Research on Technology Forecasting Based on Patent Mining and Technology Evolutionary Trends

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Abstract—In order to help enterprises, improve their innovation ability and grasp the future development direction of technology. A technology forecasting model based on the Integration of patent mining and technology evolutionary trends is proposed. Through patent retrieval, patent data cleaning, patent clustering, the technical road map of patent linkage in the target field is constructed. Then, combined with the technology evolutionary trends, the potential nodes in the target field are added to form a complete hypothetical road map of technology evolution, and the potential technology evolution road of the target field is predicted. The concrete steps of applying the method to forecast are described, and the feasibility of the method is verified by applying the method to the prediction of gesture control in the field of air conditioning.

Keywords- technology forecasting; patent mining; evolutionary trends

1 INTRODUCTION

With the rapid development of science and technology, the rapid update of knowledge and information, and the constant change of market demand, the difficulty and complexity of technological innovation are constantly increasing. Therefore, it is of great strategic guiding significance for technological innovation to carry out scientific technological prediction according to the development trend of specific fields [1]. Technology forecasting is the prediction and prediction of the future development of technology according to the basic principles of technology development and scientific methods, to provide support for technological innovation decisions [2]. Through the effective technology forecasting, can help enterprises grasp the development of technology, identify the future development direction of technology, to obtain competitive advantages, make enterprises in the fierce competition in an invincible position.

The traditional technology forecasting is mainly based on the qualitative prediction method of expert opinion, such as Delphi method, scenario analysis, technology roadmap, analytic hierarchy process (AHP). The qualitative prediction methods relying on experts' opinions has a large prediction range, but it is highly dependent on experts, and takes a long time and costs a lot. In order to avoid the instability of prediction results caused by subjectivity brought by human participation, scholars have applied bibliometrics, patent analysis and other methods to the research of technology forecasting, such as prediction methods based on patent citation analysis, patent network analysis and patent map. Donghyun Choi et al. predicted the technology trend in the field of logistics based on patent analysis of subject modeling [3]. Yujin

Jeong et al. proposed a patent development roadmap based on technology roadmap through the analysis of patent development mode [4]. With the advent of the era of big data, the rise and development of computer technologies such as natural language processing, artificial intelligence and deep learning, data-driven text mining methods have gradually become the main tools for technology prediction, such as SAO structural semantic analysis, LDA topic analysis and machine learning. Junegak Joung et al. used the method of text mining to identify core technical keywords and found new technical fields through clustering of technical keywords [5].

In order to effectively improve the reliability of forecasting results and overcome the defects of single research method, this study integrates patent analysis with technology evolutionary trends, grasps the development context of technology from macro and micro aspects, identifies potential opportunities of technology development, and provides methodological support for enterprise technology forecasting.

2 RESEARCH ON TECHOLOGY FORECASTING BASED ON PATENT MINING AND TECHNOLOGY EVOLUTIONARY TERNDS

Patent mining is an effective tool for technology forecasting, and the analysis of patent literature is one of the most effective methods to understand and grasp the trends of innovation. The law of technology system evolution reveals the general law of product system evolution, which can guide the direction of technology forecasting. The combination of patent mining and technology system evolutionary trends is used to predict the evolution process of technology system and identify the potential evolution road of technology to guide product innovation. The framework for technical forecasting is shown in Figure 1.
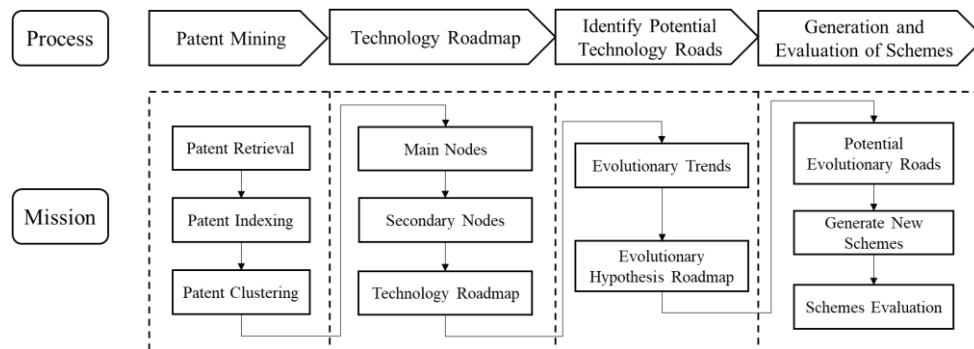
Figure 1. Technology forecasting framework based on the fusion of patent mining and technology evolutionary trends

2.1 Patent mining

As the most effective carrier of technical information, patent data have incomparable advantages over other data, such as convenience, certainty, timeliness and openness. Therefore,

patent data can be used as the best information source for technology forecasting activities. Patent mining refers to collection, processing and analysis patent information in a specific field by using data mining method, to obtain valuable patent information.

In this paper, patent text mining is used to collect patent information in the target field, patent abstracts are formed though patent indexing, and then the patent information is clustered to provide relevant data for constructing the technical roadmap of patent linkage. The specific implementation steps of patent mining are as follows, and the flow chart is shown in Figure 2.

1)Identify the target areas: Defining the technical field to be studied is the primary task of patent mining, which lays the foundation for the subsequent comprehensive and accurate collection of patent information.

2)Patent retrieval and data cleaning: Select the patent database according to the target domain, and formulate the target domain search strategy in combination with expert opinions. In the process of patent retrieval, patents with low correlation with the target domain usually appear, so it is necessary to screen the patent data obtained from the preliminary search to filter out the patent data with low correlation.

3)Patent indexing and clustering: By analyzing the key information such as patent names, abstracts and attached figure, the key information is summarized and filled in the patent indexing template, which lays the foundation for subsequent patent clustering. According to the user's key needs and technology perspective, combined with the hierarchical structure of system technology, the patent data is first sub-clustered, and then the patent groups with different technical topics are formed.
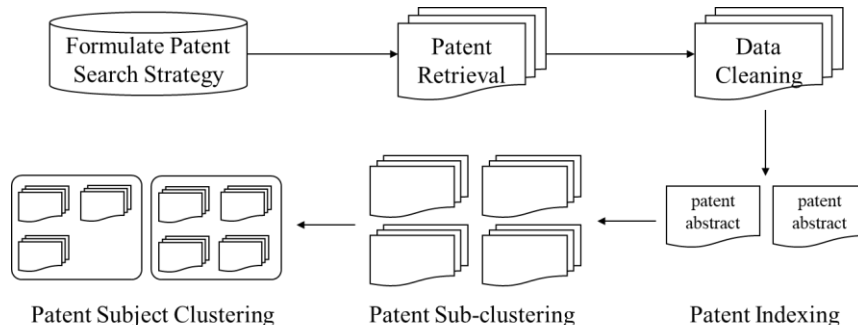
Figure 2. Patent mining process

2.2 Technology roadmap based on patent linkage

The development of any technology is traceable and predictable. Technology roadmap can help users to define the development direction of this field and key technologies needed to achieve the goals, clarify the relationship between products and technologies, and various resources needed for the development of key technologies [6]. Technology Roadmap (TRM) refers to the application of concise graphics, tables, words and other forms to describe the logical relationship between the steps of technological change or related links of technology [7]. The technology roadmap of patent linkage proposed in this paper was burn under the inspiration of

traditional technology path roadmap and evolutionary tree theory. Nicola Shpakovski's evolutionary tree theory can not only help users sort out the objective information of technical system, but also guide the generation of new schemes.

Based on the results of patent clustering, this paper puts forward the hypothesis of technological evolution in the target field. The proposed evolutionary hypothesis is taken as the backbone node (trunk) of the technology roadmap, and then the patent classification results are taken as the branch nodes (branches) and supplemented to the branches of each backbone node to form a complete technology roadmap of the current technology system. Through patent-linked technology roadmap, we can not only grasp the context and direction of technology development, but also identify the potential evolution nodes of technology development to guide technology innovation.

2.3 Identify potential technology roads

The development context of existing technologies can be grasped through the patent-linked technology roadmap. If we want to further identify the potential technology roads in the target field, we need to combine the technology evolutionary trends to achieve it.

After analyzing tens of thousands of patents containing the most effective and innovative solutions in different fields, G.S. Altshuller, a former Soviet scientist, revealed the objective evolutionary trends of engineering systems, and concluded the S-curve evolution law and eight evolution laws. Nikolai Shpakovski put forward ten evolutionary routes on the basis of the evolution law of technological system in TRIZ theory: "Single-double-multi-system" evolution route, system trimming route, system expansion- trimming route, object segmentation route, object surface characteristic evolution route, object internal structure evolution route, object set evolution route, dynamic evolution route, evolution route to improve controllability and coordination degree [8]. In this paper, the technology system evolution route mentioned above is combined to help identify the potential technology evolution nodes on the technology roadmap of patent linkage.

Increase the main nodes and secondary nodes of the technology roadmap of the target domain to form a complete technology evolution hypothesis roadmap. Finally, according to the hypothetical roadmap of technological evolution obtained above, the potential technological evolution roads in the target field is summarized, to guide the generation of new technical schemes and provide method support for enterprise technological innovation.

3 CASE ANALYSIS

Gesture interaction is a natural and intuitive man-machine interaction mode. Gesture control is another intelligent technology after speech recognition technology, which makes man-machine interaction more abundant, intelligent and convenient. In order to verify the operability of the above prediction model, this study selects the application of gesture control in air conditioning field as the research object for empirical analysis.

3.1 Patent mining stage

In this study, Patentics database is used as the patent data source, and the retrieval strategy is formulated according to the opinions of relevant experts in the field. The final retrieval scheme is shown in Table 1. According to the retrieval scheme, 165 patents were finally obtained. After preliminary reading, the patents with low relevance were removed, and 106 related patents remained.

Table 1 Patent retrieval scheme of target field

Retrieval Platform	Patentics（https://www.patentics.com/）
Retrieval Time	2021.9
Database Scope	Chinese invention patent, utility model patent
Time Range	2000-2021
Retrieval Expression	Ipc /(F24F or F25b) and A/gesture

3.2 The stage of constructing the technical road map of patent linkage

According to the obtained patent clustering results, the evolutionary hypothesis "gesture control is more and more convenient" is put forward. The hypothesis of evolution is divided into three stages, the first stage: basic gestures, the second stage: naturalized gestures, and the third stage: intelligent gestures (at present). The evolution hypothesis is taken as the backbone node of the technology roadmap, and then the branch nodes are supplemented one by one according to the patent clustering results, forming a complete patent-linked technology roadmap.
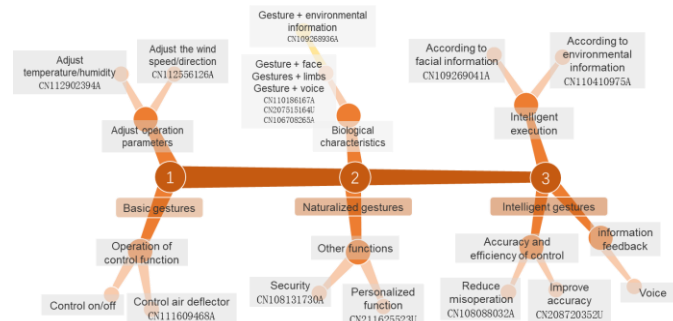

Figure 3. Patent-linked technology roadmap

3.3 Identify potential technology roads

On each branch, it is judged whether it is possible to use the evolutionary route, first on the main node, and then on the secondary node.

Combining with the technology evolutionary trends to identify the potential nodes of technology development, the green node is the potential node of gesture control in the field of air conditioning.
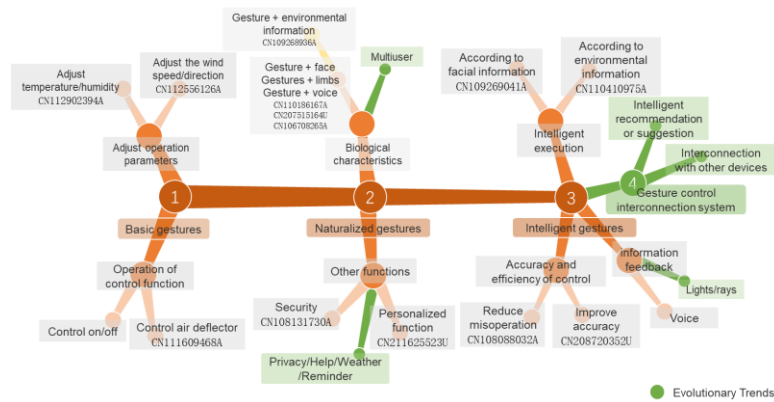
Figure 4. Evolutionary hypothesis roadmap

According to the assumed roadmap of technology evolution obtained above (Figure 4), the potential technology evolution route of gesture control in air conditioning field is predicted:

(1)   According to the single-double-multi evolutionary trend. Check the number of users, which can be operated by one person or many people. At present, the existing gesture control is basically aimed at a single user's gesture control, or when there are many people, the user's gesture with high authority is selected to execute the command. At present, there is no patent to realize simultaneous gesture control of many people.

(2)   According to that evolutionary trend of improving controllability. Increase the intelligent recommendation or suggestion of gesture control to improve the automation degree of gesture control. The existing air conditioning control is in semi-automatic control, and the next step is to enter the automatic control stage. Under the automatic control, the air conditioner collects environmental information and user information, and the user only needs to confirm or cancel the operation by gestures, thus reducing numerous of user operations and improving the user experience.

(3)   According to the dynamic evolutionary trends. Increase the interconnection between air-conditioning equipment and other equipment, and you can control other smart homes by controlling air-conditioning. For example, after turning on the air conditioner, turn off the fan or turn on the fan to realize integrated air supply; You can also control the bedroom air conditioner, the living room air conditioner, TV and other smart home appliances. Similarly, by controlling other intelligent products, the related functions and modes of air conditioners can be controlled remotely by gestures.

4 CONCLUSION

In this paper, a technology forecasting method based on patent analysis and technology evolutionary trends is proposed, and the application of gesture control in the field of air conditioning is taken as an example. This method by searching and reading patents manually, clustering patents with expert opinions, and establishing a technical road map according to the clustering results, we can grasp the thread and direction of technological development from a

microscopic point of view. Then establish the technical main nodes that are not available in the target domain, and then predict the potential technical evolution nodes in the target domain in combination with the technical evolutionary trends, to predict the future development direction of technology from a macro perspective. The forecasting model put forward in this study combines the macroscopic technological evolutionary trends with the microscopic technological road map based on patent linkage, identifies the potential opportunities of technological development, obtains innovative schemes, and provides methodological support for enterprise innovation.

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