Development of patent roadmap based on technology roadmap by analyzing patterns of patent development

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ABSTRACT

Recently, patent forecasting and planning has been emphasized as an essential process in the strategic management of technology because well-planned patents will make larger profits and occupy dominant positions first. Thus, this paper aims to suggest the concept and process of a patent roadmap based on a technology roadmap and patterns of patent development. For this, first, ontology of technology is generated to structure the characteristics of technology based on the existing technology roadmap and then patents are collected from a patent database. Second, collected patents are grouped by similarities based on vectors of extracted keywords and grouping results are classified by TEMPEST. In this step, keywords extracted from the previous phase are matched with TEMPEST individually and patent groups are categorized in accordance with high relevance between representative keywords in patent groups and core keywords in each category of TEMPEST. Third, the patterns of patent development are identified for each patent group and categorized by two types – structural and temporal patterns. Consequently, extracted patterns serve as evidence of patent planning, and the patent roadmap is drawn with the technology layer composed of the technology roadmap and the patent layer that each group is mapped on. The proposed approach is illustrated by the case of the transparent AMOLED display. The patent roadmap will enable managers to establish patenting strategies in order to achieve a valuable core patent that has the potential to become a business model, yielding good returns in the long term.

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1. Introduction

A great deal of R&D investments and efforts to pursue innovation by firms and governments have continuously generated new technology and products, which are able to achieve a high profit in a short period of time. Notwithstanding substantial growth in economics and technological performance, there are many questions as to whether or not enormous investments guarantee innovative technology advances due to factors such as limitations of capability and level of support. In particular, radical change has occurred in technological and business environments surrounding the firms, who are having difficulty satisfying customer's diverse needs with both lower price and higher quality. It is also difficult to find the right time for market penetration, since the life cycles of technology and related products are rapidly shortening. Hence, the planning and forecasting activity becomes more and more important in R&D management with the purpose of gaining and maintaining competitive advantage.

After R&D activities are completed, most outcomes, including new technology or products, are generally connected to a patenting process in order to protect a new invention from competitors. Currently, the patent competition is deepening, sometimes resulting in patent wars between global firms. An example of this might be the recent patent wars surrounding smartphone technology (Charlton, 2012; Lloyd et al., 2011). Recently, many firms have realized the importance of acquisition and exploitation of intellectual property as a key enterprise activity. Recently, most departments taking on technology development in research institutes or firms start from planning patents and creating new technology, and technology-driven roadmapping will be effective in these cases. Thus, the importance of patent forecasting and planning should be emphasized as an essential process in the strategic management of technology.

While there is much existing research related to technology forecasting and planning for the future, few studies concerning patent planning have been conducted. For instance, the technology roadmap has to be in the limelight as a tool that leads to effective technology planning by showing milestones of technology development step by step. It has to be generated by brainstorming and environmental scanning at the international level (IEA, 2011, 2012; Kim et al., 2009; U.S. DOE, 2010), or workshop,

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text mining and data mining, QFD, and so on (An et al., 2008; Choi et al., 2013; Lee et al., 2008; Phaal et al., 2007; Yoon et al., 2008a,2008b). Contrary to technology planning, relatively little research has been carried out on patent planning and forecasting. The previous study, which directly employed the concept of a patent roadmap, aimed to identify trends of patent development and devise a response strategy related to patent infringement. For instance, the patent roadmap on Global System for Mobile communication (GSM) was established by the Institute for Information Technology Advancement (IITA) in Korea in order to observe trends of technology concerning GSM as well as investigate a counterplan for patent infringements. However, it was limited to simply patent infringement, and did not cover patent planning or forecasting. In addition, other studies concentrated on analyzing past trends based on patent data and identifying patent-development trajectory (Bigwood, 1997; Choi and Park, 2009; Hsu and Yuan, 2013; Lee et al., 2011b; Mina et al., 2007; Segev and Kantola, 2012; Versparge, 2007; Wartburg et al., 2005; Yoon and Park, 2004).

Therefore, this paper proposes a new roadmap and process – *patent roadmap*, which is a new concept for forecasting patents that should be applied in the near future. Additionally, planning patents in terms of content and development duration in a dynamic time frame will also become necessary. This tool intends to focus especially in analyzing and planning patents to achieve technology planned on the technology roadmap, and it can be constructed at both the government and firm levels. It can provide several candidate fields for research and development to create new technology derived from a pre-developed technology roadmap, which considers market and product. Moreover, the roadmapping process will be suggested using patent analysis and identified patterns of patent development based on the technology roadmap. Although the patent roadmap can be viewed as a concept similar to technology roadmap and patent map, all three approaches have individual distinct characteristics, as shown in Table 1. First of all, one must compare technology patents from the viewpoint of conceptual definition before examining differences between technology roadmap, patent roadmap, and patent map. According to the *Britannica and Oxford Dictionary*, technology is defined as the application of machinery, devices, or scientific knowledge for practical purposes, especially in industry or regarding the change and manipulation of human environment. A patent is a legal right that includes detailed specifications and is exclusively provided to inventors regarding new technical inventions with a possible economic value (Brockhoff, 1991; EPO, 1997–2011;

Granstrand, 1999). In addition to their dictionary definition, the patents include rights and administrative action with respect to new scientific inventions which will be applied as machines or devices. To acquire a patent as a legal right is necessary in the development of new technology to connect new product development to the growing importance of intellectual property. As a result, the patent roadmap concentrates on both patents and technology as a subject of analysis to implement new technology, providing candidates patenting areas that are essentially required to conduct and dominate R&D activities in order to develop new technology. On the other hand, the technology roadmap has a wide range of subjects – technology, product, and market – because it aims to explore and communicate the dynamic linkages between technological resources, objectives of a given firm, and changing environments (Lee et al., 2008). In the case of patent map, the analysis subject is only limited to the patent itself for the purpose of visualizing mass patent information. The other major difference between the three approaches is the time frame, i.e., whether it is dynamic or static. A dynamic time frame can show changeover as times passes, while a static time frame only represents current conditions. Thus, the patent map shows only stationary results at a specific point of time, while the technology roadmap and the patent roadmap have an intention of representing dynamic time frames for the future.

When developing the patent roadmap, utilizing a technology roadmap shows that there is already a consensus about promising technology in terms of using a technology roadmap and patent roadmap, which will be developed to meet the needs and opportunities of the future on an industrial level. At this point, the patent roadmap has two layers, technology and patent. A technology layer is inserted from an already-established technology roadmap; conversely, a patent layer is newly created by analyzing patent information and positioning nodes on patents in the patent layer. The results of analyzing a patent are exposed as the patterns of patent development, determining contents of nodes, links, and application time as well as enabling the planning of a potential patent in the suggested roadmap.

There are many forecasting methods, and they can be divided into two categories – normative forecasting and exploratory forecasting. A normative methodology has its foundation in the methods of systems analysis and begins with future needs, identifying the technological performance requested to meet those needs (Martino, 1993). Notable examples in normative methods are the technology roadmap and relevance tree. Another forecasting methodology, exploratory forecasting, estimates the future

Table 1
Comparison between technology roadmap, patent roadmap, and patent map.

	Technology roadmap	Patent roadmap	Patent map
Definition	A means to link technology and other resources to future products, as well as to business objectives and milestones	A tool for forecasting and planning patents that will need to be applied in the near future to meet the needs	Visualizing patent information by analyzing bibliography of mass patent documents
Purpose	– Forecasting and planning – Exploring and communicating the dynamic linkages between technological resources, organizational objectives and the changing environments	– Forecasting and planning through focusing on technology and patent	– Identifying current status of patent development – Allowing complex patent information to be understood easily and effectively
Time frame	Dynamic	Dynamic	Static
Methodology	Qualitative: workshop with domain experts and TRM experts Quantitative: QFD, AHP, Patent analysis, text mining Bayesian Network	Quite qualitative analysis depending on patent analysis and text mining	Quantitative method – Simple chart, Self-organizing map, Generative Topographic Mapping, Principal Component Analysis
Subjects of analysis	Technology, product, market	Patent and technology	Patent