A trend-based patent alert system for technology watch

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This paper presents development of a trend-based patent alert system (PAS) to find out current trends in patents on industrial technologies. Patent count data based on number of patents filed in specified duration is considered an indicator to define current trend. PAS retrieves data of associated patent counts using extended markup language (XML). Trend extraction algorithm is developed based on linear regression analysis of patent data. Implementation of PAS on real data of textile technologies extracted from online patent database search spaces detected realistic trends for making policy decision on existing technology upgradation and research planning.

Keywords: Computer-aided innovation (CAI), Patent alert system (PAS), Technology tracking, Trend extraction

Introduction
Patent databases contain valuable information to detect technology evolution1-4. Numerous studies5-9 on patent data for different purposes cover patents issued in a certain time period, within a geographical location. This dynamic-volatile nature of patenting has forced to use of computerized patent analysis. Recent availability of patent archives and databases in electronic form has made application of web techniques for technology forecasting feasible10. XML (Extended Markup Language) based data extraction can search new trends in patent databases distributed across globe. This paper presents development of a trend-based patent alert system (PAS) to find out current trends in patents on industrial technologies.

Patent Alert System (PAS)
PAS is a responsive alert system, which uses fresh patent data to search trend changes in patenting activities. PAS behaves like an alarm clock. It uses XML to capture and update patent data from publicly accessible patent databases. Captured data is tested for trend changes in technologies requested in the alert. An online trend-extraction algorithm is developed to search the trend changes within captured patent data. Algorithm fits a constant line for counts of patents and then calculates deviation between fitted and real value.

System Architecture
PAS (Fig. 1) has been implemented using 'Visual Basic 6.0'. First step is setting of alert by the user. Relevant International Patent Classification (IPC) section, class and subclass of patents to be watched are selected through use of interface (Fig. 1A). Requested alert is then transmitted to PAS engine (Fig. 1B). PAS retrieves relevant database using XML (Fig. 1C) and patent count data for selected IPC section, class and subclass is captured (Fig. 1D). PAS software is capable of connecting to patent databases of TPI (Turkish Patent Institute) and EPO (European Patent Office) instantly and any change in number of patents has been captured on-line. PAS can be configured for various periods (annual, daily or monthly update). Next step is to create own database of PAS (Fig. 1E). An online trend-extraction algorithm is employed to find trend changes in captured patent data (Fig. 1F). If a trend change is found (Fig. 1H), some indicators [stabilized (steady), positive (upward), or negative (downward)] immediately alert user. If no trend is extracted, then loop is repeated in each update (Fig. 1G).

Alert Configuration
Patent studies may benefit from existing classification scheme of World Intellectual Property Organization (WIPO). PAS is also designed in such a way that alerts are configured and patents are analyzed based on IPC codes. Configuration of an alert includes: i) Assignment of a unique alert number; ii) Giving a unique alert name; iii) Selection of IPC section to be monitored; iv) Selection

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of IPC class of selected IPC section; v) Selection of IPC subclass of selected IPC class; vi) Selection of search space (use of issued patent data or use of applied patent data); vii) Selection of responsiveness sensitivity; viii) Selection of database; ix) Selection of alert forwarding method; and x) Saving alert.

There is a certain time gap between application and completion of patenting process. Therefore, if one chooses ‘applied patent data’ as search space, it may be more informative about the future as compared to use of ‘issued patent data’. Although it is left to preference, not all of patent databases include and publish patent applications\(^1\text{1}\) (database of USPTO). Therefore, in such circumstances, alerts are disabled for ‘applied patent data’.

**Data Capturing**

Freely accessible databases have been launched on Internet\(^1\text{2,13}\) to popularize and promote patent information. A new era has been initialized in patent analysis with three very specific developments\(^1\text{4}\) (IPC reform, XML and MIMOSA retrieval software). IPC reform enabled easy modification for possible changes in future and adaptation of existing data to electronic environment. XML enables capture of structured data in electronic environment. MIMOSA software made it easier to access databases over Internet to load required data\(^1\text{4}\).

PAS used XML to capture data from patent databases through Internet. Having connected to relevant patent databases by predefined queries and filters, patent count received in selected IPC code is recorded to own
database of PAS, which is located in the server. PAS enables users to select database to be used in trend analysis. Database (search space) options are also shown in interface of PAS (Fig. 2). In this way, trend changes can be watched across countries by setting different type of alerts. Data provided by patents properly processed offer a valuable source of information useful to keep track of evolution of technological strategy of firms and to make comparisons. PAS for comparative technology watch creates opportunities to make comparative analysis among countries. Users may benefit from this comparison to draw conclusions about technological differences.
among countries. PAS enables to monitor and compare alerts (Fig. 3), which are configured by users previously. This is one of the most outstanding properties of PAS developed in this study. As illustrated at the bottom right of snapshot (Fig. 3), alert-10 and alert-15 were evaluated and configured by the users for Japan and US patents, respectively. Alerts for both Japan and US patents ascertained in the compared pairs of periods are shown in the summary table of the screen. Here, U denotes a new upward trend while D stands for a new downward trend. In PAS system, only comparable alerts (periods to be compared should be equal) can be compared with each other.

**Trend Extraction Algorithm**

Technology foresight, using tools of knowledge and information management based on primary and secondary sources, is extremely useful in arriving at an understanding of the state of art of a given sector, to generate value-added information about technological and market trends and thus feeding cycle of creating new wisdom. Patent publications can be used for statistical purposes to provide a general view of worldwide technical activity. Analysis on issued or applied patent counts can be used with scope of decision-making and can create value-added information. In this paper, trend analysis has been used to create alerts, which react upon change in patenting activities monitored constantly. A trend is known as general tendency or direction in a collection of data. Trend analysis is a useful approach to extract information from numerical data and represent it symbolically, in a qualitative or semi-qualitative way.

A trend extraction algorithm developed in this study searches trend changes within specified search space. Algorithm initially fits a constant line for counts of patents and then calculates deviation between fitted and real value of patent counts. If cumulative deviation is more than predetermined threshold value, then a new line is searched by regression analysis. If no trend change is found, algorithm halts until database is updated. As soon as a new data captured by the system, trend-search restarts. Trends found in patent data express time evolution of patent and technology with symbols [upward (+), downward (-) and steady (stabilized)] (Fig. 1), which are used to generate alerts that are then forwarded online to users who request/set alerts. A step-by-step explanation of the methodology developed for extracting trend changes from counts of patents/applications is as follows:

**Step 1**

Initialization of trend change extraction algorithm

\[ P(t) = R(t=0) \]

where, \( t \), period number (it depends on update frequency of patent databases requested by users) and starts with zero and increments one in each update, \( P(t) \), hypothetic line which sets patent count, \( R(t) \), real patent count captured in time \( t \)

**Step 2**

In each data update, cumulative deviation is calculated between hypothetic line and real value obtained as

\[ \text{dev}(t) = P(t) - R(t) \]

\[ \text{cumdev}(t) = \text{cumdev}(t-1) + \text{dev}(t) \]

**Step 3**

If absolute \( \text{cumdev}(t) > \text{th} \) then linear regression is run and a new line is fitted as and \( \text{cumdev}(t) \) is set to zero.

\[ P(t) = a(t) \pm b \]

where, \( a \) is slope of trend line.

Otherwise update patent data under consideration and go to Step 2.

**Step 4**

If there is a change in the model, this trend change is forwarded to user as an alert using one of the following indicators:

Downward trend: If \( a < 0 \) negative (-)

Upward trend: If \( a > 0 \) positive (+)

Steady trend: If \( a = 0 \) stabilized

**Specification of Threshold Value (th) for Trend Extraction Algorithm**

Trend extraction algorithm uses a threshold value (responsiveness parameter) for initializing trend search within patent counts being considered. New linear models are searched when deviation between fitted and real value of patent counts exceeds threshold value. Responsiveness level (sensitivity) of system is determined or adjusted by users configuring alerts through user interface (Fig. 2). User can select any one from high, middle and low sensitivity suggested by system. “1” is assigned to threshold value. This means that any deviation in patent count will lead a new trend search.
Threshold parameters are assigned based on mean value of patents issued in specified duration, which is lowest for low sensitivity threshold value. As value of parameter (th) decreases, sensitivity of PAS is improves and therefore frequency of alerts generated and forwarded to users increases correspondingly.

Adjustment of threshold parameter can be considered as a limitation of trend extraction algorithm for naive users. Another limitation of proposed algorithm is linear regression model for finding new trend in patent moves.

**An Example**

A real-life example is presented here for demonstrating execution of trend extraction algorithm. Textile technologies including laundering, drying, ironing, pressing or folding textile articles have been selected.
from patents classified in IPC-D06 (Table 1). Annual number of patents retrieved from TPI has been used instead of instantaneous data.

**Determination of Threshold Value**

One of the most convenient methods is to find an average of historical data. For this example, alerts, generated after 2000, are investigated. Therefore, average number of patents granted between 1987 and 2000 are used as threshold value, which is 14.42 (calculated from Table 1). Execution of trend extraction algorithm can be traced (Fig. 4) in a stepwise manner, which allows viewing intermediate steps as well. Cumulative deviations for 2001, 2002 and 2003 are 0, 13 and 34 respectively in comparison with threshold value of 14.42. As cumulative deviation in 2003 exceeds threshold value, a new P(t) is required and a new line is fitted as

\[ P(t) = -0.2 \times t + 418.4 \]

A new downward trend is detected since \( a = -8.5 \)

**Conclusions**

Patent Alert System (PAS) used trend analysis to find direction of changes in patenting activities, technology and research for creating an online visual decision support for managers. Demonstration of real example of textile technologies in patent database showed effectiveness in detection of current patent trends. A more advanced and sophisticated fuzzy based genetic model may be required to clarify variation in patenting activities. Selection of optimal threshold values for trend extraction algorithm is vital for making robust decision from PAS. Several decision makers with different objectives can use trend-based PAS to evaluate value of existing technologies, to find promising technology-related investment areas, and to establish a long-term strategic plan including technology planning.

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