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On the development of a technology intelligence tool for identifying technology opportunity

Byungun Yoon *

Department of Industrial & Systems Engineering, School of Engineering, Dongguk University, 3-26 Pil-dong, Chung-gu, Seoul 100-715, Korea

Abstract

Technology intelligence tools have come to be regarded as vital components in planning for technology development and formulating technology strategies. However, most such tools currently focus on providing graphical frameworks and databases to support the process of technology analysis. *Techpioneer*, the proposed tool in this paper, aims to offer decisive information in order to identify technology opportunities. To this end, the system uses textual information from technological document databases and applies morphology analysis to derive promising alternatives and conjoint analysis to evaluate their priority. In addition, the method used in developing a technology dictionary is presented, employing clustering and network analysis. This system also has the ability to communicate with experts in order to estimate the value of existing patents, which is inevitable for the priority-setting of alternatives, construct a morphological matrix and so on. This paper presents the system architecture and functions of this tool and moreover, illustrates the prototype implementation and case study of the same.

Keywords: Morphology analysis; Text mining; Technology intelligence tool; Technology opportunity analysis

1. Introduction

Technology development mostly depends on the creativity of technologists or product designers. Since unprecedented opportunities in developing new technology must be explored by domain experts, their novel, innovative ideas are fundamental for successful technology development (Arai, 2006; Yang & Liu, 2006). Creativity can be defined as the ability to discern new relationships, examine subjects from new perspectives and form new concepts from existing notions (Couger, 1995; Evans, 1990). However, many factors such as cognitive, environmental and personality variables affect the achievement of creativity (Eysenck, 1995). Furthermore, researchers have found that creativity is more dependent on an idea-nurturing environment than an individual genius (Gatignon, Tushman, Smith, & Anderson, 2002). Therefore, creativity-related work needs to be enhanced by a systematic approach which facilitates an idea generation process and provides valuable information.

As a method to improve the performance of technology development with creativity, technology intelligence has been introduced to identify potential alternatives for new technology and reduce the probability of failure in the face of technological discontinuities (Cooper & Schendel, 1976; Utterback & Brown, 1972). This notion includes technology monitoring, technology assessment, technology forecasting and so on (Lichtenthaler, 2004). Technology intelligence has several advantages in comparison with an expert-based approach in technology management. Firstly, it can deal with massive volumes of information which cannot be analyzed by humans alone. The lack of information usage might bear a biased output in technology analysis. Secondly, technology intelligence tools can generate significant amounts of information which humans cannot produce. They can visualize the relationship between technology and companies, and analyze the characteristics of technology with statistical analysis. Finally,

* Tel.: +82 2 2260 8659; fax: +82 2 2269 2212.
E-mail address: postman3@dongguk.edu

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technology intelligence is capable of managing updated information which is created in the internet as well as within companies. Systems which support a decision-making process with technology intelligence can handle real-time data and respond to the requirement of users quickly.

Recently, these systems have been actively developed to assist researchers and practitioners to make strategic technology plans. TRIZ, the Soviet inventive problem-solving system, has been used extensively to resolve conflicts of parameters in products and technology, applying 40 fundamental solutions to perceived problems (Kobayashi, 2006). TRIZ is built on the systematic study of over two million patents by encapsulating the best practices of the world's most successful patents. However, most recent studies in technology intelligence tools tackle the application of data mining techniques to technology management. Diva, a visualization system for exploring document databases, helps to perform bibliometric analysis of scientific literature and patents for technology forecasting (Morrisa, DeYongb, Wua, Salmanb, & Yemenub, 2002). In addition, intelligence systems such as VantagePoint and Aureka can support analysts to discover relationships or trends in technology by providing clustering, mapping, searching techniques and so on (Zhu & Porter, 2002; Trippe, 2003). However, in general, existing tools are no more intelligent as their brand names. Although they can show the trends in technological keywords and the relationship between patents, this information hardly provides the potential for a technology breakthrough. Advanced technology intelligent tools need to identify promising opportunities for new technology development by investigating the detailed characteristics of technology, rather than the historical change of keywords in their documents.

As a remedy, this paper proposes a supporting system that uses text mining and morphology analysis in order to understand the trend in the morphology of technology and excavate potential technology opportunities from documents. *TechPioneer*, as discussed earlier, has a communication function with domain experts, which enables reflecting the expertise knowledge in defining the structure of a technological feature and estimating the value of a patent. Additionally, it can support the process of generating a technology dictionary that consists of groups of technological keywords. Therefore, this tool takes a hybrid approach which is supported by both computational algorithms and experts, providing valuable information such as the trends of keywords, the morphology of existing technology, the structure of technology and promising opportunities of technology development.

This paper is organized as follows. Section 2 reviews the background of technology forecasting based on text mining. Section 3 describes the systemic architecture of *TechPioneer,* and its functions are presented in Section 4. Section 5 explains the prototype implementation and case study. Section 6 discusses the limitations and future research of this paper.

2. Text mining-based technology forecasting

Text mining can be defined as a knowledge discovery process which automatically extracts useful information and analyzes significant patterns from large amounts of textual data (Atkinson, 2002). The ability of this technique to elicit unknown, beneficial information allows itself to be distinguishable from search engines or database management systems. Many researchers have carried out advanced text mining studies, theoretically and practically, which can be classified into four categories. Firstly, text mining can be employed to cluster documents on the basis of their similarity. K-means and hierarchical clustering are used to group textual data (Dhillon & Modha, 2001) and on-line clustering has been suggested in response to requirements for readiness and effectiveness of clustering in an internet era (Cutting, Karger, Pedersen, & Tukey, 1992). Secondly, many studies deal with the subject that classifies documents into a category by a predefined pattern. Various techniques such as a machine learning and k-nearest neighbor (k-NN) technique can be applied for automatic text classification (Cohen & Hirsh, 1998; Sebastiani, 2002). The third category is to study information extraction from texts. This research examines the subject of documents (Clifton, 2004) and summarizes the contents of them in an automatic way (Mani & Maybury, 1999). Finally, various approaches to visualizing the relationship among documents have been presented in order to produce information regarding the linkage among the contents of documents as well as their authors (Rohrer, Ebert, & Sibert, 1998).

The advantage of text mining has recently been acknowledged by technology management. Profiles of research projects are identified by visualizing keywords of documents (Porter, Kongthon, & Lu, 2002) and the trend in technological growth is investigated by tracking the historical change of keywords (Watts & Porter, 1997). However, many researchers have recognized the potential of text mining in technology forecasting. Zhu and Porter (2002) introduce a family of maps that help convey emphases, players and patterns in a technology trajectory through text mining. Yoon and Park (2004) propose a keyword-based morphology analysis to identify the detailed configurations of promising technology. Kostoff, Boylan, and Simons (2004) suggest a systematic approach to exploring disruptive technology that is realistic and operable by taking advantage of text mining literature. Van Raan and van Leeuwen (2002) assess the economic and technological value of research on the basis of keywords and forecast promising research to influence technology landscape.

3. System architecture

3.1. Basic concepts

TechPioneer is a technology intelligence tool that supports the process of technology forecasting by identifying new technology opportunities systematically. Most