applied in a variety of areas, and has been validated by many researchers (Crotti, Ghitti, Regazzoni, & Rizzi, 2007; Fey & Rivin, 1999; Mann, 2003; Savransky, 2000a; Zhang & Xu, 2006; Zhang, Yang, Tian, & Tan, 2007).

Recently, a new TRIZ tool, called Function-Oriented Search (FOS) (Litvin, 2005a, 2005b) has been proposed. The main objective of FOS is to find an existing technology and apply it as a solution to the target problem. The problem solving process of FOS is based on that of TRIZ (Fig. 1), which consists of four steps: (1) identify a specific problem; (2) abstract the problem as a generic problem; (3) find a generic solution for the generic problem; and (4) apply the solution to the specific problem. However, TRIZ cannot be easily applied in industry because traditional TRIZ tools use a generic solution, and so are too abstract and limited to apply directly to industrial problems. To solve this limitation, FOS searches existing technologies to find the appropriate generic solution FOS also consists of four steps: (1) identify a target problem; (2) generalize the problem; (3) find the existing solution by using a Function-based Technology Database (FTDB); and (4) apply the existing solution to the target problem. FOS looks similar to the traditional TRIZ problem-solving process. However, by using existing technology, FOS makes TRIZ more acceptable to users in industry. Existing technology can be more easily understood than traditional TRIZ tools which use generic solutions developed by engineers and technology experts who seek a solution to a problem. Because of this advantage, FOS has been applied in a variety of areas to solve technological problems (http://www.gen3partners.com).

To implement FOS effectively, a well-structured FTDB is essential (Litvin, 2005a). An FTDB is a data repository of technology information represented as "function". The concept of function can be defined as "The action changing a feature of any object" (Savransky, 2000b). This concept provides information on the uses and purposes of a technology. To implement an FTDB, four major features should be addressed. (1) The FTDB should be continually updated, because new technology appears continuously and replaces old technology. A new technology may be useful as a new solution to an old problem. (2) The FTDB should support search for a specific technology area. If a researcher tries to find a solution by searching in all remote engineering areas, the search field is almost infinite (Litvin, 2005a). This unlimited search uncovers huge amounts of unnecessary information, which a researcher must then remove. (3) The FTDB should support function generalization. Because a direct technology search is very ineffective (Litvin, 2005a), implementing an FTDB requires that technology function be generalized. By generalizing target technology function, the researcher can use existing technologies from various

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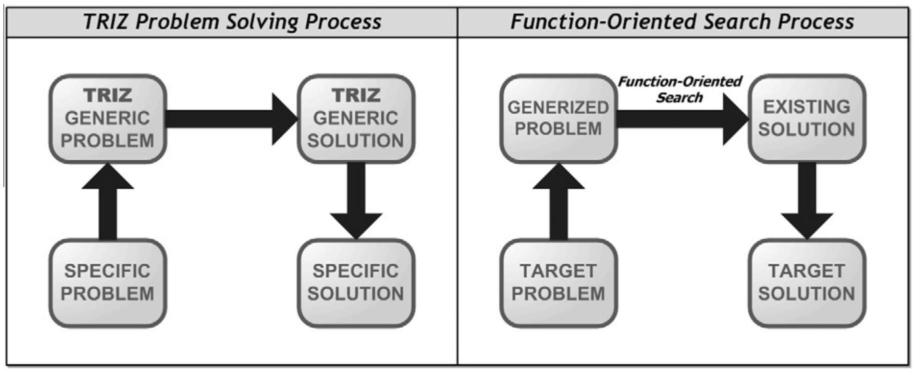

Fig. 1. Comparison of TRIZ and FOS process.

areas of engineering as a solution to the problem. (4) The FTDB should support semantic search. In technology, terms are represented in various formats (synonyms). For example, the terms "solar cell" and "photovoltaic cell" have the same meaning. Because of these kinds of words, users of FTDBs face the semantic confusion problem (Borenstein & Fox, 2003), which limits the effectiveness of FOS.

In this paper, we suggest a fact-oriented ontological approach to Subject–Action–Object (SAO)-based function modeling of patents for implementing FTDB. The proposed approach considers the four major features of FTDBs. For this purpose, we collect technology function information from patent information, SAO structure, and a fact-oriented ontological approach for modeling technology function information. Patent information can be used to satisfy the first and second features of an FTDB. Patent information includes valuable up-to-date technological information and is continuously updated. Patents also include bibliometric information (e.g., International Patent Classification (IPC) code), which can be utilized to search limited information. SAO structure and a fact-oriented ontological approach can be used to satisfy the third and fourth features of an FTDB. Each patent document has specific function information, which can be represented using an SAO structure. An SAO structure is commonly used to represent a function of technology. By modeling SAO structures using a fact-oriented ontological approach, the relationships among technological terms are defined. These relationships can support function generalization and remove the semantic confusion problem. A fact-oriented ontology is represented as similar structure of SAO structure and it is modeled as a simple sentence, which technology experts who have no knowledge of information modeling can use to model technology information.

The proposed approach suggests fact-oriented ontology modeling using SAO structures extracted from patent documents, and implements an FTDB, which is an SAO-based patent retrieval system to support FOS. We also verify the feasibility of the proposed approach by using it to conduct case studies.

The rest of paper is organized as follows. In Section 2, we compare the state of the art of FTDB with proposed framework. In Section 3, we describe the related work of the proposed framework. In Section 4, we suggest detailed description for our framework. In Section 5, we illustrate the proposed framework by conducting case studies of patent retrieval of function information. In Section 6, we present concluding remarks and directions for further study.

2. The state of the art of FTDB

In this section, we describe the state of the art of FTDBs and analyze them with respect to the features mentioned (Table 1). Current work related to FTDBs can be divided into two types: tools for constructing FTDBs, and FTDBs already constructed. Tools of these two types have been developed by companies that use TRIZ – Invention Machine (http://inventionmachine.com) and CREAX (http://www.creax.com).

The first category includes FTDB development tools. Knowledgist 2.5, developed by Invention Machine, supports construction of SAO-based FTDBs to analyze patent databases and technology documents. Knowledgist 2.5 directly supports analysis of patent databases such as that of the US patent and Trademark Office, and users can access the continually updated database and find information in specific areas. However, Knowledgist 2.5 cannot support generalization of retrieved information; it can only handle verb synonyms, and so cannot fully solve semantic problems.

The second category includes FTDB systems currently available. CREAX developed Function DB (http://function.creax.com) and Attribute DB (http://attributes.creax.com). The CREAX FTDB provides a web-based interface so that users can easily access the databases (DBs). Moreover, the DBs support search for well-defined generalization information composed of four generalizations (Solid, Liquid, Gas, and Field). However, the DBs have limitations to their use as FTDBs. First, the DBs are static, so updating information is not provided. Second, the DBs cannot support specific search because they do not consider bibliographic information. Lastly, the amount of information provided by the DBs is absolutely insufficient and the interface to access the DB is inconvenient. Invention Machine developed Goldfire Innovator by adding new features to Knowledgist 2.5. The 'Scientific Effects DB' module in Goldfire provides function-based technology information as well as does the FTDB of CREAX. Compared with the CREAX DB, this module can provide more generalized information, but like the CREAX DB cannot support the specific search. But with new modules, Goldfire can overcome the limitations of the Scientific Effects DB. The patent collection and knowledge base modules enable continual update of function information and allow search for information in specified areas. These two modules support search of patent documents and construction of technology knowledge bases. The main limitation of Goldfire is that it cannot generalize function information. Although Goldfire can handle ontology and synonym information, this feature cannot suggest related generalized terms. For example, if users search the word 'ceramic', Goldfire retrieves only documents that contain 'ceramic'; it does not retrieve documents that include 'brick' which is a specialized type of 'ceramic'. This retrieval makes users have difficulty in finding all documents related to ceramics. In addition, Goldfire can only solve the semantic confusion problem for verbs, not for nouns or noun phrases. If users want to find a document that includes acronyms such as 'PEMFC', Goldfire cannot interpret the acronyms as an original word (in this case, Proton exchange membrane fuel cell), and cannot find documents that include it.

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