Technological Forecasting & Social Change xxx (2013) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Exploring technological opportunities by linking technology and products: Application of morphology analysis and text mining

Byungun Yoon [a,*], Inchae Park [a], Byoung-youl Coh [b]

[a] Dongguk University, Seoul, Republic of Korea
[b] Korea Institute of Science and Technology Information, 66, Hoegi-ro, Dongdaemun-gu, Seoul 130-741, Republic of Korea

ARTICLE INFO

Article history:
Received 3 June 2013
Accepted 8 October 2013
Available online xxxx

Keywords:
Technological opportunity discovery
Morphology analysis
Text mining

ABSTRACT

The technological opportunity discovery (TOD) can be divided into two types: anticipating new technology and applying existing technology. The latter is useful for small and medium companies, which have weak technology forecasting capability. Thus, this research aims to suggest the methodology for the TOD based on existing technology by using morphology analysis and text mining. The extracted results of TOD are classified into three categories based on the types of product — existing, applied, and heterogeneous product. To illustrate the process and validate the utility of application, LED heat dissipation technology and LED lamps are selected as the technology and product for the illustration. The method contributes to suggest a semi-automated normative method for technology forecasting by combining morphology analysis and text mining.

1. Introduction

Exploring technology opportunities is considered as an essential process for companies and governments since the possession of promising technology can provide a core competitive advantage in the future among the competitors. Thus, many developed countries conduct science and technology forecasting through technological and economical scanning periodically and reflect the result of forecasting to the national science and technology policy. Furthermore, many global leading companies perform technology forecasting activities for preoccupancy of their new business driver in the future.

Technological opportunity is defined as a set of possibilities or potential for technological advance or technological progress in general or within a particular field [1,2]. The concept of technological opportunity reflects the possibilities for technological progress in different industries [3]. It indicates that technological opportunities bring innovations in a given field of knowledge and a given industry in terms of time and costs. Technological opportunity also reflects the cost of achieving some normalized unit of technical advance [4].

The research regarding technological opportunity discovery (TOD) is divided into developing methodology, framework, and index. Researches on TOD methodologies presented a modified methodology based on both qualitative analysis like Delphi [5], scouting [6], and morphology analysis [7] and quantitative analysis like bibliometrics and patent analysis [8], which are generally used in technology forecasting. The technology intelligence framework is suggested as a framework for TOD from an information gathering and analysis perspective [9]. Knowledge spread, research duplication between firms, and research scope is defined as indices for measuring the influence of technological opportunity [10]. The effect of technological opportunity on the probability that they would be commercialized through the creation of new firms is examined by technological importance, radicalness, and patent scope [11]. As an example of the ongoing TOD project, foresight and understanding from scientific exposition (FUSE) is suggested by the intelligence advanced research projects activity (IARPA) in the US. The program, initiated in 2011, seeks to develop

* Corresponding author at: Department of Industrial & Systems Engineering, School of Engineering, Dongguk University, 3-26, Pil-dong 3ga, Chung-gu, Seoul 100-715, Republic of Korea. Tel.: +82 2 2260 8659; fax: +82 2 2260 8743.
E-mail address: postman3@dongguk.edu (B. Yoon).

0040-1625/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.techfore.2013.10.013

automated methods that aid in the systematic, continuous, and comprehensive assessment of technical emergence using publicly available information found in published scientific, technical and patent literature. TOD is an activity of searching promising technologies to offer business opportunities in the future. TOD enables to improve technological competitiveness by minimizing trial and error in R&D and preventing duplication of research since TOD offers a global research trend. Therefore, exploring technology opportunity is considered as an essential process for many companies.

Small and medium enterprise (SME) has high innovation competitiveness with flexibility and specialty compared to a large company and generally has high R&D productivity [12]. However, SME conducts innovation through various types of collaboration since SME has a lack of information and resources compared to a large company [13,14]. SME has limitations to conduct technological opportunity discovery activities since TOD requires exploring new technology or promising emerging technology. Therefore, TOD for SME is defined as a searching activity to maximize the effectiveness using limited resources based on existing technology or products in SME. TOD based on the existing technology enables a reduction in the level of risk compared to TOD based on the new technology.

The TOD process need not depend on the knowledge and experience of technology interested parties since companies can create and store rich information as growing the level of information technology rapidly. Therefore, this paper suggests the automated TOD method using existing technology in the company. The technological opportunities based on existing technology are explored in three product areas, which include existing, applied, and heterogeneous products since the technology mainly creates business opportunities through the product.

This research aims to suggest the methodology for TOD by using keyword based morphology analysis, which is considered as an automated normative method. The keywords are extracted from patent documents, which are an ample source of technical and commercial knowledge in terms of technical progress, market trend, and proprietary ownership [15]. The suggested method is expected to be a useful tool for SME, which has a lack of technology forecasting capability, to discover the technological opportunity based on existing technology.

This paper is organized as follows. First, as an introductory statement, the general background of technology opportunity analysis (TOA), text mining, and morphology analysis (MA) is presented. Next, the research framework is presented. In this section, the research concepts, overall process, and types of technological opportunity discovery (TOD) is described. In the next section, development of the TOD model is described with concepts of morphology development, linking grid of morphologies, and the process of TOD. Then, an exemplary case is used to exhibit the process of analysis and to assure the utility of application with LED technology. Finally, implications of current research and issues of future research are discussed.

2. Background

2.1. Technology opportunity analysis

Technology opportunity analysis (TOA) has been under development at Georgia Tech since 1990 and the research aims at systematizing the process that prioritizes R&D investment in the emerging technology areas [16]. TOA performs value-added data analysis, collecting bibliographic and/or patent information and digesting it to a form useful to the research or technology manager, strategic planner, or market analyst. The premise is that useful information on the prospects of particular technological innovations can be extracted from abstracts collected by searching on the given topic in suitable publication, patent, citation, and/or project databases.

The TOA process entails these main steps [17]: (1) Searching and retrieving text information, typically from large abstract databases, (2) Profiling the resulting search set, (3) Extracting latent relationships, (4) Representing relationships graphically, and (5) Interpreting the prospects for successful technological development. Porter and Detampel [16] presented a framework supporting technological opportunity analysis on emerging technologies by combining monitoring with bibliometric analysis. Yoon and Park [7] presented a systematic approach for identifying technology opportunities by using keyword-based morphology analysis. Yoon [18] developed *Techpioneer*, which is a system for identifying technology opportunities, as a technology intelligence tool to offer decisive information.

However, there are some attempts to discover the opportunity between the technology and product. Lee et al. [19] suggested a new technology roadmap (TRM) approach based on keywords, which are effective tools for connecting product and technology planning. OuYang and Weng [20] presented a new approach called New Comprehensive Patent Analysis model (NCPA) which combines the patent family with patent citation analysis in a new product design process. The model is able to construct patent technology performance maps and to discover product niches. It is important to understand product opportunity since technological opportunity is realized through product development. In this research, applicable product opportunity based on existing technology is suggested.

2.2. Text mining

Text mining techniques which are a particular class of data mining aim to perform knowledge discovery from collections of unstructured textual data. Most of text mining tools assume that keywords can be used to label the important content of documents, and thus the operation for knowledge discovery can be executed on the labels of documents [21]. In short, text mining puts a set of labels on each document and discovery operations are performed on the labels. The usual practice is to put labels to words in the document. Then, the document in text format can be featured by keywords that are extracted through the text mining algorithm.

Text mining is widely used in the fields of knowledge management and customer relationship management. Dai et al. [22] proposed MinEdec, a decision-support model that combines two well-known and widely used competitive intelligence analysis methods, the Five Forces analysis and a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis with various text mining technologies. Godbole and Roy [23] deployed a text mining solution in services industry settings, specifically in contact centers (call centers). They

Please cite this article as: B. Yoon, et al., Exploring technological opportunities by linking technology and products: Application of morphology analysis and text mining, Technol. Forecast. Soc. Change (2013), http://dx.doi.org/10.1016/j.techfore.2013.10.013