

Mapping of Innovations at Indian Institute of Technology Bombay: A Scientometric Approach

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Abstract

This paper reviews innovation activity at Indian Institute of Technology Bombay (IITB) and analyzes 717 Patents filed by it during the period of 1997-2015 as indexed in the Derwent World Patents Index. Data analysis is done to understand growth rate, productivity, collaboration of inventors with individuals, industries and institutions, class/subject-wise distribution of patents. Study also does a visualization of patent title keywords.

Keywords: IIT Bombay Patents, Innovation, Intellectual Property Rights, Patents, Patent Analysis, Patent Trends, Scientometric Mapping

1. Introduction

A patent is a set of exclusive rights granted by a sovereign state to an inventor or assignee for a limited period of time in exchange for detailed public disclosure of an invention. Patents are valid for 20 years from the date of filing patent application. In order to get a patent, an innovation must be novel, useful, and non-obvious.

Patent documents are an important source of technical and commercial information. Scientometric analysis of patents makes it possible to get information on innovation activities in: a. various fields of science, engineering and technology; b. different countries; c. educational and research institutes; and d. by individuals. Patent literature in a particular industry can identify trends and forecast further research in these areas and, consequently, attract the attention of academic institutions and government agencies and help to find source of funding and obtain grants for the development of research. “The number of patents acquired by a company reveals the technology innovation ability of that organization”⁸. Analysis of patent data has long been considered to be an important

method for assessing various aspects of technological change¹.

IIT Bombay was established in 1958 and aligns its R and D focus with the national goal of achieving technological self-reliance and also keeps pace with expanding frontiers of knowledge and global developments. IIT Bombay has collaborations with over 30 world-class institutions across America, Europe and Asia and received the “Thomson Reuters India Innovation Award, 2014”, “Top Indian Academic Institution for Patents”, and Best commercialization of patents and WIPO user trophy in 2015^{10,11}. This study attempts an analysis of patents filed by IIT Bombay during 1997-2015 as indexed in Derwent Database.

2. Review of Literature

Patent analysis studies have been conducted by a number of researchers and organizations to measure innovations; scientific and technological developments; technological changes and technological competencies of institutions, industries and countries over a period of time. In a study

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conducted in Iran, it was found that there has been a significant increase in patents filed by Iranian Inventors. Of the 212 patents registered during 1976-2011 in USPTO, WIPO and EPO databases, 119 patents were registered during 1996-2011, with highest number of patents (27%) being registered in Chemistry and metallurgy field, followed by 18% in human necessities field, and 17% in electricity field as per IPC classification⁵.

Guan and He³ analyzed Chinese Patents granted by USPTO during 1995-2004 to study science-technology interaction using Patent citations to scientific references. The findings suggested that patents and the corresponding scientific citations are related in different ways. While Electricity was the most productive sector in terms of number of patents it shares only 4.1% scientific non-patent references. Out of 11 technological fields, non-patent references had a much stronger connection in Biotechnology; Pharmaceutical and Organic chemistry, whereas ICT sectors, Semiconductors and Optics are less science-based domains.

A study examining patent activity at the Council of Scientific and Industrial Research (CSIR) for the period 1976-2000, found that it had filed 1,978 Indian patents and 177 US patents. The study did not find a uniform trend in patent activity in that it was highly concentrated in relatively small number of inventors⁴. Another study in India revealed that that 33 states / union territories together filed 29,018 patent applications during 2005-2010^{2,7} compared prolific patenting institutions of India and China on the basis of US patents and found that there are 8 institutions from each country, which have filed more than 10 patents. The study found that China and India filed 676 and 536 US patents respectively for the period 1998-2002. While Indian institutions have filed more plant patents and utility patents, Chinese institutions had more design patents.

The review reveals that patent analysis studies have so far been done at much broader level such as country/group of institutions/laboratories and no such studies have been reported of individual research institutes. This study, therefore, attempts to bridge the gap in knowledge by studying the patenting activity at one of the leading academic and research institutes, the IIT Bombay.

3. Objectives

This study aims to investigate the patenting activities at IIT Bombay based on Derwent World Patents Index (DWPI). The study aims to identify

- Number of patents filed and annual growth rate;
- The top inventors;

- Collaboration Pattern of inventors' with individuals, institutions and industry (collaboration network);
- Domain-wise distribution of patents; and
- Patent title keywords and analyze them.

4. Methodology and Data Source

All patents having at least one inventor with affiliation of IIT Bombay were extracted from the Derwent World Patents Index (DWPI) database, a database containing patent applications and grants from 44 of the world's patent issuing authorities. The Derwent World Patents Index (DWPI) database has 20 million "inventions", corresponding to tens of millions of patents, with almost a million new inventions added each year⁹. A total of 717 patents were identified and considered for this study. Bibliometric data analysis software, Bibexcel⁶ was used for data analysis, and Gephi¹⁴ and VosViewer¹² software have been used for data visualization and network graph creation.

5. Data Analysis

5.1 Distribution of Patents Filed Year-wise

The data (Table 1) shows that 717 patents have been filed from 1997 till 2015 by IIT Bombay with the highest number (122) of patents being filed in 2012. The patenting activity has accelerated from 2008 onwards as over 82% (587) of patents have been filed since then. One of the factors for the increase could be the government policy changes with regard to creation of intellectual property.

Table 1. No. of patents filed year-wise

Sl. No.	Year	No. of Patents filed	Change
1	1997	1	
2	1998	6	500
3	2000	3	-50
4	2001	4	33.33
5	2002	17	325
6	2003	18	5.88
7	2004	17	-5.56
8	2005	23	35.29
9	2006	24	4.35
10	2007	17	-29.17
11	2008	46	170.59
12	2009	41	-10.87
13	2010	108	163.41
14	2011	116	7.41
15	2012	122	5.17
16	2013	75	-38.52
17	2014	66	-12
18	2015	13	-80.3
Total		717	

5.2 Prolific Inventors and Collaboration

This study revealed that 626 inventors were involved in the filing of 717 patent applications from 1997 to 2015. The list includes 10 inventors from Department of Electrical Engineering, followed by 4 each from Department of Chemistry and Department of Mechanical Engineering, and 3 each from Department of Energy Science and Engineering and Biosciences and Bioengineering.

Figure 1 and 2 show collaboration network of inventors. The network of collaborations of 480 inventors who had at least one collaborative patent output is depicted in Figure 1. The collaboration network is depicted using the Fruchterman-Reingold layout, which uses a force-directed layout algorithm, which assigns forces among the set of edges and the set of nodes of a graph¹³. Each node represents an inventor and each edge represents

collaboration between two inventors. Size of the edges is proportional to number of patents they have worked together.

Figure 2 shows collaboration network of 29 top inventors. Each node represents an individual inventor and each edge represents collaborative work, thickness of edges shows frequency of their collaboration work. This study shows that most productive inventors are also highly collaborative inventors, so collaboration plays major role in productivity of inventors.

5.3 Collaboration with Industries/Institutes

47 (5.7%) patents have been filed with collaboration of 21 industries and research institutes. Highest number of 7 patents have been filed in collaboration with Department of Biotechnology, India followed by 4 with EMBIO Ltd.

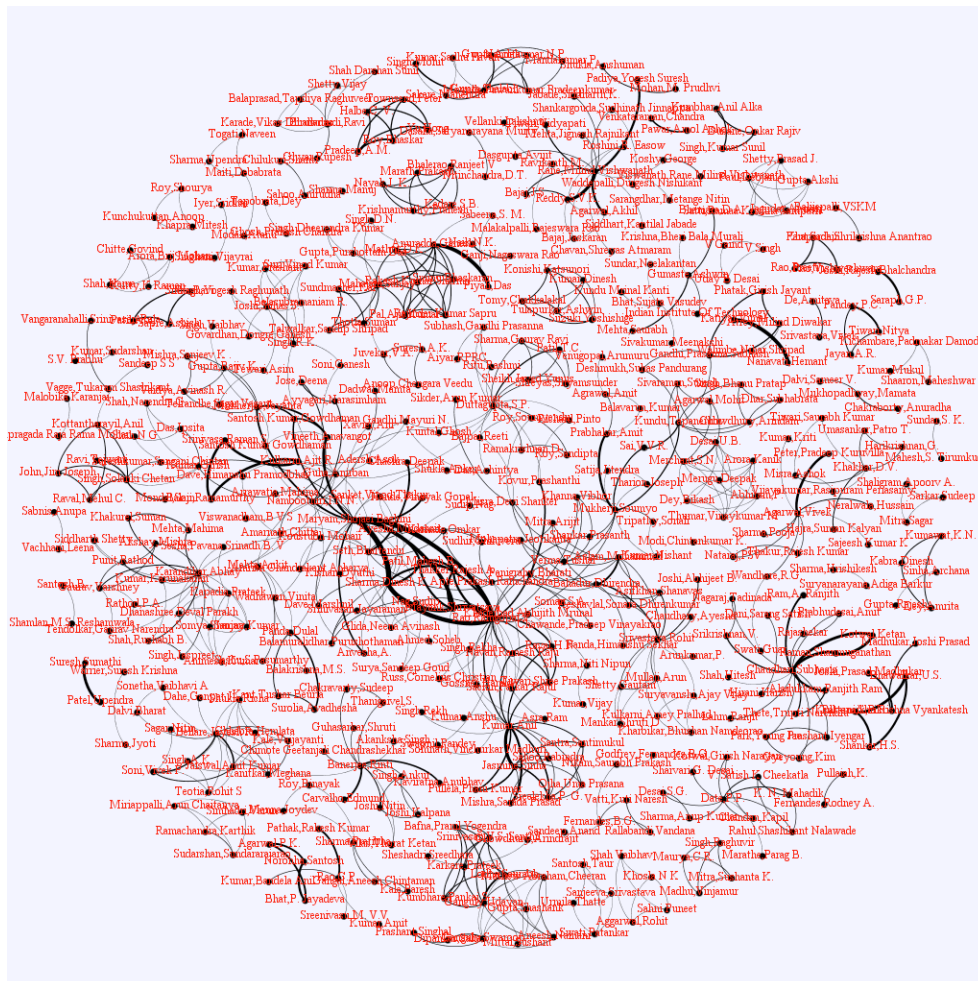


Figure 1. 480 inventors collaboration network.

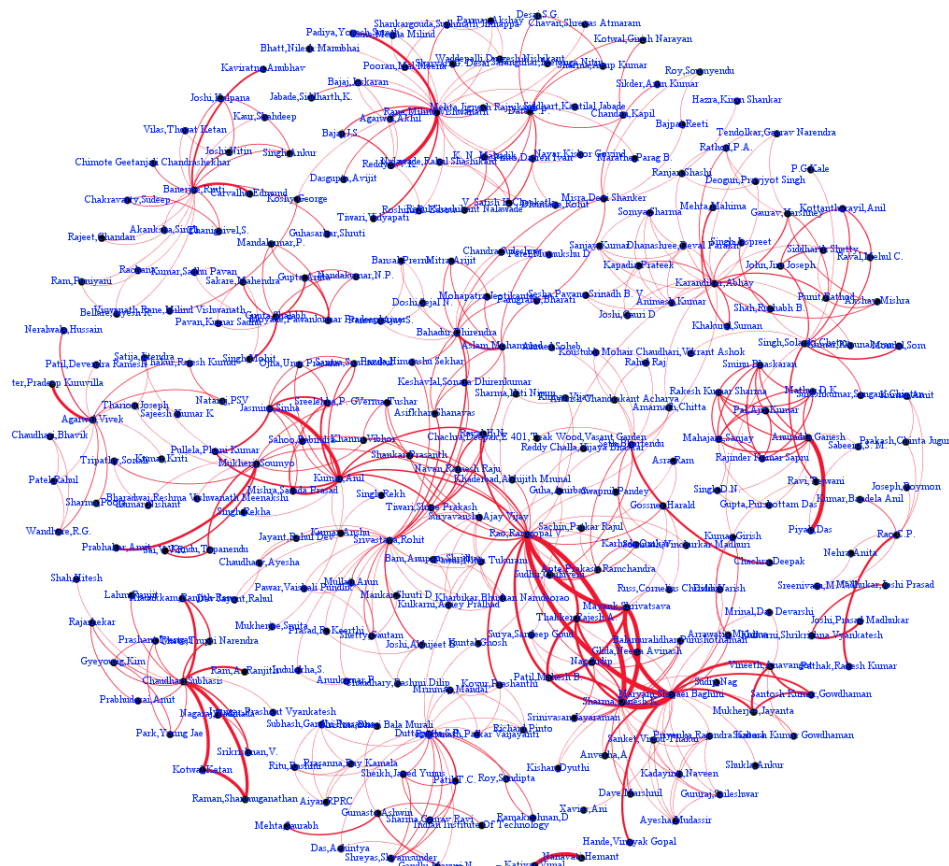


Figure 2. Top 29 inventors collaboration network.

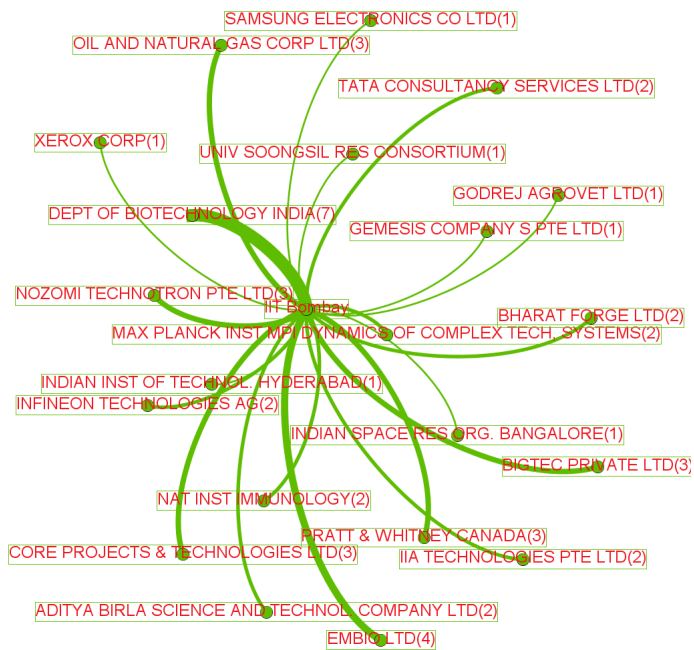


Figure 2. IIT Bombay's patent collaboration network with industries and institutes.

been deployed at several industries and government organizations. Some of such technology/products are:

- Heat Pumps/Multi-utility Heat Pump;
- Solar Photovoltaic (PV) Technology;
- Carrier Ethernet Switch Router; and
- ATM Enclosure Design.

6. Conclusion

The analysis of data extracted from Derwent World Patents Index reveals that patenting activity at IIT Bombay has significantly increased during the period 2006-2015 as 628 (88%) of 717 patents have been filed during this period. Several technologies/products developed by IIT Bombay have been deployed at various organizations and industries. It also revealed that most of the faculty members are involved in contributing patents with 29 of them contributing 10 or more patents each. This study found that most productive inventors are also most collaborative inventors. 47 (5.7%) patents have been filed with collaboration of 21 industries and other research institutes so there is a need to expand collaboration among industries and other universities in patent activities. Subject-wise distribution of Patents based on IPC system show that the highest number of 181(25.24%) patents have been filed in Electricity category, followed by 147(20.50%) in Chemistry; Metallurgy category, and 143(19.94%) in Physics category.

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