A Methodology for Patent Function Analysis

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Abstract**:** *The preceding researches on functional analysis of patents using patent classification codes or keywords as function classifiers are lack of consideration in the fact that functional elements vary from patent to patent. This study proposes the methodology for systematically identifying functional elements of patents using patent-function matrix, allowing us to better match and compare them with the actual functions in commercialized products. By applying the new methodology to the case study of Korean patents regarding smart watch, we could easily find out the distribution of patents amongst functional elements and identify the functional range of each patent.*

Keywords: *functional analysis of patents, patent-function matrix, functional elements, functional range, functional coverage.*

1. Introduction

Satisfying customer requirements is the most important purpose of the engineering design process. Functions of an item are key criteria of customer satisfaction, so engineers try to understand functional needs and realize preferable functions throughout the entire process. In order to help the engineers and make the process work well, various kinds of methodologies and engineering tools for functional analysis have been developed, such as Value Engineering, TRIZ, Quality Function Deployment (QFD), Design Structure Matrix (DSM), Function Tree. Functional Analysis Diagram (FAD), etc [1- 4].

Patent documents deal with technological inventions for solving a certain problem and they describe functions, physical structures and the way they are combined very specifically. Engineers can determine specific R&D directions by conducting a functional analysis of patents in the technical field of concern. Many of the preceding researches regarding a functional analysis of patents regard patent-classification codes or abstract keywords extracted by text mining techniques as functions of the patents [4, 5]. Though it is efficient in terms of time and cost spent for the analysis, there are several limitations of that approach. First, it is difficult to identify specific functional elements of patents in detail by the approach. The functions defined by classification codes or keywords are too comprehensive to be matched with the actual functions of the related products commercialized in the market. Thus, commercialization of the patents is difficult to be determined in this analytical method

In addition, it is difficult to differentiate specific functions of each patent with the current method. In general, a patent has one or more functional elements and the elements vary from patent to patent. Even if some patents are assigned to the same classification code and have the same keywords, the functional elements of a patent are not necessarily the same with the other patents in the same group. Some of functional elements in a patent are unique and different from the elements in other patents, while the other elements commonly appear in the other patents of the same field. Thus, the functional range or coverage that varies from patent to patent and the distribution of patents amongst functional elements cannot be exactly evaluated by the current approach.

In order to solve these problems, this study proposes the methodology for systematically identifying functional elements of patents in detail to maximize the distinguishability of them, allowing us to better match and compare them with the actual functions of the commercialized products. A Patent-Function matrix and a Function-Structure matrix are used for the newly proposed method, through which the following analytical tasks can be easily done to get useful information.

1) Analysers can obtain a complete picture of the distribution of patents amongst functional elements

2) Analysers can identify the functional range or coverage of each patent

3) Analysers can determine the commercialization of each functional element in patents

In section 2, we develop the stepwise procedure of patent function analysis. A function-structure matrix and a patent-function matrix play key roles to identify structural and functional elements of each patent. In section 3, we apply the procedure to the patents of smart watch filed by Samsung and LG in Korea. Through this case study, we evaluate the applicability of the procedure we developed. In section 4, we lastly make a conclusion of the procedure and the case study.

2. Stepwise Procedure of Patent Function Analysis

The main purpose of the procedure of patent function analysis we propose is to identify functional elements in the patents of interest so as to match them with the actual functions of commercialized products. The first step is to determine the technological field of interest and fine the related product group in the market. The information of commercialized products is needed to compare their actual functions to the functional elements identified through this procedure.

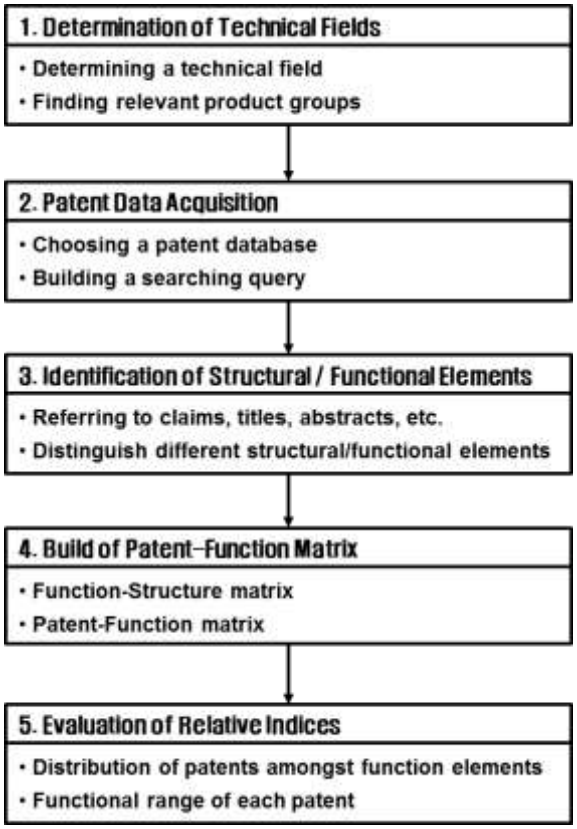

Fig. 1: Stepwise procedure of patent function analysis

The second step is to search for the patents associated with the field or product group using searching queries and acquire the patent data containing required information such as titles, abstracts, claims and so on. A searching query needs appropriate combination of keywords with operators. It is helpful to make use of field-restricted searching to get relevant patents. Even if well-designed queries and helpful searching options are used, possibly there are noise data to be eliminated among the collected patent data. The analyser can detect the noise data by reading the contents personally, but it is more efficient to use text mining techniques to find them. By eliminating the noise, valid patent data are attained.

In the third step, the contents of each patent document are examined to identify structural and functional elements of patents. The claims provides key information to do this, so it deserves to be scrutinized. Claims of a patent define which subject matter is protected by the patent and they basically include functional elements and structural elements to perform the required functions. Titles, Abstract and the other parts of patents are also used as references.

In the fourth step, the structural and functional elements identified are represented in a function-structure matrix and a patent-function matrix. A function-structure matrix maps each of functional elements onto structural elements required for performing its intended function, with which engineers easily comprehend the relationship between the functional elements and the structural elements. A patent-function matrix shows what functional elements are included in each patent.

Some important indices can be calculated from a patent-function matrix, so the last step is to estimate them. For example, the number of patents of each functional element and its relative frequency can be calculated. A functional coverage of each patent, an index newly proposed in this paper, can also be estimated. It means a set of functional elements a patent has. A size of a functional coverage is the number of elements that belong to the set. The bigger the size of the functional coverage is, the broader the range that the patent covers is. The functional coverage and its size are important because they can be used to evaluate the value of each patent for an additional analysis.

3. Case Study

To evaluate the applicability of the procedure developed in Section 2, we applied the procedure to the patents of smart watch which has been filed by Samsung and LG in Korea since 2010. From 'Wips', a patent database, the patents which include watch-related keywords in their title and whose applicant is either Samsung or LG are collected. By eliminating noise, 16 valid patent data of smart watch were attained. By scrutinizing the claims of the patents and referring to other information such as titles, abstracts and so on, the structural and functional elements represented in Table 1 were identified. Smart watch patents of Samsung and LG contain a display unit, a memory, a processor, a strap for fixing and many kinds of sensor units such as GPS, heartbeat measuring sensor, rotation sensor, tilt sensor, etc. The fundamental functional elements in the patents are display control, motion sensing, heartbeat measuring and so on. There are some secondary functional elements such as user authentication, where some fundamental functional elements, data processing and control logics are needed to perform the intended function. We assigned an identification number to each of the functional elements for the convenience of the further analysis.

TABLE I: The structural and functional elements identified

Types	Elements
Structural Elements	Display unit, Communication unit, Antenna frame, Antenna of metal thread, Memory, Processor, Power feeding unit, Hinge unit, Connector, Insulating unit, Non-metal strap, Elastic material of strap, GPS, Heartbeat sensing unit, Rotation sensing unit, Tilt sensing unit, Software
Functional Elements (1^{st})	Convenience of wearing(F1.1), Connecting components(F1.2), Data/signal transmission(F1.3), Data/signal reception(F1.4), Display(F1.5), Display control(F1.6), Heartbeat sensing(F1.7), Location sensing(F1.8), Power feeding(F1.9), Rotation velocity sensing(F1.10), Rotation angle sensing(F1.11), Tilt sensing(F1.12)
Functional Elements (2^{nd})	Detecting events of external device(F2.1), Event notification(F2.2), User authentication(F2.3)

As long as all of the elements were identified, each of the structural elements was matched with the functional elements for which it exists. The result of the matching task was presented by the function-structure matrix, shown in Table 2. The table shows which structural elements are required for performing each of the functional elements, which is an important information for engineers to design the relative products.

TABLE II: Function-structure matrix of the patents regarding smart watch

Functional / Structural	F1.1	F1.2	F1.3	F1.4	F1.5	F1.6	F1.7	F1.8	F1.9	F1.10	F1.11	F1.12	F2.1	F2.2	F2.3
Display unit					○								○	○	
Communication unit			○	○									○	○	○
Antenna frame			○	○											
Antenna of metal thread			○	○											
Memory													○		○
Processor							○						○	○	○

Power feeding unit									○						
Hinge unit		○													
Connector		○													
Insulating unit	○														
Non-metal strap	○														
Elastic material of strap	○														
GPS								○							
Heartbeat sensing unit							○								○
Rotation sensing unit										○	○				
Tilt sensing unit												○			
Software													○	○	○

The patent-function matrix based on the identified functional elements, shown in Table 3, was made to calculate some important indices. Seeing the table below, we can find out the distribution of patents amongst functional elements. According to the table, the most frequently appearing functional element is display control which 9 patents commonly include, followed by display (8 patents), data/transmission (7 patents), data/signal reception (7 patents). The functional elements that a number of patents commonly include are considered to be general elements, while the elements that appear only in few patents are considered to be unique elements.

In this study, we developed an index called 'functional coverage' to evaluate the technical range of a patent. It is defined as a set of functional elements included to a patent and the size of functional coverage is the number of elements in the set. We can also find out the functional coverage of each patent and calculate its size from the patent-function matrix. For example, according to Table 3, the functional coverage of Patent 7 is {data/signal transmission (F1.3), data/signal reception (F1.4), display control (F1.6), heartbeat sensing (F1.7), user authentication (F2.3)}, so the size of the functional coverage of Patent 7 is 5. In terms of the size of functional coverage, Patent 11 and Patent 13 have the biggest value, 6, while Patent 16 has the lowest value, 1. The bigger the size of functional coverage, the more functional elements are included and the broader the technical range a patent is. However, it does not mean that a patent that has a lower size of functional coverage is less important than other patents with a bigger size. Even if a patent has only one functional element, the functional element can be more important than the other elements, which makes the patent valuable enough. By comparing the patents with each other in terms of the functional range, we can comprehend the difference between the specific functions of the patents. If we have enough information of determining the importance of functional element, we can evaluate the value of each patent based on the identified functional coverage and its size.

TABLE III: Patent-function matrix of the patents regarding smart watch

Functional / Structural	F1.1	F1.2	F1.3	F1.4	F1.5	F1.6	F1.7	F1.8	F1.9	F1.10	F1.11	F1.12	F2.1	F2.2	F2.3
Patent 1 (KR2013-0125396)	○	○	○	○					○						
Patent 2 (KR2013-0123519)	○				○	○									
Patent 3 (KR2013-0113748)					○	○				○	○				
Patent 4 (KR2013-0103191)						○				○	○				
Patent 5 (KR2013-0104319)			○	○											
Patent 6 (KR2013-0105027)					○	○						○			
Patent 7 (KR2013-0090453)			○	○		○	○								○
Patent 8 (KR2013-0084567)	○				○	○		○				○			
Patent 9 (KR2013-0078240)					○	○									
Patent 10 (KR2013-0066657)	○	○													
Patent 11 (KR2013-0062908)			○	○						○	○		○	○	

Patent 12 (KR2013-0059799)	○	○	○	○											
Patent 13 (KR2013-0051503)			○	○	○	○							○	○	
Patent 14 (KR2013-0044001)			○	○	○	○								○	
Patent 15 (KR2013-075030)		○			○				○						
Patent 16 (KR2013-0123519)	○														
Number of patents	**6**	**4**	**7**	**7**	**8**	**9**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**1**

4. Conclusion

In this study, the new methodology for patent function analysis was developed. The stepwise procedure of patent function analysis using patent-function matrix was designed to systematically identify specific functional elements in each patent of concern. We proposed a functional coverage and a size of a functional coverage as indices for evaluating the technical range of patents. We carried out the case study of Korean patents regarding smart watch to evaluate the applicability of the new methodology. Based on the patent-function matrix created by the stepwise analytical procedure, we could easily find out the distribution of patents amongst functional elements and identify the functional range of each patent. It is expected that we could differentiate the specific functions of the patents by comparing them with each other in terms of the functional range.

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