

# Study on Internet of Things Industry Based on Patent Data

Zhi Liping<sup>1</sup> & Zhao Sijia<sup>2</sup>

<sup>1</sup> Ph. D of School of Computer Science & Information Engineering, Anyang Normal University, Anyang, China

<sup>2</sup> M.A student of Anyang Normal University, Anyang, China

Correspondence: Zhi Liping, School of Computer Science & Information Engineering, Anyang Normal University, Anyang, China. Tel: 86-135-0372-8754. E-mail: zhiliping1216@163.com

Received: July 17, 2019; Accepted: July 31, 2019; Published: August 7, 2019

*The research is financed by the Training Scheme for Young Key Teachers in Universities of Henan (No. 2016GGJS-123).*

## Abstract

Based on patent database, this article conducts patent analysis from patent applications, IPC technical field distribution, the main research institutions of the Internet of Things to reveal the development trend, technical hotspots, leading enterprises, technology leaders, also maps current technology patents, and access to essential strategic information and innovation. The results put forward suggestions on development and utilization of the Internet of Things.

**Keywords:** internet of things, patent data, patent analysis

## 1. Introduction

The concept of the Internet of Things (IOT) was first proposed by Professor Ashton of the Auto-ID Center at the Massachusetts institute of technology (MIT) in 1999 when studying RFID. The so-called Internet of Things, that is, the network of things connected. The International Telecommunication Union (ITU) defines the Internet of Things as: "The Internet of Things is a new form of communication between people and things, between objects and things, extending the communication from short-range mobile transceivers to long-distance devices and daily necessities". There are many new technologies involved in the Internet of Things. The key technologies include radio frequency identification technology (RFIT), sensor network technology, M2M technology and two-in-one fusion technology. In the 12th Five-Year Plan, the Internet of Things (IOT) technology, as an important part of the new generation of information technology, has been listed as a strategic emerging industry that the state has cultivated. This indicates that the Internet of Things has officially entered the national strategic level of China.

Patent literature, which integrates technical, legal and economic information, is an important source of access to the latest global technological information. According to the statistics of the World Intellectual Property Organization, 95% of new technologies and inventions in the world are recorded in patent literature, and about 80% of technical information only appear in the patent literature. The number and development trend of patents can reflect the latest development trend of science and technology in a country (region).

## 2. Data Sources and Patent Search

### 2.1 Data Sources

The incoPat patent database contains more than 100 million patents from 102 countries/ organizations/regions in the world, and integrates multiple functional modules such as patent search, analysis, data download, file management and user management, and patent data for more than 20 major countries. Specially, IncoPat includes and processes patent data information from more than 20 major countries, with more complete data fields and higher data quality. Therefore, IncoPat is selected as the data source, the IoT technology keywords and the patent library logical relationship words are combined to form a patent search formula, and the patent information data is obtained in the incoPat patent database.

Since it takes about three years from the application of invention patent to the authorization, and there is a certain delay in the entry of patent into the database, only pre-2015 data was used as the research sample.

## 2.2 Patent Search

According to the keywords of IoT, we want to search and the logical relationship words to be used to establish a patent search, a total of 118,586 related patents are retrieved. The following is the final patent search expression: (AD= [19850101 to 20151231]) AND (TI=Internet of things or TIAB= Wireless Sensor or TI= 2-D Code or TI= (RFID) OR TI= (Radio Frequency Identification) or (FULL=(Internet of things) AND TIAB= (Sensor) or (TIAB= (heterogeneous Network and Convergence) or TIAB= heterogeneous Network Converged or TIAB=IMS or TIAB= Multi-attribute decision-making or TIAB= Cooperative Transmission or TIAB= Stream Control Transmission or TIAB= SCTP or TIAB= Mobility Management or TIAB= SON or TIAB= automatic PCI configuration or TIAB= Mobile load balancing or TIAB= Random access Channel or TIAB= backhaul Technology or TIAB= heterogeneous Network collaboration) AND (FULL= (Internet of things) or FULL= (Wireless Sensor) or FULL= (Wireless Network) or (TI= (Internet of things AND Security) or TI= (Internet of things AND key) or TI= (Internet of things AND Digital signature) or TI= (Internet of things AND Authentication) or TI= (Internet of things AND Fault tolerance) or TI= (Internet of things AND Privacy) or TI= (Internet of things AND anonymity) or TI= (Internet of things AND signature) or TI= (Sensor AND Security) or TI= (Sensor AND key) or TI= (Sensor AND encryption)

## 3. Patent Analysis of Global Internet of Things Industry

### 3.1 Annual Distribution of Patent Applications

The “Technology Life Cycle Theory” divides the growth of technology into four phases: Germination, growth, maturity, and saturation. These four stages are graphically represented as if they are s-curves, and because they are like the human life cycle, they are called "growth curves."

This paper makes a statistical analysis of the number of patent applications of the global IoT to reflect the distribution of patents in each year. The patent applications for the global IoT are divided into three phases.

The first phase was the bud of 1985-1991. The average annual applications is less than 150, and the total number of patents in the global IoT industry is very small.

The second phase is the low-speed development period of 1992-2003. Professor Ashton of the MIT Auto-ID Center in 1999 presented the concept of the Internet of Things for the first time at the International Conference on Mobile Computing and Networking in the United States. This proposal further promotes the increase in the number of applications for IoT in the world, but The growth rate is still slow.

The third phase is the high-speed development period after 2004. On November 17, 2005, the International Telecommunication Union (ITU) released “ITU Internet speech 2005: The Internet of things”. At the World Summit on the Information Society (WSIS) in Tunis, the concept of “Internet of things” was formally put forward. ITU pointed out passionately that “the age of the Internet of things is coming”, which has received a great deal of attention from all countries around the world. With the deepening of the concept of the IoT in people's mind, the number of its patent applications is also increasing rapidly, which ushered in the rapid rise of patent applications for the IoT.

From the perspective of global society, in 2009, affected by the global financial crisis and economic crisis, the number of patent applications in this year decreased by 10.8 percentage points compared with 2008. After the economic crisis, the number of patent applications has increased, which shows that the global economy will also affect patent applications. In the case of poor external environment, it is very unfavorable for invention and patent application, so the country needs to stabilize the economy and create a sustainable development environment.

### 3.2 Analysis of IPC Technology

According to the IPC classification number, the top ten IoT technologies are counted, of which G06K ranks first, and the number is far more than other technologies; the second is H04W; H04L is ranked third.

The number of G06K patents is far ahead, because more and more data recognition technologies have been developed, such as voice recognition, fingerprint recognition, pixel recognition, face recognition technology, etc., which have gradually penetrated into our lives. Dimensional payment, mobile fingerprinting, safe face recognition, these are the applications of data recognition in our lives. The ever-increasing demand for society has further promoted the invention and creation of this technology. The wireless communication network (H04W) is composed of many wireless sensor nodes, which may be the same or different. Each sensor node is composed of many integrated boards, such as sensors, memories, converters, etc. The scope of application of the technology is also of particular importance. On the one hand, Bluetooth headsets, cellular mobile communications, wireless

LANs, etc. must use G06K technology; on the other hand, it also has great use in military applications, such as satellite positioning, search and rescue work by wireless communication in earthquakes.

Although the major IoT countries in the world are involved in the above 10 IoT related technologies, the focus of different countries is quite different. Many countries have a large proportion of G06K technology, which is consistent with the first data of the G06K technology analyzed above. At the same time, it is easy to find that China is superior to other countries in every technical field, especially in the G06K technology field. That's because China has done a good job in data processing and communication networks. For example, ZTE Corporation (China), when the economic crisis broke out in 2009, when other countries were in a recession and were unable to conduct scientific research, ZTE seized the opportunity and showed strong contrarian growth. The rapid progress includes a number of basic patents covering international communication technology standards and core patents covering key technologies in the communications industry.

### *3.3 Analysis of the Main Applicants*

Through the statistical analysis of the main patent applicants in the global IoT industry, we can see the leading enterprises in the Internet of Things industry in the world. The top two are Korean companies, South Korea's SAMSUNG ELECTRONICS CO LTD is first, followed by South Korea's ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE and the third is the Germany's GOEBEL PORZELLAN GMBH, and their patent applications are above 1000. The only Chinese company in the top 10 is ZTE Corporation, ranking ninth. It can be seen that although China's total number of patents in the Internet of Things ranks first, the number of patent applications is growing and there is a lack of leading enterprises.

However, in the United States, Germany, South Korea and other countries, patent applications are more concentrated, and related companies are much less than China, but they have applied for a large number of IoT patents.

The top two are both South Korea, indicating that Korean companies value technology investment, which is an important reason for the surge in patent applications. Samsung Electronics Co., Ltd. occupied the first place in patent applications because Samsung had officially changed its patent strategy model as early as 2010. In 2008, Samsung Electronics applied for more than 4,800 patents; in 2010, Samsung established an intellectual property (IP) center, which integrated the patent business functions that were originally dispersed in various business divisions and began to strategically manage patents; In 2011, Lee Kun-hee, chairman of Samsung Electronics, emphasized to the management that "We focus on software, talented people and patents". And Samsung's business philosophy is to create the best products and services based on talent and technology to contribute to human society. These have greatly facilitated patent applications.

Enterprises must have their own technological advantages to have core competitiveness. Samsung Electronics Technology has been involved in important technical fields, of which H04B (wireless communication network) has the largest proportion, followed by H04W. Companies such as Gerber porcelain co. LTD, Art house limited, Dragimex handels AG are rarely involved in important technical fields because the three companies do not do communication technology of IoT.

### *3.4 Geographical Distribution of Global Patent Applications*

In order to fully understand the country distribution of patent applications of IoT, we further calculated the global geographical rankings. The top ten countries and regions are China, the United States, South Korea, Germany, the World Intellectual Property Organization(WIPO), Japan, the European Patent Office, Taiwan, the United Kingdom, Canada and Australia. China has become the world's largest number of applications for patents of IoT, with more than one-third of the world's total applications, and the United States, the second largest, is only half of China. In recent years, the surge in related patents in China indicates that China attaches great importance to the research and development of the IoT industry, and has listed the IoT industry as a national strategic new industry, stimulating the innovation enthusiasm of IoT enterprises and research institutes.

## **4. Suggestions and Countermeasures**

### *4.1 The Government Should Increase Support*

From the development trend of the number of patent applications for Internet of Things, it can be found that a few patents for the IoT began to appear in 1985, and began to increase rapidly in 1999. In recent years, it has stabilized. This situation also shows that the development of the IoT industry is now growing steadily, and it has a lot of room to play in the future. It is recommended that relevant government departments should increase investment in research and development funds and create a favorable environment for the development of the IoT industry. It is

also suggested that research institutions and enterprises join hands to integrate resources and actively carry out key technologies for the Internet of Things.

#### 4.2 Enterprises Should Increase Innovation

The comprehensive strength of a country depends on the progress of science and technology and the all-round development of the economy. For IoT enterprises, first of all, they should have their own core competitive technology, and on this basis, they should invent and expand relevant technologies. On this basis, it invents and expands related technologies; it is recommended that IoT enterprises grasp opportunities, conform to the trend of the times, increase innovation, and innovate in competition.

#### 4.3 Scientific and Effective Management of Patents

The strong patent awareness has led to Samsung Electronics Co., Ltd., and the Electronics and Telecommunications Research Institute in the top of the list of patents. And the main reason why the number of patents in Chinese companies does not go away is the lack of public awareness of patent protection. Although Chinese and Korean industries share a large part of the same development goals in the future technological innovation planning, Korean independent enterprises have long been ranked among the top in terms of technological competitiveness and scientific research ability. Faced with this situation, we should strengthen scientific and effective management of patents, raise awareness of intellectual property protection among the people, and promote the sound development of the IoT industry.

#### References

- Cao, J. G., Liu, W., Cai, W. X., & Zheng, Y. P. (2009). Research on Patent Technology Transfer in Industry-University-Research Cooperation[J]. *Science and Technology Management Research*, (12), 488-490.
- Chen, K. N. (2012). Analysis of the development of patents in Beijing area during the ten years of WTO accession[J]. *China Invention and Patent*, (12), 64-66.
- Huang, L. C., Wu, D., & Zhang, J., et al. (2014). Patent-based framework for analysis of technological competition situation - taking intelligent material technology as an example [J]. *Journal of Information Science*, 33(3), 284-295.
- Jiao, Y. Y., & Mitchell, H. Q. (2014). Network Structure Analysis and Dynamic Evolution of Internet of Things Industry Alliance [J]. *Science and Technology Progress and Countermeasures*, (14), 58-64.
- Jin, B., & Qin, Y. F. (2014). Development of Internet of things industry and Countermeasures [J]. *Macro Economic Management*, (10), 68-69.
- Li, W. J. (2015). Comparative Study on Regional School-enterprise Patent Cooperation Application Network—An Empirical Analysis Based on Guangdong[J]. *Modern Intelligence*, (12), 106-110.
- Li, Z. H., & Ding, C. Y. (2016). Research on the Implementation Effect of the Patent Regulations of Guangdong Province[J]. *Journal of Political Science and Law*, (03), 6-7.
- Lin, G., Zhang, R. R., & Chen, J. (2008). Analysis and Suggestions on the Status of Patent Technology Transfer in Beijing [J]. *Science*, (02), 12-18.
- Mao, W., Liu, C., & Lin, W. (2013). Research on Patent Implementation and Industrialization of Chinese Enterprises[J]. *Science Research*.
- Noh, K., Kim, W., Kwon, et al. (2014). Tracing knowledge flows using science and technology indicators [J]. *International Interdisciplinary Journal*, 10(3), 327-337.
- Rao, K., Meng, X. F., Andrea, P., & Chen, W. (2011). Research on patent technology transfer in UK universities and its reference significance [J]. *China Science and Technology Forum*, (02), 148-154
- Song, D. L., Fu, B. H., & Tang, H. (2011). Analysis of the transfer mode of patent technology in colleges and universities [J]. *China Science and Technology Forum*, (03), 95-100.
- Tang X. X., Zhang, J. F., & Zou, Y. Y. (2014). Research on the Status Quo of Invention Patent Application in China and Countermeasures for Improving Authorization Rate[J]. *Scientific Management Research*, (01), 31-34.
- Wang, Y. H., & Wang, X. L. (2014). Analysis of the Status Quo of Patent Technology Transfer Evaluation[J]. *Software*, 35(4), 71-72.
- Yang, L. S. (2014). Research on Patent Technology Transfer in International Technology Transfer[J]. *Industrial Technology Innovation*, (02), 221-225.

- Yue, Z. G. (2014). Research on Synergistic Development of Technology Chain and Industry Chain in Strategic Emerging Industries [J]. *Science and Technology Management*, 2, 154-161.
- Zhang, Y. B., & Wang, S. D. (2015). Patent development trend and forecasting analysis of key technologies of Internet of Things based on TRIZ theory [J]. *Systems Engineering*, (3), 130-136.
- Zhang, Y., Liu, B. Q., Wang, W., & Xu, Q. X. (2013). Patent Analysis in Jiangxi Province: Strategy and Its Enlightenment[J]. *Jiangxi Science*, (2), 261-269.

### Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).