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A patent intelligence system for strategic technology planning

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ABSTRACT

Patent intelligence—the transformation of content found in multiple patents into technical, business, and legal insight—is considered a key factor in gaining a competitive advantage in technologically competitive business environments. Although keyword-based patent intelligence tools are widely used due to their simplicity and ease of use, they are limited in that they cannot represent key technological concepts and inventive knowledge by relying only on the frequency of occurrence of defined keywords. As a remedy, this paper proposes a Subject–Action–Object (SAO)-based patent intelligence system. SAO structures that can be extracted from textual patent information are known as the expertise and inventive findings of the relevant patent. On the basis of semantic analysis of patent SAO structures, our proposed intelligence system constructs patent maps and patent networks. Building on the maps and networks, the system provides specific functionalities including identification of technology trends and significant patents, detection of novel technologies, and identification of potential infringement. This paper describes the architecture of our proposed patent intelligence system in detail, and illustrates the system's functionalities using case studies. We anticipate that our proposed system will be incorporated into the technology planning process to assist experts in the formulation of technology strategies.

1. Introduction

In today's competitive business environments, patent intelligence—the transformation of content found in patents into technical, business, and legal insight—is getting much attention as a tool to aid in efforts to secure competitive advantages. Analyzing patents that are representative industrial property provides information about specific conditions in relation to technological or market-related development, which aids decision makers in the tracking of competitors' activities and new innovation trends (Cantrell, 1996). Recently, companies have increasingly been making patent applications in order to protect their inventive knowledge. This increase in the number of patents makes patent intelligence a vital tool for formulating strategic technology planning (Yoon & Kim, 2012b). Patent intelligence tools incorporate a variety of functionalities including technology monitoring, technology assessment, and technology forecasting (Lichtenthaler, 2004). They provide several advantages over qualitative patent analysis done by human experts. These include (1) ability to analyze large amounts of patent data that cannot be analyzed by humans alone, (2) ability to generate much useful information, such as visual relationships between technology and companies (characteristic of statistical analysis technology), which humans cannot produce, (3) ability to support decision making processes by providing relevant information including technology assessment and technology forecasting (Yoon, 2008; Yoon & Kim, 2012b).

Many patent intelligence tools have been developed to support decision-making in technology planning. Overall, they can be classified into two approaches—the bibliographic approach and the content-based approach. The bibliographic approach uses bibliographic patent information including citations, applicants, inventors, and international patent classification (IPC) codes. Although the bibliographic approach is widely used to identify meso- and macro-trends in technologies, companies, and inventors (No & Park, 2010), it cannot identify detailed technological features and significant insights because it mainly relies on bibliographic information, which is considered to be superficial data (Yoon & Park, 2004). In this regard, the content-based approach emphasizes technologically significant patterns, trends, and opportunities by extracting useful information such as abstracts, detailed description of invention and claims from patent text (Tseng, Lin, & Lin, 2007; Yoon, Choi, & Kim, 2011).

Content-based patent intelligence tools are increasingly being proposed by researchers. One representative content-based

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approach method is keyword-based analysis (KWA). Many researchers have developed keyword-based patent intelligence tools to identify trends in high-technology (Yoon & Park, 2004), to discover new technological opportunities from patent vacuums (Lee, Yoon, & Park, 2009), to forecast new technological concepts (Yoon & Park, 2005), and to develop technology roadmaps (Lee, Seol, & Park, 2008; Yoon, Phaal, & Probert, 2008). The keyword-based patent intelligence approach uses occurrence information including frequencies of defined keywords and co-occurrences among the keywords. In general, by exploiting the vector space model (Salton, Wong, & Yang, 1975) used in information retrieval, KWA transforms each patent into a keyword vector, identifies similarities among patents using similarity measures including Cosine similarity and Euclidean distance, and then constructs patent maps and patent networks. Despite its simplicity and ease of use, KWA is limited in that it cannot incorporate key technological concepts such as objectives, uses, and structures of the relevant patent (Cascini, Fantechi, & Spinicci, 2004; Cascini & Zini, 2008; Yoon et al., 2011). Furthermore, several studies have indicated that frequencies and co-occurrences of keywords in patents cannot represent the inventive knowledge and method of relevant patents (Park, Ree, & Kim, 2013; Wanner et al., 2008).

As a remedy, this paper proposes an SAO-based patent intelligence system. SAO structures are the grammatically sequenced sentence of a subject, a verb, and an object that can be extracted by exploiting natural language processing (NLP) of textual patent information (Cascini et al., 2004). Specifically, SAO structures that are obtainable from a patent are considered as being able to provide the expertise, know-how, and significant findings of the patent (Bergmann et al., 2008; Moehrle, Walter, Geritz, & Müller, 2005; Sternitzke & Bergmann, 2009). Building on the semantic similarities of patents' SAO structures, the system constructs patent maps and patent networks that provide several functionalities for patent intelligence. Using the patent maps and patent networks, the system creates significant information to support decision-making for technology planning. In this paper, we describe the architecture of the proposed intelligence system and illustrate the system's functionalities using several practical case studies. We anticipate that the proposed patent intelligence system will be incorporated into the technology planning process to assist experts in the formulation of technology strategies.

The rest of this paper is organized as follows. Section 2 overviews related work while Section 3 describes the architecture and functionalities of the proposed system. In Section 4, the functionalities of the system are illustrated using case studies, and finally, Section 5 concludes the paper by outlining future research topics.

2. Related work

Our proposed patent intelligence system is based on SAO-based patent analysis. Thus, this section lays the groundwork by explaining patent intelligence for technology planning and SAO-based patent analysis.

2.1. Patent intelligence for technology planning

Technology planning—a process that sets the goals of technology development and formulates specific strategies on how to acquire, manage, and exploit technologies—is recognized as the single most important ingredient for achieving the future vision or end-state of organizations (Bettis & Hitt, 1995; Kerr, Mortara, Phaal, & Probert, 2006; Phaal, Farrukh, & Probert, 2004). For successful technology planning, the knowledge and insight of human experts who are conversant with a specific domain play significant roles in various technology related decision-making processes. However, in today's fast changing technology environment, depending solely on them (experts and managers) is insufficient, as they cannot capture every small, but important, signals of technological change. Therefore, the decision-making processes of experts should be supported by a systematic approach that provides valuable technological information gleaned from big technology data.

Accordingly, technology intelligence—an activity that identifies the technological opportunities and threats that can affect an organization's business—has been receiving increasing attention and has come to be regarded as a key component in technology planning (Cooper & Schendel, 1976; Lichtenthaler, 2003; Porter & Detampel, 1995; Utterback, 1996). In particular, Patent intelligence—the transformation of content found in patents into technical, business, and legal insight—is receiving a great deal of attention because patents are the most abundant and well-organized source of technological information. According to many surveys of authorities, patents cover more than 90% of the latest technical information in the world, and 80% of the patent information is not published in any other form (Zha & Chen, 2010). The use of patent intelligence tools, which facilitate the gathering and analysis of patents and provides decisive information for technology planning, has several advantages. They can handle the analysis of massive numbers of patents that would otherwise require considerable labor or may be impossible using human experts only. In addition, they can generate the characteristics of technologies by statistical analysis and visualize technological relationships in the form of patent maps and patent networks (Yoon, 2008; Yoon & Kim, 2012). Patent maps—snapshots of the technology landscape of a technology industry—and patent networks, which show technological relationships among technologies in a technology industry, can provide overall and specific understandings of a given technology domain, and thus they are recognized as crucial outputs from patent intelligence tools that can increase user understandability.

2.2. SAO-based patent analysis

Technological information in a patent is described in textual form in sections such as the title, abstract, summary, detailed description, and claims. In order to mine crucial information from patents, a content-based approach is adopted. Although KWA has been widely adopted due to its simplicity and easy application, it cannot incorporate the key concepts and inventive knowledge of patents. Recently, SAO-based patent analysis has been receiving attention as an alternative that overcomes KWA's limitations.

An SAO structure is composed of Subject (noun phrase), Action (verb phrase), and Object (noun phrase)—a canonical form that represents the main idea in a complex sentence. In the technology field, SAO structures have mainly been used to represent the functionalities of technologies. The Theory of Invention Problem Solving (Russian acronym: TRIZ) adopted an SAO structure to express and analyze functional relationships among components of a technical system. Because a 'function', which can be defined as an action or task that a system is able to perform, can be represented as Action-Object (AO), and a 'tool' or 'method' which makes a function do can be represented as Subject (S) in a technological sentence, the functionalities of technical systems and their components can be clearly expressed using SAO structures. In particular, S and O represent components of a technical system and A specifies a functional relationship between the components (Cascini et al., 2004). For example, a technological sentence such as 'Shock-waves remove small particles' is composed of subject ('shock-waves'), action ('remove'), and object ('small particles'), and 'remove' clearly represents a structural relationship between