

Aligning Patent Claims with Detailed Descriptions for Readability

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Abstract

Patent specifications consist of patent claims and detailed descriptions. While patent claims are the most important part of patent specifications, they are compositionally or combinationally described and difficult to read. By aligning patent claims with detailed description, the readability of patent claims can be improved because paraphrases for the claims can be found. In this paper, we propose a method to align patent claims with detailed descriptions by analyzing the structure of claims to get core elements of claims, aligning between each core element in the claim and each sentence in the detailed description, and filtering the result based on the existence of "effectiveness expressions" in the sentence.

Keywords: claim analysis, alignment, readability

1 Introduction

The most important part of patent specifications is where the claims are written, because "the claims specify the boundaries of the legal monopoly created by the patent" [2]. In general, patent claims are described in one sentence with peculiar style and wording and they are difficult to read and understand for ordinary people[15, 14].

The patent law specifies that what are claimed have to be described in the specification and the description is given in the detailed description[4]. The detailed descriptions are usually written in a style as in technical papers and their readability are higher than the claims.

In principle, one can understand inventions by reading the claims and the detailed descriptions. But as the claims are difficult to read and the detailed descriptions are lengthy, it takes long time to read and understand patent specifications.

If patent claims are appropriately aligned with sentences in the detailed descriptions, the readability of claims would

be improved because the aligned sentences in the detailed descriptions are more readable than the claims.

In this paper, we propose a method to align patent claims with detailed descriptions. In the method, patent claims are first analyzed by the structure analysis method proposed by us[15, 14]. Next, the similarity scores between each core element in the claims and each extracted sentence from the detailed descriptions are computed by finding multiple local alignments. Finally the results are filtered based on the existence of "effectiveness expressions" in the sentence.

2 Nature of Patent Specification

2.1 Structure of Patent Specification

Patent specification has the structure specified by the patent system of each government. For example, Japanese patent specifications have the following structure:

- Invention Title
- Claims
- Detailed Description
 - Field of the invention
 - Prior art
 - Means of solving the problems
 - Embodiments of the invention
 - Effects of the invention
- Brief Explanation of Drawings

2.2 The Role and the Characteristics of Effects of the Invention

We believe that the effects of the invention plays an important role in understanding patent specifications, because

Table 1. Description patterns at each sentence end in the “effects of the invention”

No	Pattern	Percentage
1	できる。 (dekiru.) [be able to]	51.3 %
2	可能(に と)なる。 (kanou (ni to) naru.) [become possible]	8.7 %
3	(得 え)られる。 (erareru) [can get]	4.8 %
4	可能である。 (kanou de aru.) [be able to]	2.5 %
4	効果がある。 (kouka ga aru.) [have effect]	2.5 %
5	<サ変名詞>する。 ([noun] suru) [do something]	2.3 %

it describes what effects are achieved or how the invention is useful.

There are some patent specifications which do not have the “effects of the invention” section. But they have the descriptions in other sections such as the “means of solving the problems” or the “embodiments of the invention”.

To find out the characteristics of the description for the effects of the invention, we examined 132 patent specifications taken from the NTCIR3 patent data collection[11] ¹. We tried to find out what kind of expressions are used at each sentence end in the “effects of the invention” for them. The result is shown in Table 1. The sum of percentages for the top five expressions is 72.1% and those expressions can be treated as the “effectiveness expressions”. They can be used to find the sentences which express the effects in the “means of solving the problems” or in the “embodiments of the invention.”

In addition, we examined the description patterns just before the touten “、” (comma) in the sentences which end with the description patterns in Table 1. The result is shown in Table 2. In Table 2, the sum of percentages for the patterns marked from *i* to *m* are 22.7%. Because they represent the cause-effect relationship in Japanese, we can assume the cause for the effect is described just before those patterns.

2.3 Finding Correspondences between Claims and Effects

Claims are described compositionally or combinationally. To put it more specifically, combination of products or the structure of products are described for the invention of

¹The 132 patent specifications are taken from the search topic for laser jet printer for the patent search task of NTCIR3.

Table 2. Description patterns just before the touten “、” (comma) in the “effects of the invention”

No	Pattern	Percentage
1	(Verb)	19.5 %
2	は (wa) [be]	16.5 %
3	て (te) [does]	13.7 %
4	(Noun)	12.8 %
...		
<i>i</i>	により (niyori) [as]	5.6 %
<i>j</i>	ば (ba) [as]	5.1 %
<i>k</i>	ので (node) [as]	4.7 %
<i>l</i>	(従 したが)って (shitagatte) [therefore]	3.9 %
<i>m</i>	ため (tame) [as]	3.4 %

product, and combination of processes (acts or operations) are described for the inventions of method[4] ². In fact, the phrases of “comprising” and “consisting of” are often used in claims written in English.

If we assume that claims perform some functions and achieve some effects, we can find correspondences between claims and effects in patent specifications. Considering that claims are compositionally or combinationally described and have structures, the correspondences can be found for each element in claims.

For a sample claim in Figure 1, the structure can be analyzed by the method we proposed before[15, 14]. The method is based on the RST (Rhetorical Structure Theory) [7] and uses cue phrases obtained from the corpus analysis of patent data. The result can be shown by using the RSTTool [12] as in Figure 2. The claim is in the “Jepson-like style” that consists of the first part representing the known thing or the presupposition and the last part representing the novel thing or the main issue[15, 14]. The elements in the last part are considered to be the core elements. Two of the core elements in the claim have corresponding descriptions in a sentence in the detailed description. The corresponding parts in the elements and in the sentence are underlined in Figure 1 and Figure 3.

Finding correspondences between claims and effects has the merits as follows:

- Paraphrases for the claims which are more readable and are functionally described can be found.
- Direct effects for the claims can be found.

In the example of Figure 1, two paraphrases are found as follows:

²“Functional claims” in which functions of the invention are described can be accepted only if the descriptions are clear.

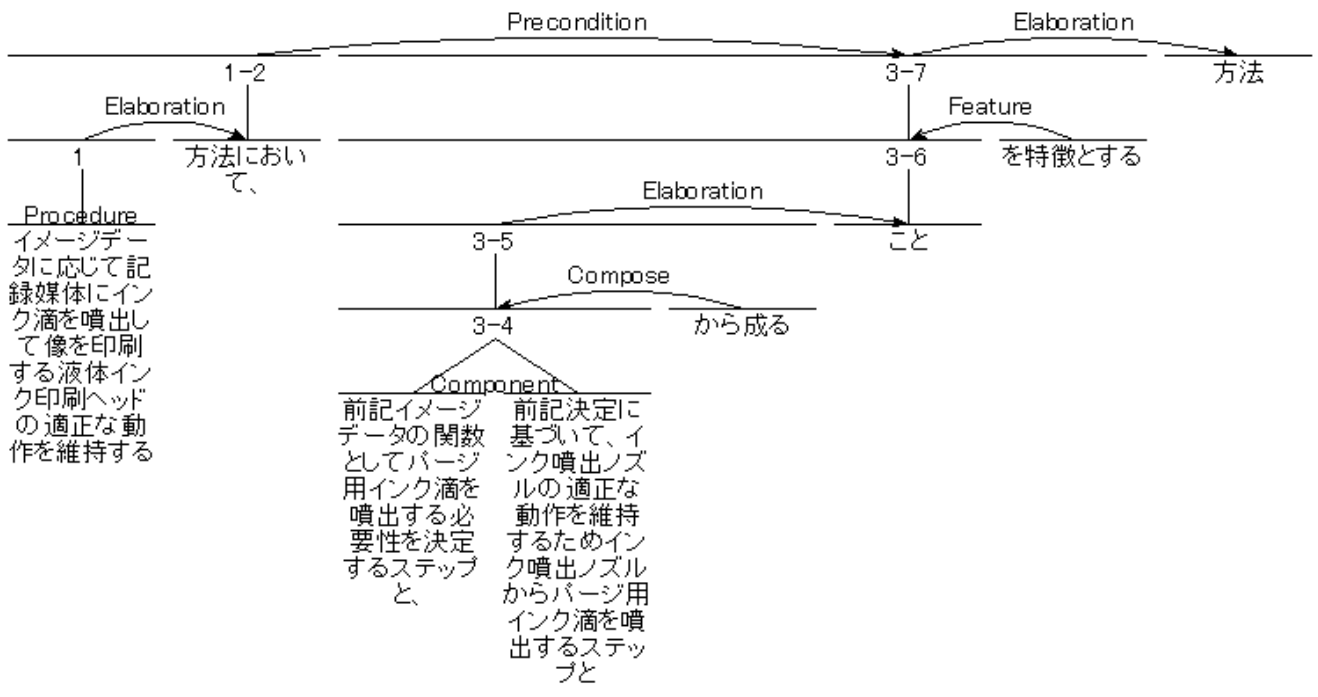


Figure 2. A result of structure analysis of the claim in Figure 1 (using RSTTool v2.7)

イメージデータに応じて記録媒体にインク滴を噴出して像を印刷する液体インク印刷ヘッドの適正な動作を維持する方法において、前記イメージデータの関数としてパージ用インク滴を噴出する 必要性を決定する ステップと、前記決定に基づいて、インク噴出ノズルの適正な動作を維持するため インク噴出ノズルからパージ用インク滴を噴出する ステップとから成ることを特徴とする方法。

(An method to maintain appropriate motion of liquid ink printing heads which jet ink drops to printing materials based on image data, comprising:
 (a) a step which decides the necessity of jetting ink based on said image data;
 (b) a step which jet purging ink drops from ink jetting nozzles to maintain appropriate motion of ink jetting nozzles.)

Figure 1. A sample Japanese claim extracted from a patent (publication number=10-6528)

これらの問題を考慮して、本発明は、全ノズルアレイからインクをパージする代わりに、印刷ヘッド内のどのノズルがメンテナンスを 必要としているかを決定し、それらのノズルだけから選択的にインクをパージする 装置および方法を提供する。[このような知能的メンテナンスは、走査型インクジェットプリンタにおいて処理量を増加させるばかりでなく、全幅アレイプリンタにおいても廃インクの量を減少させる。]

(Considering the above problems, this invention provides a device and a method which decides which nozzles need to be maintained and which purges ink only from those nozzles, instead of purging from the array of all nozzles. [As an intelligent maintenance mechanism, this invention not only increases the processing ability of scanning ink jet printers, but also decreases the amount of waste ink for full-width array printers.]

Figure 3. The aligned sentence in the detailed description for the claim in Figure 1

Paraphrase 1

- 必要性を決定する
(hitsuyou sei wo kettei suru)
[decide the necessity]
- 必要としているかを決定し、
(hitsuyou to shite iruka wo ketteishi)
[decides which nozzles need to be maintained]

Paraphrase 2

- インク噴出ノズルからパージ用インク滴を噴出する
(ink funshutsu nozzle kara purge you ink eki wo funshutsu suru)
[jet purging ink drops from ink jetting nozzles]
- インクをパージする
(ink wo purge suru)
[purges ink]

We should note that these paraphrases are found including the last “bunsetsu” (basic block in Japanese composed of several words) in the core element of claims whose head word is declinable. In Japanese, declinable words include verbs and adverbs and the bunsetsu whose head word is declinable can represent some action or function. Therefore we can infer that the last bunsetsu in a core element of claims whose head word is declinable represent the function of the element.

The direct effect for the claim in Figure 1 are found in the next sentence starting as “このような知能的メンテナンスは、...” (As an intelligent maintenance mechanism, ...). The sentence is enclosed with a set of brackets in Figure 3.

3 Aligning Method

For Japanese patent specifications, we designed an aligning method described in the following.

1. Analyze the structure of patent claim by using cue phrases and extract core elements in the structure.
 - Because we use the approach in Shinmori et al.[15, 14], we only deal with independent claims. In other words, we do not deal with dependent claims that cite other claims.
 - For the claims of Jepson-like style, we just use the elements in the last part as the core elements.
 - For other styles, we use all elements as the core elements.
2. Extract sentences from the “means of solving the problems”, the “embodiments of the invention”, and the “effects of the invention”.
 - The “field of the invention” just generally described the background or the target field of the invention and has little to do with the functions and the effects achieved by the claims.
 - The “prior arts” has some relationship with the first part of the Jepson-like claim, but has little to do with the functions and the effects achieved by the claims.
3. For the pair of each core element of the claim and each extracted sentence, compute the similarity score by finding multiple local alignments.
 - The similarity is computed based in the unit of bunsetsu and the similarity of bunsetsu is calculated in a similar way as in Takeuchi[16].
 - Let b_1 be a bunsetsu from the core element, b_2 be a bunsetsu from the extracted sentence, and $s(b_1, b_2)$ be the similarity score for them. Then,
 - * $s(b_1, b_2) = 3$, if b_1 and b_2 are completely equal except the last touten “、” (comma) if any.
 - * $s(b_1, b_2) = 2$, if the head words for b_1 and b_2 are declinable and the basic forms are equal, or if both b_1 and b_2 are in the form of noun or symbol followed by postpositional particles for the nominative case.
 - * $s(b_1, b_2) = 1$, if b_1 and b_2 contain a common word.
 - Create a dynamic programming table by using recurrence[3, 9].
 - Start finding local alignments from the last bunsetsu of the core element whose head word is declinable and move backward to the head finding non-overlapping local alignments.
 - The reason of finding multiple local alignments instead of finding the global alignment is to try to align fundamentally important sets of bunsetsu only, ignoring excessive words and phrases that exist in both claims and detailed descriptions.
 - The reason of starting the finding process from the last bunsetsu of the core element whose head word is declinable is that it is considered to represent the function of the element. Putting it another way, we analyze the structure of claim to get the set of core elements and to find the last bunsetsu for each core element.

- After finding a local alignment for the last bunsetsu of the core element, move backward to find the maximum score in the left-upper remaining portion of the table and start the next local alignment from there.
 - If there is a gap between adjacent local alignments, deduce the gap cost of 0.5 for each direction.
- An example of alignment for a patent (publication number = 10-146993) is shown in Table 3. Each of the underlined parts is a local alignment.
4. For each extracted sentence, sum up the similarity for each core element to get the total similarity score.
 5. Filter the result by checking whether one of the “effectiveness expressions” exists at the sentence end, or in the next sentence and by checking the subject of the sentence.
 - As the “effectiveness expressions”, we use the ones described in the following regular expression which are based on Table 1 and modified by our observation:
 (でき(る|た)|可能(に|と)な(る|った|つた)|((得|え)られ(る|た)|可能である|効果がある|った|つた)|を提供する|が省け(る|た)|を行(え)?(る|た)|を行(え)?(る|よう|様)にな(る|った|つた)|をおこなえ(る|た)|をおこなえる(よう|様)にな(る|った|つた)|達成され(る|た)).
 - Checking the subject is done by first checking if the postpositional particle “は” (wa) exists. If it exists and the subject is neither the one representing the invention, nor the one of the strings at the end of the claims, nor the one of the following strings, then the sentence is filtered out.
 - 本発明は、(hon hatsumei wa,) [this invention]
 - 本発明においては、(hon hatsumei ni oiteha,) [in this invention]
 - 本実施形態では、(hon jisshi keitai deha,) [in this embodiment]
 - In the example of Table 3, the part enclosed with a set of brackets has the pattern “できる” (dekiru) [be able to] at the sentence end. In addition, it has the postpositional particle “は” (wa) and the subject “このインクジェットプリンタ” (kono ink jet printer) [this ink jet printer] is equal to the string representing the invention. Therefore this sentence is not filtered out and considered to represent the effect of the claim.

4 Experiment

4.1 Materials and Method

To evaluate the effectiveness of our method, we used the NTCIR3 patent data collection[11] which consists of all patent specifications made public in Japan in 1998 and 1999.

Depending on the field of the invention, patent specifications do not have the sentences in the detailed descriptions that can be aligned with claims. For example, the patent specifications on the inventions of chemical substances describes chemical formulae in claims in many cases. Because the field of the invention can be identified by looking at the IPC (International Patent Classification) code in the specification, we decided to exclude the patents whose IPC code specify chemistry, metallurgy, or fiber³.

We randomly picked up 50 patent specifications from the NTCIR3 patent data collection. Of the 50 specifications, 12 (24%) are in the field of chemistry, metallurgy, or fiber. For the first claims of the remaining 38 specifications, we ran the aligning method explained in the previous section. The result was checked by us if it was correct or not.

To divide Japanese sentence into bunsetsu, we used “cabocha” [6], a Japanese dependency structure analyzer.

4.2 Results

By checking the 38 patent specifications we found that 12 (31.6%) specifications do not have the alignment we have been discussing so far. In other words, for 31.6 % of the patent specifications there is no sentence in detailed descriptions that can be aligned with the first claim and that includes or is followed by one of the “effectiveness expressions”.

The aligning method found 35 alignments in which 20 were correct. We investigated all of the 38 patent specifications and confirmed that the number of total alignment is 26. The recall(R) and the precision(P) are calculated by the followings, where c is the number of correct alignment, n is the number of alignment our method found, and t is the number of total alignment.

$$P = \frac{c}{n} \quad (1)$$

$$R = \frac{c}{t} \quad (2)$$

They are shown in Table 4.

For the 20 correct alignments, we can get 16 (80.0 %) useful paraphrases. Some of them are shown in the appendix.

³Those codes are for inorganic chemistry(C01, C03-C06, C30), organic chemistry(A01N, A61K, C07), high polymer chemistry(C08-C11, C14), metallurgy(B22F, C21-C25), and fiber(A41-42, D).

Table 3. An example of alignment for an element of a claim and an extracted sentence of a patent (publication number=10-146993)

str1 (a core element) = 前記 時間 計測手段の 計測結果に 基づいて、 前記 印刷ヘッドの 増粘インク除去処理を、 定期的に 実行する 増粘インク除去手段と、
 str2 (an extracted sentence) = この インクジェットプリンタは、 印刷ヘッドが ヘッドキャップに密着している 非印刷状態においても、 定期的に 増粘インク除去処理を 実行する ため、 [非印刷状態で 長期間放置しても、 印刷ヘッド等の増粘インクが 除去された 状態を 維持できる。]

	...	前記 (zenki)	印刷ヘッドの (insatsu head no)	増粘インク除去処理を、 (zounen ink jyokyo shori wo,)	定期的に (teikiteki ni)	実行する (jikkou suru)	増粘インク除去手段と、 (zounen ink jyokyo shudan to,)
この (kono)	0	0	0	0	0	0	0
インクジェットプリンタは、 (ink jet printer wa)	0	0	0	0	0	0	0
印刷ヘッドが (insatsu head ga)	0	0	<u>2</u>	1	0	0	0
ヘッドキャップに (head cap ni)	0	0	1	0	0	0	0
密着している (micchaku shite iru)	0	0	0	0	0	0	0
非印刷状態においても、 (hi-insatsu jyotai ni oitemo,)	0	0	1	0	0	0	0
定期的に (teikiteki ni)	0	0	0	0	<u>3</u>	2	1
増粘インク除去処理を (zounen ink jyokyo shori wo)	0	0	0	3	<u>2</u>	1	3
実行する (jikkou suru)	0	0	0	2	1	<u>5</u>	4
ため (tame)	0	0	0	1	0	4	3
...	0	0	1	0	0	3	2

$Score = 5 + 2 - 0.5 * 2 = 6$

Set of local alignments from str1 = 印刷ヘッドの...定期的に実行する (insatsu head no...teikiteki ni jikkou suru)

Set of local alignments from str2 = 印刷ヘッドが...定期的に増粘インク除去処理を実行する (insatsu head ga...teikiteki ni zounen ink jyokyo shori wo jikkou suru)

(Note: In the above, "..." means a gap.)

Table 4. The result

Recall(R)	76.9 %
Precision(P)	57.1 %

5 Discussion

The reason why the precision is low is that our method tried to find alignments even for the specifications which do not have the alignment we have been discussing so far. Considering this, we need to add more filtering mechanism.

In some cases, one of the “effectiveness expressions” is located in the sentence next to the next of the target sentence. Because the current filtering mechanism just checks the sentence end or the next sentence, the recall could be improved if it additionally checks the next of the next sentence of the target sentence.

There are some patent specifications that include sentences of almost verbatim copy of claims in the “means of solving the problems”. If those sentences are followed by the sentences which include one of the “effectiveness expressions”, our method finds them as the alignment. In this case, our method cannot find any useful paraphrase. As a possible solutions for finding paraphrase for this situation, we could detect the verbatim copy, ignore the alignment, and continue the search in the following sections.

The effects of the invention can be described in other sections than the “effects of the invention.” In fact, there are some patent specifications that do not have the “effects of the invention”. Our aligning method could find the effects of the invention for the three patent specifications in which the effects are described in other sections than the “effects of the invention.”

Because our aligning method depends on the result of claim structure analysis, the precision of the structure analysis directly influences the result. In the above experiment, the structure of two claims were incorrectly analyzed. The causes of the incorrect analysis include bugs of the structure analyzer and the existence of unexpected cue phrases. By improving the structure analyzer, the result of the alignment could be improved.

As a statistical analyzer, “cabocha” uses data learned by some corpus. In using “cabocha” we used the data distributed with itself which were learned by Japanese newspapers. If the data learned by patent data collection is used with “cabocha”, the precision of the analysis could be improved.

Though the test data used in the above experiment was selected randomly, the number of patent specifications was not enough. We need to evaluate our method for more data.

6 Related Work

In recent years, many researches on alignment for monolingual corpora are done in the context of summarization and paraphrase[8, 5, 1].

Marukawa et al.[9] and Murata[10] treated patent specifications as a monolingual corpus and tried to find alignments between claims and embodiments. Marukawa et al.[9] proposed to identify multiple local alignments to avoid the “intersection problem”. Their approach uses the whole claim and does not have any filtering mechanism. They do not report any quantitative evaluation. Murata[10] proposed to use the “diff” command for the alignment between claims and embodiments. But, their approach assumes that for patents specification with multiple claims, the embodiments are written in the sequence of the claims. In reality, the assumption rarely holds. Moreover, their approach makes no contribution in readability for the patent specifications that have just one claim and a lot of embodiments.

A research on analyzing patent claims written in English is reported in Sheremetyeva[13]. The focus of the research is patent claim analysis based on the “symbolic grammar formalisms with data intensive method”. An idea to apply the result to improve claim readability is described in the paper. But her approach concentrates on claim analysis and does not make use of detailed descriptions.

7 Conclusions

As an effort to improve readability of patent claims, we have proposed a method to align patent claims with detailed descriptions and reported the result of an experimentation. Although the precision is not high at this point, the method can find useful paraphrases and the direct effects of claims. Therefore the method can be used to improve readability of patent claims.

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Appendix

Paraphrase 3

- 水道水に含まれる塩素イオン濃度に対応する前記電極への通電時間を複数設定可能な (suidou sui ni fukumareru enso ion noudo ni taiou suru zenki denkyoku heno tuuden jikan wo fukusuu settei kanou na) [can set multiple settings for the time of turning electricity for the Chlorine ion density contained in tap water]
- 水道水の塩素イオン濃度に対応する通電時間を任意に選択できる (suidou sui no enso ion noudo ni taiou suru tuuden jika wo nin-i ni sentaku dekiru) [can select arbitrarily the time of turning electricity for the Chlorine ion density contained in tap water]

Paraphrase 4

- 演算手段は、この波形整形手段からのパルス信号によって表される予め定められたパターンに反応して、レベル変更手段を制御することにより、パルス信号のレベルを変更する (enzan shudan ha, kono hakei seikei shudan kara no pulse shingou ni yotte arawasareru arakajime sadamerareta pattern ni outou shite, level henkou shudan wo seigyo suru koto ni yori, pulse shingou no level wo henkou suru) [the calculation device reacts to a designated pattern which can be represented by the pulse signal from the wave shape fairing device, and change the pulse level by controlling the level changing device]
- 演算手段は、波形整形手段からのパルス信号を入力し、このパルス信号によって表される予め定められたパターンに反応して、レベル変更手段を制御することにより、波形整形手段に入力されるパルス信号のレベルを変更している。 (enzan shudan ha, hakei seikei shudan kara no pulse shingou wo nyuuryoku shi, kono pulse shingou ni yotte arawasareru arakajime sadamerareta pattern ni outou shite, level henkou shudan wo seigyo suru koto ni yori, hakei seikei shudan ni nyuuryoku sareru pulse shingou no level wo henkou shiteiru.) [the calculation device inputs the pulse signal from the wave shape fairing device, and reacts to a designated pattern, and change the pulse level by controlling the level changing device]