Study on Early Warning of Competitive Technical Intelligence Based on the Patent Map

Zha Xianjin
Center for Studies of Information Resources, Wuhan University, Wuhan, China
Email: xianjinzha@163.com

Chen Minghong
Center for Studies of Information Resources, Wuhan University, Wuhan, China
Email: chenmh629@yahoo.com.cn

***Abstract*—The patent documentation has a higher technical value than the general scientific documents. Through analyzing the content of technical intelligence of patent documentation, enterprises may find out some effective solutions, having access to new ideas about Research and Development (R&D) and avoiding existing patent landmines at the same time. In this paper, with the help of database Derwent Innovations Index (DII) and the corresponding software-Thomson Data Analyzer(TDA), a series of patent maps of Web2.0 technologies were built up through basic statistical analysis, trend analysis and correlation analysis. These patent maps could offer important reference value for the R&D activities of enterprises.**

***Index Terms*—patent map, technical patent map (Technical PM), competitive technical intelligence (CTI), technical early warning, Web2.0**

I. INTRODUCTION

Patent documentation(abbreviated to "patent"), which covers more than 90% latest technical information of the world, could provide technical information more early 5-6 years. Compared to the general publications, it is informative and accurate[1]. According to many surveys of authorities, 80% of the patent information would not be published in other forms (Papers, conferences, etc.).Thus patent is the most valuable source of technical information, and the number of patents can objectively reflect the technical strength of the enterprise. Many multinational companies agree with the theory that the patent contains important technical intelligence, which is regarded as the most important resource of technical progress and industrial development[2]. Meanwhile, many scholars began to research some theories and methods of patent analysis. For example, stating patent systems[3], characteristics of the patent[4], its sources and access methods, and proposing many different Research and Development (R&D) indicators to assess the company's R&D policies of different countries by comparing the situation of patent application[5].

It is a fact that patent contains a plenty of competitive technical intelligence and that patent statistics is unmatched in the following aspects, the data quality, the availability, industry analysis and the technical details. However, patent information contained so many obscure technical and professional terms that non-professional staff is very difficult to extract valid conclusions directly from the raw patent data. And patent maps could uncover the relationship between economic growth and technological progress well[6], could predict the new technology by using technology road map and could uncover the technical development. In particular, the conclusion of co-occurrence analysis could supply R&D strategies for the decision- makers[7].

However, current patent maps had certain shortcomings, for example, they could not represent the overall relevance of technical patent or they were confined to a limited scope and quantity of the patent. At present, it has not yet been devoted to analyzing patent information from the perspective of early warning capabilities of technology deeply and systematically. In this paper, which was related to Web2.0 technologies and applications, we regarded Derwent Innovations Index (DII) as a search database, and then analyzed and summarized the capabilities of technical early warning and relevant problems systematically from the perspective of technical competitiveness. And the main steps are as follows: firstly, we target Web2.0 technologies interested in. And referring relevant documents and consulting the experts, we select keywords to search related patent documents. After that, we redefine a list of keywords for further analysis. And now with a set of patent documents and a list of keywords, we preprocess, clean and analyze the raw data sequentially so as to build up some technical patent maps macroscopically and microscopically.

II. RELATED WORK

A. Patented Technology and Competitive Technical Intelligence

As we all know, technology is a main parameter related to the dominant market competition and Competitive Technical Intelligence (CTI) is of high value[8]. Cohurn thought CTI was a analysis process of changing technical data of competitors into valuable strategic and technical knowledge about the competitor's market position, R&D priorities and the trend of the development; Ashton etc. proposed that CTI referred to the information of external scientific and technological

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threats, opportunities or development and to the all process of search, analysis, use and evaluation of the information which has a underlying effect on organizations' competitive position[9]; Lichtenthaler pointed out that CTI was an important part of competitors' information and that CTI provided strategic decision support for enterprises[10]. In fact, the patent specification recorded some important information about the condition of patent technologies, along with their problems and solutions. Through a series of analysis process, enterprises could extract effective CTI, which could help enterprises understand the condition and trends of technological developments, grasp the cutting- edge of technology in order to avoid the risk of R&D and recognize external threats and opportunities timely and further to give off an early warning about technological threat. These activities provide support for technological innovation macroscopically and microscopically [11].

B. Technical Patent Map

As an important patent map, technical PM is an effective tool for CTI analysis[12]. It is aimed at analyzing the technical trend and the concentration of specific domain. Usually, technical PM are some charts, tables and graphs, which offer simple and intuitive ways to deal with complex technical information for the purpose of uncovering technology diffusion, fixing direction of technology development and discovering mainstreams of R&D. Hence, technical PM is able to uncover specific technology trend according to the quantity and quality of patent, so as to provide early warning information according to competitors' situation of input-output for patents, and to analyze technological gap for avoiding falling into the patent trap of competitors and setting up patent barriers to competitors. On the basis of these awareness, the Japan Patent Office has been producing and providing more than 50 types of expressions and more than 200 maps for several technology fields since 1997[13]. In addition, many other countries such as Korea[14], Italy[15] [16] and the USA[17] also provide many kinds of patent maps. Currently, most patent analysis use patent citations to represent the meaningful relationship in patent information. But it is known that patent citation analysis has some serious drawbacks. Our approach contributes to establishing patent maps from several different perspectives. We expect to keep the balance of micro and macro analysis.

C. Early Warning of the Patent Technology

Early warning activities could send out an alarm to R&D activities as well as decision-makers timely by discovering the sign or the symptom which shows that enterprises may lose technical competitiveness in advance, if they made the best of patent intelligence. Generally speaking, the function of early warning mainly represents in the following aspects:

- Forecasting the development trends and conditions of specific industries and related technologies.
- Making sure the life cycle of products or technologies.
- Discovering a new branch of technology and the direction of technical applications.
- Having an insight into market interstices of technologies and selecting target markets effectively.
- Analyzing competitors' strategic purpose, technical characteristics, and implementation.
- Finding technical partners and guiding technology trades.
- Enhancing the ability of technical screening and technological innovation.
- Shortening the development cycle, cutting R&D costs and increasing the efficiency of innovation.

III. METHODOLOGY

A. Targeting a Domain Technology

Our approach begins by targeting a domain technology which analyzers are interested in. And then initial keywords needs to be collected from experts to search related patent documents. After searching patent documents, we collect keywords from patent documents. And then, they are merged with the initial keywords. Meanwhile, we should choose appropriate search database according to the necessity and feasibility of study[18]. Owning to Derwent Innovations Index (DII), combined by World Patent Index and Patent Citation Index[19], includes comprehensive content and overcome the difficulties encountered in the process of patent search. And it is suitable to regard DII as the search database.

B. Patent Search

The general process of patent retrieval is shown in Figure 1:

- Refining the subject.
- Forming keywords list.
- Establishing query formulation.
- Improving the search strategy.
- Obtaining a satisfactory patents.

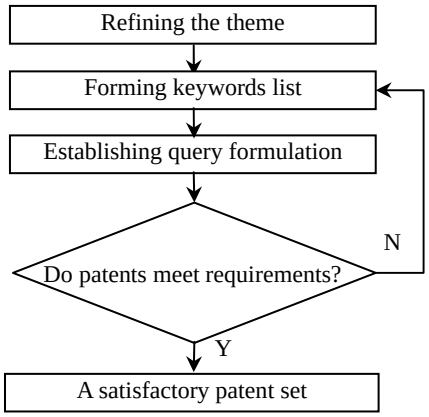

Figure1 The steps of patent search

C. Patent Analysis

The patent documents received in the last step are so chaotic that we can not extract useful information[20]. Usually, we need to extract important information with the help of specialized analysis tools. At present, there are many ready-to-use tools, such as the Thomson Data Analyzer(TDA), Delphion, Aurek, Anaqua, Aurigin, Focust, IP Software, IP Drafting Software, IP Filing Software, IP Management Software, IP Miscellaneous

Software and so on[21], which almost have the function of analysis and statistics. And in this paper, we are interested in TDA and view it as the analysis tool for its outstanding advantages.

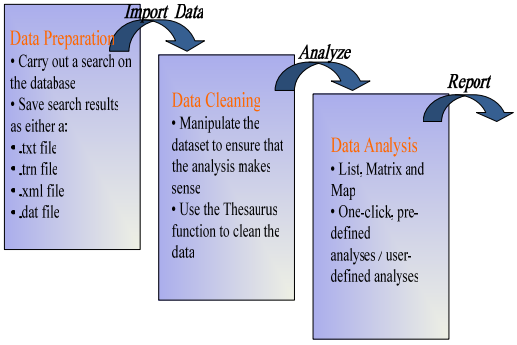

Figure 2 TDA's workflow

TDA's workflow is showed as Figure 2, and it includes 3 steps: firstly, it saves search results as .txt, .trn, .xml and. dat file; secondly, use thesaurus function to clean the search data, which is often incomplete, inconsistent and non- standard due to different indexing rules; thirdly, TDA could carry out one-click, pre-defined analyses or user-defined analyses by virtue of basic statistics, text mining and cluster analysis, showing the results in various forms of lists, matrixes and maps.

D. Forming patent maps

Although the charts and graphs are technical PM, it may not meet our requirements. And we need to deal with them further. In the perspective of patents, only these patent assignees who has a counterweight to others, could regarded as competitors. Therefore, we may set up undergroups to build various technical PM, which included different competitors.

IV. APPLICATION TO PATENT ANALYSIS OF WEB2.0

Web 2.0, a new concept of the Internet, is received widespread attention from enterprises and the academia in recent years. In this paper, we studied the technologies and related applications of web2.0. Correspondingly, the following 13 keywords: Information Message, RSS, Wiki, Blog, Trackback, Tag, Podcast, Ajax, Open API, SNS, Social Bookmark, Webservice, P2P as search words. Having searched in the DII, 20,358 patents were gotten.

Furthermore, the early warning capability of patent technologies represent at the macro and micro level. And the former involves the quantity and quality of patents of a country or region; the latter is related to the situation of the patent application of the specific technology or organization. Hence, we mainly research patent documents searched before from the following aspects: basic statistical analysis is to uncover the overall development of Web2.0 technologies, such as national patent trends and hot spots distribution, and further to infer the prospects of Web2.0 technologies and to lay foundation for investment decision-making of enterprises; trend analysis of patent assignees and patent technologies is not only to recognize primary competitors but to forecast the trend of cutting edge of technologies; correlation analysis of competitors is to discover inter-relationship in technological competition.

A. Basic statistical analysis

Figure 3 is a graph of patent trends since 1968. It shows the R&D trend of Web2.0. Before 2000 when the Internet is at the "Web1.0", it developed relatively slowly, which result in the recession of R&D of Web2.0. And after the 21st century, especially after that the Internet bubble was burst there was a peak period of licensing Web2.0 technologies, which is represented as a sharp curve of rise. And in 2005, patent number is up to 3420, which is closely related to the fact that the concept of Web2.0 was just formally put forward in the brainstorming session between O'Reilly and MediaLive. Followed by two years, there is a rapid growth until new technologies and financial crisis had a negative impact on web, resulting in a significant decline in 2008.

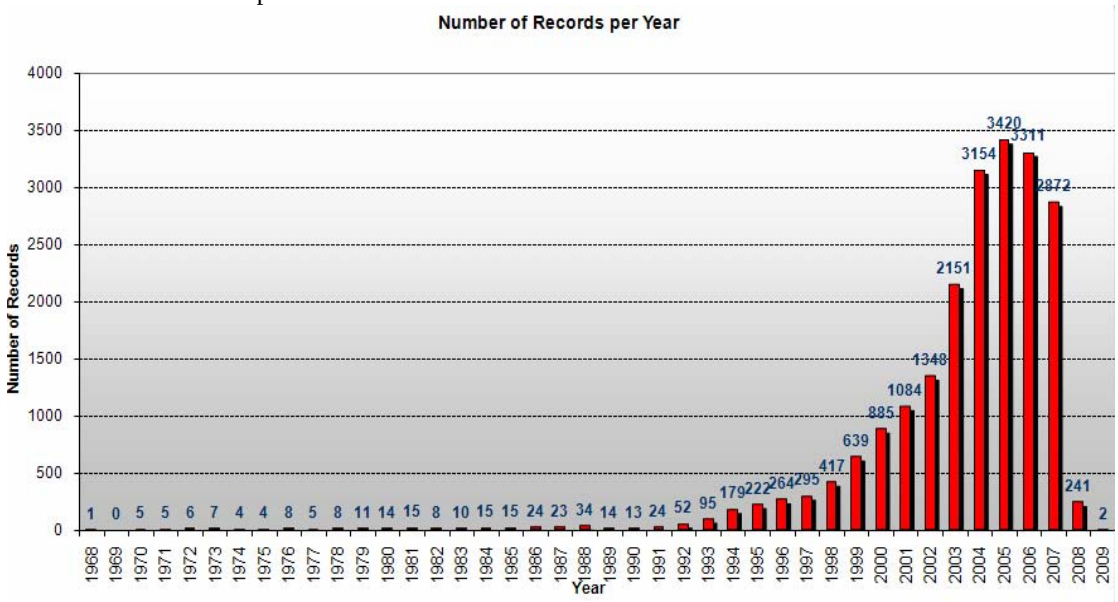

Figure 3 Patent trends graph

Figure 4 shows that Japan (JP) whose total and average amount of patents was the first, is powerful in Web2.0 technologies, followed by the United States (US) and South Korea (KR), and China ranked the fourth. Clearly, the number of patents of China is far less than those of Japan, the United States and South Korea. It indicates that if Chinese enterprises want to explore the international markets, they would strengthen relevant researches. And these excellent enterprises of the three countries could be regarded as a benchmarking for study. At the same time, it is also necessary to enhance the awareness of patent application and protection for more international markets.

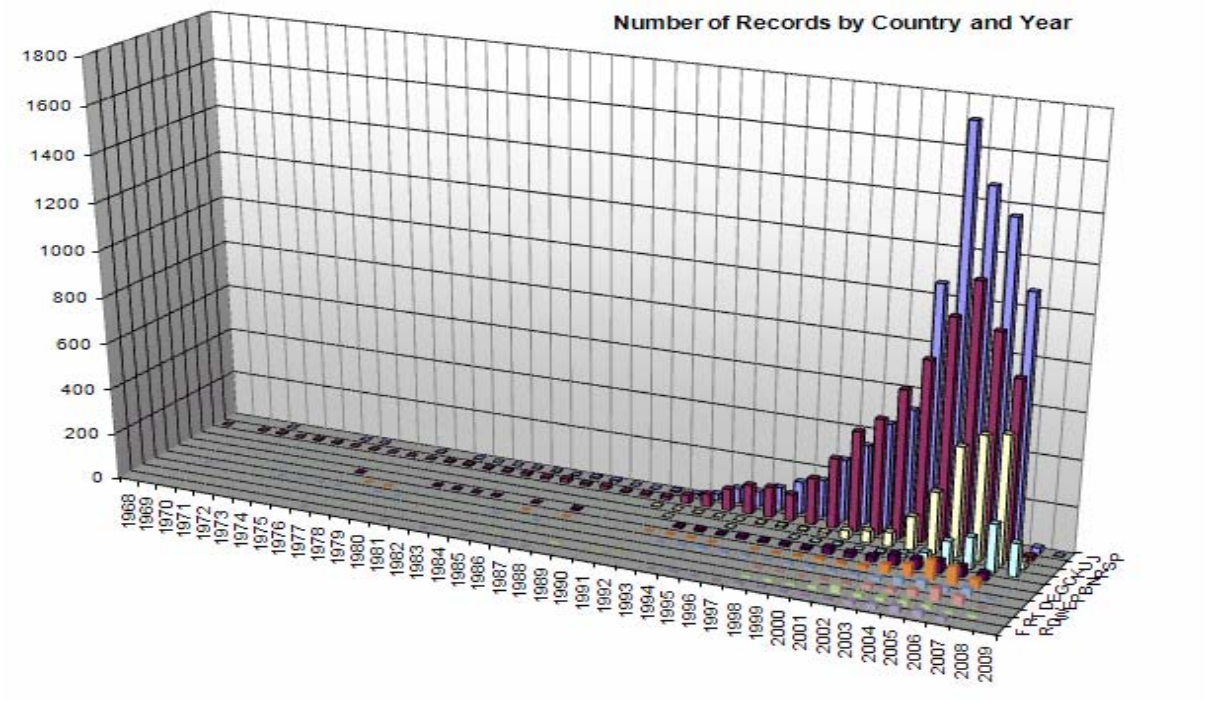

Figure 4 National patent trends graph

It is showed as Figure 5 that the top 10 categories, which cover Web2.0 technologies, are G06F, G06K, G08B, H04B, H04L, G06Q, HO4Q, B42D, H04N and H01Q. In addition, G06 and G06K occupy the vast majority. It can not be denied that Web2.0 technologies involve a number of major categories, and its technological development is not confined to a large category. Therefore, enterprises should pay close attention to patent changes of several major categories.

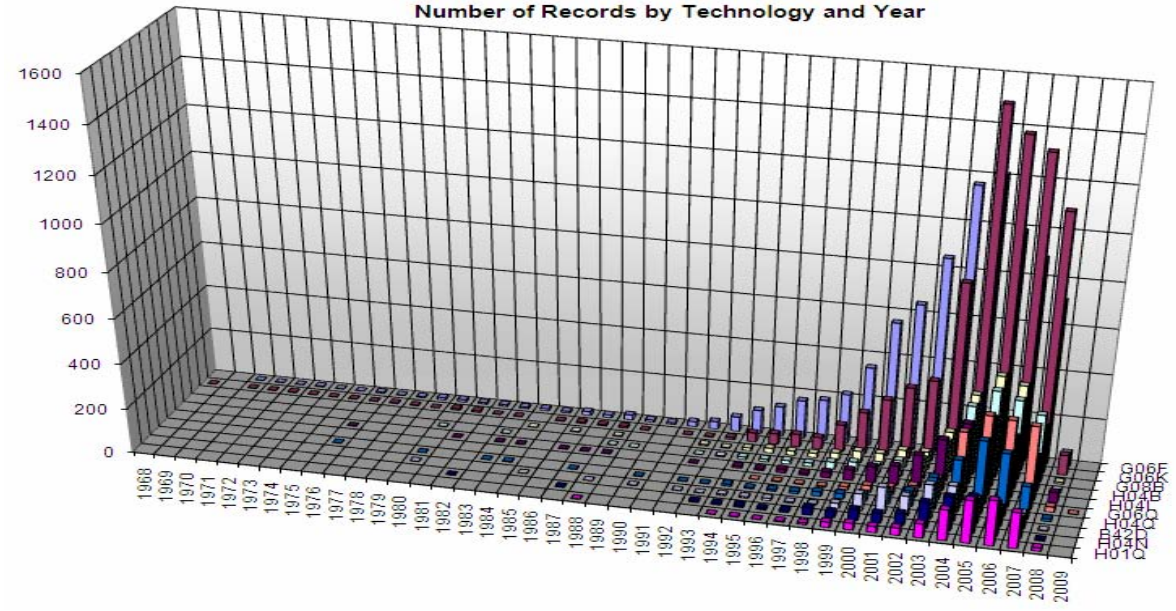

Figure 5 The distribution of technology hot spots

B. Trend Analysis

It mainly analyzes patent assignees and technologies. Figure 6 is a part of the chart of trend analysis of patent assignees. By uncovering the top organizations, the

organizations no longer published and their patents in last 3 years, we may explore competitors' activities of patent application and further to compare their technical competitiveness. Besides, the middle column represents the organizations first published in last 3 years. It is easy to found that some Chinese universities and companies begin to apply for patents of Web2.0, for example, Zhejiang University, Beijing University and China Mobile Communication Group Corp etc. In other words, Web2.0 technologies are developing very quickly in China and Chinese people began to attach importance to the relevant patents.

Organization Trends in Last 3 Years

Last 3 Years is: 2009 - 2007

Top Organizations in Last 3 Years	Organizations First Published in Last 3 Years	Organizations No Longer Published in Last 3 Years
BROTHER KOGYO KK [86]	EMW ANTENNA CO LTD [13]	SUN MICROSYSTEMS INC [98]
DAINIPPON PRINTING CO LTD [85]	UNIV ZHEJIANG [10]	TOPPAN MOORE KK [54]
INT BUSINESS MACHINES CORP [72]	UNIV KOREA IND&ACADEMIC COLLABORATION [9]	DANIELL W T [45]
HITACHI LTD [70]	UNIV BEIJING POSTS&TELECOM [8]	NORTEL NETWORKS LTD [38]
FUJITSU LTD [66]	SATO CHISHIKI ZAISAN KENKYUSHO KK [7]	TOYOMARU SANGYO KK [34]
MICROSOFT CORP [51]	SHANGHAI KESHITONG INFORMATION TECHNOLOG [6]	AMERICA ONLINE INC [32]
SAMSUNG ELECTRONICS CO LTD [37]	NARU TECHNOLOGY CO LTD [6]	NTN CORP [32]
SK TELECOM CO LTD [33]	SHENZHEN YUANWANGGU INFORMATION TECHNOLO [5]	LUCENT TECHNOLOGIES INC [31]
TOKYO ELECTRIC CO LTD [30]	KARAOGUZ J [5]	AT & T CORP [28]
FUJI XEROX CO LTD [25]	BUER M [5]	MALIK D W [25]
NEC CORP [25]	WALLEY J [5]	DAIGLE B K [25]
ELECTRONICS & TELECOM RES INST [22]	MACINNIS A G [5]	HITACHI MAXELL KK [23]
YAHOO INC [20]	CHENGDU WUHOU PATENT CONSULTATION DEV [5]	NIPPON ELECTRIC CO [22]
TOSHIBA KK [19]	BEHZAD A [5]	SENTAN JOHO KOGAKU KENKYUSHO KK [21]
MATSUSHITA DENKI SANGYO KK [19]	BITCORN KENKYUSHO KK [5]	FRIEDMAN L G [21]
UNIV YONSEI IND ACADEMIC COOP FOUND [18]	QUIGLEY T [5]	ALCATEL [20]
MITSUBISHI ELECTRIC CORP [18]	HYEOK S K [5]	DAVIS J A [19]
HUAWEI TECHNOLOGIES CO LTD [18]	SAMBO CORRUGATED BOARD CO LTD [4]	SAXA INC [19]
OMRON KK [17]	INT SEMICONDUCTOR TECHNOLOGY LTD [4]	FUJITSU SUPPORT & SERVICE KK [19]
TOKIN CORP [16]	AWAREPOINT CORP [4]	COMPUTER ASSOC THINK INC [19]
RICOH KK [16]	SUK G Y [4]	TAMURA ELECTRIC WORKS LTD [18]
DENSO WAVE KK [15]	UNIV BEIJING [4]	KENT L G [18]
SYMBOL TECHNOLOGIES INC [15]	LAUREL SEIKI KK [4]	KONICA MINOLTA MG KK [18]
NIPPON TELEGRAPH & TELEPHONE CORP [15]	CHINA MOBILE COMMUNICATION GROUP CORP [4]	INAX KK [17]
3M INNOVATIVE PROPERTIES CO [15]	CODMAN&SHURTLEFF INC [4]	DIGITAL EQUIP CORP [17]
TOPPAN FORMS CO LTD [14]	OKUMURA YUKI KK [4]	KONICA MINOLTA PHOTO IMAGING KK [17]
MICRON TECHNOLOGY INC [14]	DONGMIN DATA SYSTEM CO LTD [3]	YOKOGAWA DENKI KK [17]
TOSHIBA TEC KK [13]	TAIWAN LAMINATION IND INC [3]	EASTMAN KODAK CO [16]
EMW ANTENNA CO LTD [13]	E3NET CO LTD [3]	NISHIDA N [16]
LG ELECTRONICS INC [13]	UNIV XIAMEN [3]	ALIEN TECHNOLOGY CORP [16]
LG INNOTEK CO LTD [13]	ENZERU SHOJI KK [3]	PANTECH CO LTD [16]
ANONYMOUS [12]	ANGEL CO LTD [3]	PYO C [16]

Figure 6 Trend analysis of patent assignees

Figure 7 is a part of the trend analysis of Web2.0 technologies. By looking into the changes of the terms first used, terms no longer published and unexpectedly high/low terms in last 3 years, we could find out the development of patent technologies. It is showed as figure 7 that new categories and increased patents are not more, while the reduction is far more than the increase. That is to say, the total number and coverage of patents and is reducing, which is consistent with the conclusion of Figure 3, namely, new technologies and financial crisis had a negative impact on web in last 3 years.

Technology Trends in Last 3 Years

Last 3 Years is: 2009 - 2007

Terms First Used in Last 3 Years	Terms No Longer Published in Last 3 Years	Unexpectedly high/low terms
C01G [2]	G06G [28]	G06F [-1]
E05G [2]	C12M [15]	G08B [-1]
F16J [1]	H02H [14]	H04L [-1]
B25G [1]	A47J [13]	H01Q [1]
B24C [1]	G03C [11]	H04Q [-1]
B82B [1]	A23L [10]	H04N [-1]
C06B [1]	B41C [10]	B42D [-1]
B26B [1]	A47L [9]	B41J [-1]
A63C [1]	G03D [8]	B65G [-1]
A45B [1]	A01H [8]	H04M [-1]
G05G [1]	D06H [8]	H04W [1]
E02B [1]	B41N [8]	G03G [-1]
E02F [1]	G04C [7]	G11B [-1]
B01F [1]	H04R [7]	G06T [-1]
E04D [1]	B01D [7]	G07F [-1]
F02P [1]	F04B [7]	G09G [-1]
B27M [1]	B60T [6]	B61L [.999]
E21F [1]	H03L [6]	G11C [-.999]
F02D [1]	B64D [6]	G03B [-.998]
	B29L [6]	H05K [.997]
	E04H [6]	A61J [-.997]
	B21C [5]	G07G [-.996]
	G01T [5]	A01K [.988]
	G04B [5]	B31F [.987]
	G21K [5]	G06G [-.985]
	G03H [5]	H04J [-.983]

Figure 7 Technology trends analysis

C. Correlation analysis

Correlation analysis is aimed at competitors. In the perspective of patents, we transform to analyze patent assignees who have the same number of patents. Figure 8 shows that the top 10 patent assignees of Web2.0 are as follows: INT BUSINESS MACHINES CORP, DAINIPPON PRINTING CO LTD, HITAACHIL LTD, FUJITSU LTD, MICROSOFT CORP, MATSUSHITA DENKI SANGYO KK, BROTHER KOGYO KK, NEC CORP, TOKYO ELECTRIC CO LTD, IBM CORP. Comparing with Figure 6, we can see that although INT BUSINESS MACHINES CORP, whose total amount of patent is most, is the third in last 3 years. This indicates that Internet technology develops extraordinarily rapidly once again and that network companies should track cutting-edge of Internet technologies in order to maintain their competitive position.

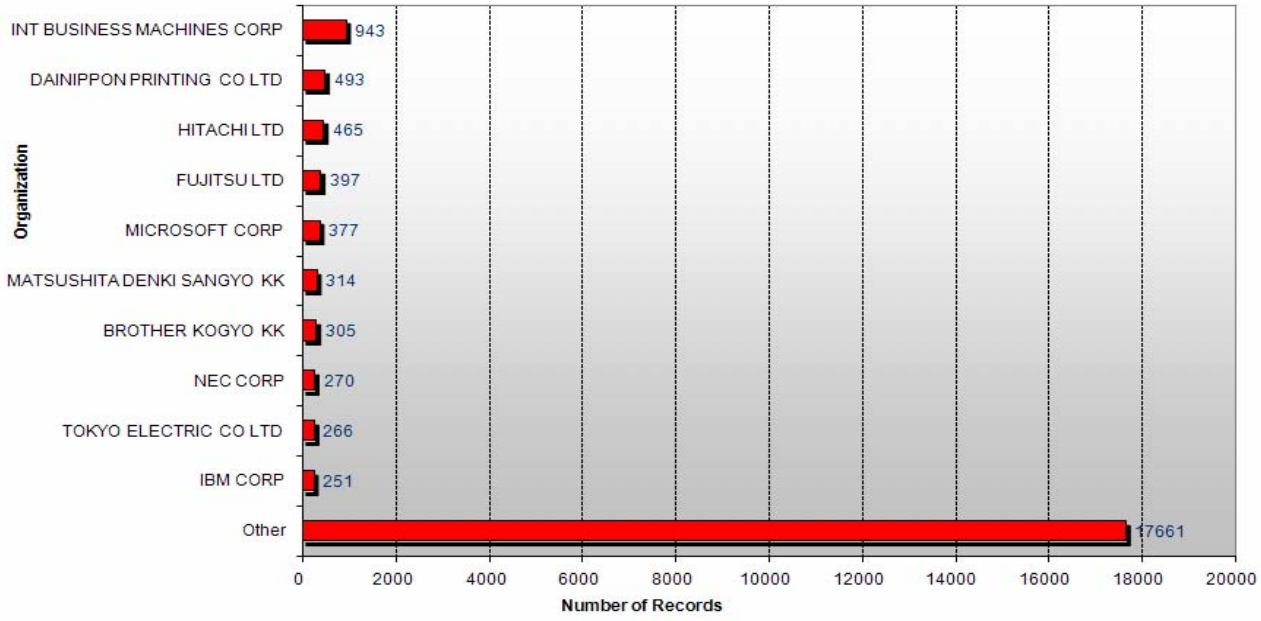

Figure 8 Distribution of the patent assignees

Figure 9 is a cross-correlation map of the top 10 corporation based on IPC clustering. It shows that NEC is in an isolated position, which indicates that the correlation of NEC and other companies is weak or that NEC has unique patent system. At the same time, correlation coefficient of INT and IBM is more than 0.75, that is, they have strong correlation. It means that the two corporations may be long-term partners or competitors that act as a counterweight to the others. Hence, above corporations need to pay attention to each other's situation of patent application. However, the remaining are more or less related, their technical trends are not necessary to be concerned too much for their less correlation coefficients.

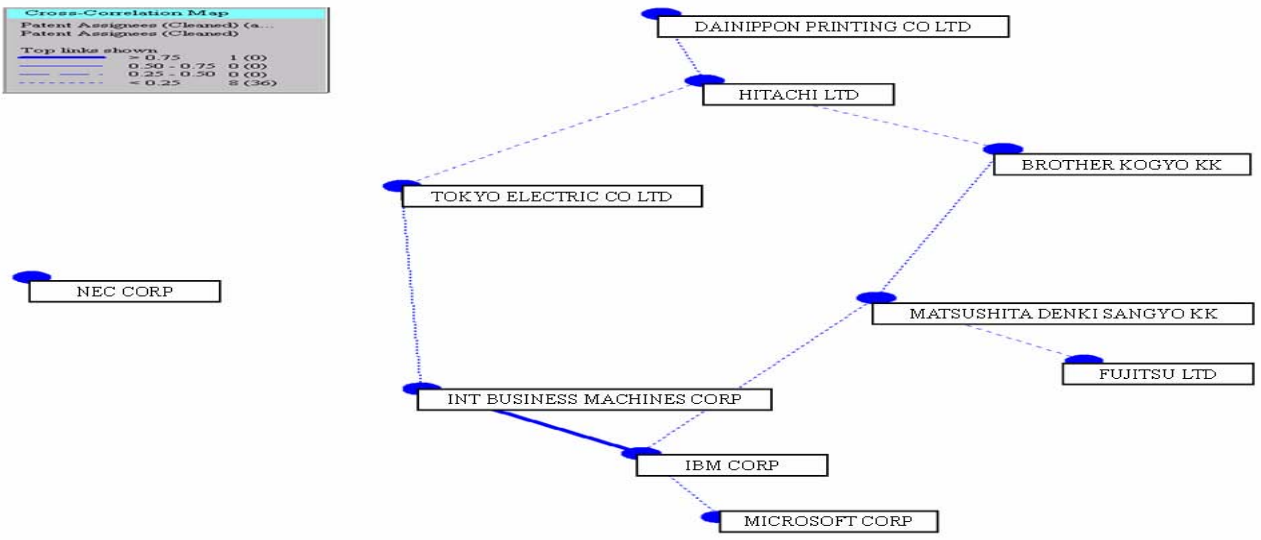

Figure 9 Cross-correlation map

Figure 10 is an auto-correlation map that depicts the degree of the strength of enterprise cooperation. Among the top 10 corporation, the auto-correlation of INT BUSINESS MACHINES CORP and IBM CORP is strongest, which indicates that they cooperated to apply a number of patents. Clearly, DAINIPPON PRINTING CO LTD and HITAACHIL LTD have the same patents while the others cooperate a little. The main reason is that Web2.0 technologies cover a wide range, and these corporations, which have more patents, have difficulty to each other at a high frequency.

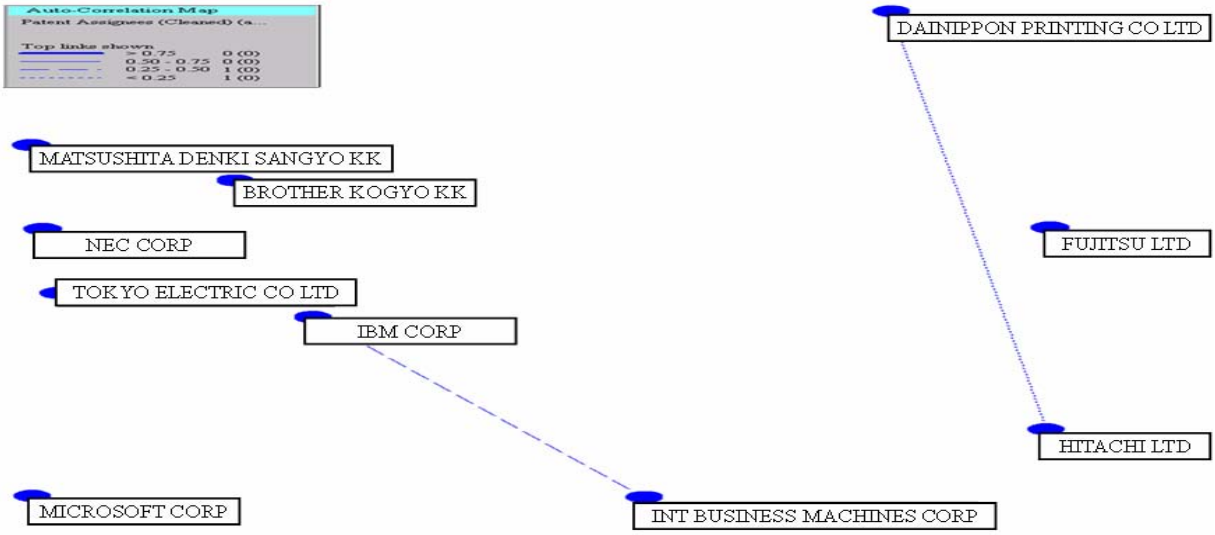

Figure 10 Auto-correlation map

V. CONCLUSION AND FORESIGHT

In this paper, we researched the patents of Web2.0 technologies and applications with DII and TDA. Taking advantages of the methods of information analysis, we analyzed the changes and condition of specific patent application particularly and deeply from both the macro and micro level. Moreover, basic statistical analysis is aimed at patent trends, national patent trend, and the distribution of technology hot spots; trend analysis points at changes of patent assignees and technical trends; and the purpose of correlation analysis is to analyze coefficients of correlation and auto-correlation of the top 10 corporations and further to uncover their strategies of patent application. The above research can help the enterprises in this field inspire R&D ideas, guide the layout of patent, analyze future technical trends, discover the technological gap, and recognize major competitors, its technical composition and the strategies of patent applications in order to enhance early warning capabilities, to avoid falling into the trap of patents and to set up patent barriers to competitors. However, there are some drawbacks in this paper. It is quite necessary to broaden the width of the research and to deepen the depth of analysis to supply decision-makers with higher reference value.

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Zha Xianjin was born in Huangshan, China, in 1967.He got his Doctor Degree of information science from school of information management, Wuhan University in 2001.
He is a professor and doctoral advisor of Wuhan University. He has published some books and articles such as "information resources allocation & sharing" (Wuhan University Press,2008). His research interests are competitive intelligence, information analysis.
Professor Zha has received a program for New Century Excellent Talents in University of MOE.

Chen Minghong was born in Chongqing, China, in 1983. She finished her Master Degree of information resources management from center for studies of information resources, Wuhan University, in 2008.
She has published some books and articles such as "competitive intelligence：an effective tool in a supply chain context" (ITICTI 2008). Her research interests are competitive intelligence, information resources management.
Ms. Chen currently is a candidate for Doctor Degree of information science from Wuhan University.