Identification and Analysis of Converging Technology Based on Patent Co-Classification Relationship

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ABSTRACT

Patent documents are an ample source for technical knowledge, and increased dramatically in recent years. This paper aims at identifying and analyzing converging technology based on patent analysis. The identification method of Converging technology is through cluster analysis based on USPC co-occurrence matrix calculated by the cross USPC class patents of five parties during the 2005-2015 years. Finally, 161 converging technologies are identified. Converging technology is mainly distributed in the new generation of information technology, new material industry. High end equipment manufacturing industry is the most active industry in technological convergence.¹

KEYWORDS

Patent data mining, Converging Technology, Co-Classification Analysis, Technical activity

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1 INTRODUCTION

Converging technology is the product of technological convergence. The identification and analysis of converging technology has positive effects on recognizing the trend of technological convergence and guiding the research direction and industrial distribution. Accordingly, there are many research papers on technological convergence. Since the concept of technological convergence was first proposed in Rosenberg's research on the evolution of the US Machine Tool Industry[1], many authors have tried to develop similar conceptions of convergence and put forward various analysis method.

Patent documents are an ample source for technical knowledge, and increase dramatically in recent years. In particular, patents have been employed for the technology driven convergence. A representative example is the paper of Geum et al.[2] which takes a

quantitative approach by citation analysis and co-classification analysis to analyze the technological convergence of information technology (IT) and biotechnology(BT).

With the rapid development of the Internet, AI and robotics in recent years, the trend of technological convergence is more and more obvious. Under such an environment, what is the new converging technology? Which industries are they distributed in?

This paper aims at identifying and analyzing converging technology based on patent analysis. Research method is co-classification analysis because citation analysis has the problem of time lag. A patent classification was arranged by the examiners of a patent office according to the technical features of inventions. Since the same document may be classified in several classes, the co-classification information can be used to identify the relationships between technologies. The relevant method was later applied in a science and technology context [3]. Based on this, we assume that technologies with a high degree of co-classification are converging technologies.

2 DATASET AND METHODS

Figure 1 shows the specific process, like the following:

s1. Download 79986 quintuple patent families during the 2005-2015 years from Incopat database. Quintuple patent family means patent in family granted in China and the US, and applied in Europe, Japan and South Korea.

s2. Select the cross USPC class patents, and the number is 36880.

s3. Calculate the USPC co-occurrence matrix based on the co-occurrence relationship of USPC, and the dimension is 13512.

s4. Cluster based on the USPC co-occurrence matrix by the hierarchical clustering, and obtained 161 clusters, that is, 161 converging technologies.

s5. Interpret the converging technology and establish the mapping relationship between converging technology and strategic emerging industries and sub-industries through domain experts. The list of strategic emerging industries was released by the National Development and Reform Commission, including seven industries and related sub-industries.

s6. Draw converging technical structure map based on industrial relation of converging technology.

s7. Analyze the technical activity(TA) of converging technologies. Equation 1 is the calculation of TA. Y_n is the latest patent application year in converging technology. Y_m is the most patent application year in converging technology.

$$TA = \frac{(2015 - Y_n)}{(2015 - Y_m)} \quad (1)$$

Figure 1: Process of the study

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3 RESULTS

Figure 2 shows the distribution of industries of converging technologies. Here are seven strategic emerging industries and one "other traditional industries" that refers to converging technologies that don't belong to the strategic emerging industries.

Figure 3 shows converging technical structure map of 161 converging technologies. Each circle represents a converging technology. The size of a circle represents the number of the quintuple patent families in the converging technologies. The color of the circle represents the industrial classification of the converging technology. The line between circles indicates that two converging technologies belong to a certain emerging sub-industry. The thickness of the lines is proportional to the number of same emerging sub-industries between two converging technology. The lines between circle of different colors represent that converging technology is cross-industry.

Figure 4 shows distribution of the average TA of industries. The smaller TA value, the more active.

Figure 2: Distribution of industries of converging technologies

Table 1 lists 4 cross-industry and $TA \geq 4$ cross-industry converging technologies. The column named as "Description of Technology" shows technology interpretation. The column named as "Associated Industries" shows several industries that converging technology can be used.

Converging Tech No	Description of Technology	Associated Industries
No.65	Related manufacturing methods and process engineering of liquid crystal, light emitting diode and other display devices, semiconductor light emitting devices and so on.	Energy saving and environmental protection industry, New generation of information technology industry
No.97	The preparation of the whole carbon family and its composite materials and its application in the fields of photoelectric and heat.	New material industry, New energy industry, Energy saving and environmental protection industry
No.115	Manufacturing methods and technology of solar cell; Related manufacturing methods and technology of other photoelectric conversion elements such as solid state image sensor.	New generation of information technology industry, New energy industry
No.154	Robotics, such as control systems, visual and voice systems and so on; Power and control technology of electric vehicle/hybrid vehicle;	High end equipment manufacturing industry, New energy vehicle industry

Table 1: Cross-industry and $TA \geq 4$ converging technologies (For lack of space, only show part of the result)

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- [1] Rosenberg N. Technological Change in the Machine Tool Industry, 1840-1910[J]. Journal of Economic History, 1963, 23(4):414-443.
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- [3] Tijssen R J W. A quantitative assessment of interdisciplinary structures in science and technology: Co-classification analysis of energy research [J]. Research Policy, 1992, 21(1):27-44

Figure 3: Converging technical structure map

Figure 4: Distribution of the average TA value of industries

4 CONCLUSIONS

In this paper, 161 converging technologies are identified. Most of the converging technologies are converging in the same industry. The new generation of information technology, new material industry and biological industry are the top 3 industries of converging technologies. High end equipment manufacturing industry is the most active industry