# The Cultivation of a Chinese-English-Japanese Trilingual Parallel Corpus from Comparable Patents

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## Abstract

Ranging from machine translation (MT) to cross-lingual information retrieval, many NLP applications require parallel corpora as critical resources. Given the phenomenal growth in patents and in the need to mediate between different languages, we explore a new but important area involving patents by investigating how a Chinese-English-Japanese trilingual parallel corpora can be cultivated from comparable patents, and introduce our mined trilingual corpus, which demonstrates the considerable potential of cultivating large-scale parallel corpora from comparable patents.

## 1 Introduction

Although many parallel corpora have been built, such as the Canadian Hansards (Gale and Church, 1991), the Europarl corpus (Koehn, 2005), the Arabic-English and English-Chinese parallel corpora used in the NIST Open MT Evaluation[1], few parallel corpora exist for other language pairs, such as Chinese-Japanese, Japanese-Korean, Chinese- French or Japanese-German. Since parallel data are critical resources for building multilingual applications (e.g. machine translation and cross-lingual information retrieval), the shortage of parallel corpora would be a major limitation for multilingual applications to achieve higher performance.

In this paper, we explore a new but important area involving patents by investigating the potential of cultivating large-scale parallel corpora from comparable multilingual patents. The amount of multilingual patents, i.e. 1.8 million[2], is comparable to the size of multilingual Wikipedia, e.g. 3.5 million English articles[3], but much less work has been done on patents than that on Wikipedia.

This paper presents our new work on mining high-quality Chinese-English-Japanese trilingual parallel sentences from the comparable patents, by following the previous work in Lu et al. (2010a; 2011). Since one million high-quality Chinese-English sentence pairs have been provided to the participants in the Patent MT evaluation at NTCIR-9[4], the new trilingual corpus may be used as training data for the Japanese-Chinese patent translation task, through which we hope to further promote research on machine translation involving Chinese, English and Japanese, especially in the patent domain.

Related work is introduced in Section 2. Patents, PCT patents, multilingual patents are described in Section 3. Then, harvesting multilingual patents from the Web and mining parallel corpora from them are introduced in Sections 4 and 5, respectively. The cultivation of the trilingual parallel corpus is introduced in Section 6, followed by the conclusion in Section 7.

## 2 Related Work

To overcome the lack of parallel documents, comparable corpora are also used to mine parallel sentences, such as Zhao and Vogel (2002), Resnik and Smith (2003), Munteanu and Marcu (2005), Wu and Fung (2005), etc. Another direction is to

[1] http://www.itl.nist.gov/iad/mig/tests/mt/

[2] Retrieved Feb., 2011 from http://www.wipo.int/pctdb/en/. The data below involving PCT patents comes from the website of WIPO.

[3] Retrieved Feb, 2011 from http://en.wikipedia.org/.

[4] http://ntcir.nii.ac.jp/PatentMT/

directly mine bilingual terms from the Web, such as Cao et al. (2007), Lin et al., (2008), Jiang et al. (2009). Smith et al. (2010) investigated the viability of Wikipedia as a comparable corpus and extracted parallel sentences from it. In their experiments, they extracted more than 1 million sentences pairs for two language pairs, namely German & English and Spanish & English, as well as 140 thousand Bulgarian-English parallel sentences.

There are a few papers on related work in the patent domain. Higuchi et al. (2001) used the titles and abstracts of 32,000 Japanese-English bilingual patents to extract bilingual terms. Utiyama and Isahara (2007) mined about 2 million parallel sentences by using the *description* section of Japanese-English comparable patents. The corpus was used for the NTCIR-7 Japanese-English patent machine translation task (Fujii et al., 2008).

For the parallel patent corpora involving the Chinese language, Lu et al. (2009; 2011) derived about 160K high-quality parallel sentences from about 6,000 comparable Chinese-English patents by aligning sentences and filtering alignments with the combination of different quality measures. Following that, Lu et al. (2010a; 2010b) reported a large-scale Chinese-English patent parallel corpus containing about 14 million parallel sentences mined from a large number of comparable patents, from which we have chosen one million sentence pairs for the Patent MT evaluation at NTCIR-9. This paper follows this line of work.

## 3 Introduction to Multilingual Patents

In this section, we briefly introduce multilingual patents (see Lu et al., 2010b for more details). Patent applications have been increasing very quickly in recent years. From 1996 to 2010, China's patent applications have increased by 10 times, and USA and R. Korea have doubled in their patent applications, and USA and Japan are still the top two with most applications in 2011.[5]

The Patent Cooperation Treaty (PCT) system offers inventors and industries an advantageous route for obtaining patent protection internationally. By filing one *"international"* patent application under the PCT system via the World Intellectually Property Organization (WIPO), the protection of an invention can be sought simultaneously in each of a large number of countries.

The number of PCT international applications filed is more than 1.8 million, and English, Japanese and German are the top 3 languages in terms of PCT applications, and English accounts for over 50% of applications in terms of language of both publication and filing.

An applicant who has decided to proceed further with his PCT international application could file that patent in another language at the patent offices of countries where he seeks protection, and then the patent application will have versions in different languages. Such multilingual patents are considered comparable (or noisy parallel) because they are not parallel in the strict sense but still closely related in terms of information conveyed (Higuchi et al., 2001; Lu et al., 2009).

A patent application consists of different sections, namely, *bibliographical data (including title, abstract), drawings, claims, description*, etc. Since we focus on texts in patent applications, only *title, abstract, claims and description* are used in the experiments discussed below.

## 4 Harvesting Multilingual Patents

In this section, we introduce how we harvest the Chinese-English-Japanese trilingual patents from different websites. The official patent office in China is the State Intellectual Property Office (SIPO), and by searching on its website[6], we found about 200K Chinese patents previously filed as PCT applications in English and crawled their *bibliographical data*, *titles*, *abstracts* and *the major claim* from the Web, and then *other claims* and *descriptions* were also added.[7]

All PCT patent applications are filed through WIPO. With the Chinese patents mentioned above, the corresponding English patents were searched from the website of WIPO to obtain relevant sections of the English PCT applications, [8] including *bibliographical data*, *title*, *abstract*, *claims* and *description*. About 80% (160K) out of the Chinese patents found their corresponding English ones.

[5] Retrieved March 2010, from http://www.wipo.int/

[6] http://www.sipo.gov.cn/

[7] Some contents are in image format. Thus the images were OCRed and the characters recognized were manually verified.

[8] Some contents of the English patents were OCRed by WIPO.

Out of the above 160K bilingual patents, we managed to locate the corresponding Japanese version of about 130K of them from the Industrial Property Digital Library[9], which is provided by Japan's National Center for Industrial Property Information and Training and is the public access portal of the Japanese Patent Office (JPO).

## 5 Mining Parallel Sentences from Comparable Patents

Different approaches have been proposed to mine parallel sentences from bilingual documents based on the following information: (1) sentence length (Brown et al. 1991; Gale and Church, 1991); (2) lexical correspondence in bilingual dictionaries (Ma, 2006); (c) statistical translation model (Chen, 1993), or the composite of more than one approach (Simard and Plamondon, 1998; Moore, 2002).

Since the comparable patents are not strictly parallel, the individual alignment methods mentioned above would not be effective. Thus, we, in this study, combine these three methods to mine high-quality parallel sentences from comparable patents by following Lu et al. (2009).

For the patents, we automatically split them into individual sections according to the respective tags inside the patents, and segmented each section into sentences according to punctuations. The sentences in each section of English patents were aligned with those in the corresponding section of the corresponding Chinese or Japanese patents to find parallel sentences after the Chinese or Japanese sentences were segmented into words.

We first use bilingual lexicons to preliminarily align the sentences in each section of the comparable patents for the two language pairs: Chinese vs English and Japanese vs English. The dictionary-based similarity score for each sentence pair is computed based on bilingual lexicons: the combined Chinese-English bilingual lexicon from three sources: namely, LDC_CE_DIC2.0 constructed by LDC,[10] bilingual terms in HowNet and the bilingual lexicon in Champollion (Ma, 2006), and the Japanese-English lexicon EDICT.[11]

We then remove sentence pairs using length filtering and ratio filtering, e.g. (1) for length filtering, if a sentence pair has more than 100 words in the English sentence or more than 333 characters in the Chinese one, it is removed; (2) for length ratio filtering, we discard the sentence pairs with Chinese-English length ratio outside the range of 0.8 to 1.8. The parameters here were set empirically.

We further filter the parallel sentence candidates by learning IBM Models (Brown et al., 1993) on the remaining aligned sentences and compute the translation similarity score for each sentence pair by combining the translation probability value of both directions (e.g. Chinese->English and English->Chinese) based on the trained IBM models (Brown et al., 1993; Moore, 2002; Chen, 2003; Lu et al., 2009). Sentence pairs with similarity score lower than a predefined threshold were filtered out as wrong aligned sentences.

## 6 Parallel Corpora Mined from Multilingual Patents

In this section, we introduce two bilingual parallel corpora and a trilingual one mined from multilingual patents.

### 6.1 A Large-scale English-Chinese Parallel Corpus

The statistics of each section for Chinese and English patents are shown in Table 1. Based on the alignment approach mentioned in Section 5, we aligned the Chinese-English bilingual patents (Lu et al, 2010a; 2010b). Table 2 shows the sentence numbers and the percentages of sentences kept in each step above with respect to all sentence pairs. In the first row of Table 2, *1.DICT* denotes the first step of using the bilingual dictionary to align sentences; *2. FL* denotes the length and ratio filtering; *3. TM* refers to the final step of using translation models to filter sentence pairs.

Table 1. Statistics of comparable patents

| Sections | Chinese | | English | |
|---|---|---|---|---|
| | #Char | #Sent | #Word | #Sent |
| Title | 2.7M | 157K | 1.6M | 157K |
| Abstract | 33M | 596K | 20M | 784K |
| Claim | 367M | 6.8M | 217M | 7.4M |
| Desc. | 2,467M | 48.8M | 1,353M | 54.0M |
| Total | 2,870M | 56.2M | 1,591M | 62.3M |

[9] http://www.ipdl.inpit.go.jp/homepg.ipdl
[10] http://projects.ldc.upenn.edu/Chinese/LDC_ch.htm
[11] http://www.csse.monash.edu.au/~jwb/edict.html

Table 2. Numbers of sentence pairs

| | 1. DICT | 2.FL | 3. TM (final) |
|---|---|---|---|
| Abstr. | 503K | 352K (70%) | 166K (33%) |
| Claims | 6.0M | 4.3M (72.1%) | 2.0M(33.4%) |
| Desc. | 38.6M | 26.8M (69.4%) | 12.1M(31.3%) |
| Total[12] | 45.1M | 31.5M (69.8%) | 14.3M (31.7%) |

Both the 31.5M parallel sentences after the second step *FL* and the final 14.3M after the third step *TM* are manually evaluated by randomly sampling 100 sentence pairs for each section. The evaluation metric follows the one in Lu et al. (2009), which classifies each sentence pair into *Correct*, *Partially Correct* or *Wrong*. The manual evaluation of sampled sentences shows that, in the final corpus, the percentages of *wrong* parallel sentences are no higher than 5%. Thus, the mined 14M parallel sentences are of high quality with only 5% wrong pairs.

### 6.2 A Large-Scale Japanese-English Parallel Corpus

The Japanese texts are downloaded and segmented using the chasen [13] utility. For the Japanese-English bilingual patents mentioned in Section 4, similar preprocessing is conducted to get individual sections and sentences. The statistics of each section for Japanese and English patents are shown in Table 3.

Table 3. Statistics of comparable patents

| Sections | English | | Japanese | |
|---|---|---|---|---|
| | #Word | #Sent | #Word | #Sent |
| Title | 1.6M | 157K | 1.4M | 130K |
| Abstract | 20M | 784K | 23M | 460K |
| Claim | 217M | 7.4M | 250M | 3.8M |
| Desc. | 1,353M | 54.0M | 854M | 21.1M |
| Total | 1,591M | 62.3M | 1128M | 25.5M |

Based on the alignment approach mentioned in Section 5, we build the English-Japanese parallel corpus using Japanese-English bilingual glossary at the size of about 500k entries. Table 4 shows the sentence numbers and the percentages of sentences kept in each step above with respect to all sentence pairs. Since the focus of this work is the final trilingual corpus and there is already a Japanese-English parallel patent corpus (Utiyama and Isahara, 2007), we do not conduct quantitative evaluation of this one.

### 6.3 A Chinese-English-Japanese Trilingual Parallel Corpus via Pivoting

With the trilingual patents harvested in Section 4, a trilingual sentence-aligned patent corpus can be established. As introduced in Section 6.1 and 6.2, the English-Japanese and Chinese- English corpora are first built, and then we use the English sentences as the pivot to align Chinese-English and English-Japanese sentence pairs together as Chinese-English-Japanese sentence triplets.

This pivoting effort gives us 2.1M trilingual sentences with 1.4M from *Description*, 0.59M from *Claims* and 0.06M from *Abstract*. The preliminary manual evaluation of sampled sentences shows that about 70% of the trilingual sentences are correctly aligned, but this accuracy is not satisfactory for the purpose as MT training data. Therefore, we further conduct the following filtering steps:

(1) First, automatically score each Chinese-Japanese sentence pair with a Chinese-Japanese bilingual dictionary, and keep only the highest scored 70% pairs;

(2) Then, learn IBM Models (Brown et al., 1993; Och and Ney, 2003) on the remaining sentences and compute the translation similarity score of sentence pairs by combining the translation probability value of both directions (i.e. Chinese->Japanese and Japanese-> Chinese) based on the trained IBM models.

(3) Finally, sentence pairs with a translation similarity score lower than a predefined threshold are filtered out as wrong aligned sentences.

Finally, we arrive at about 1 million trilingual sentence triplets. The manual evaluation of 1,000 randomly sampled triplets show that about 93% of sentences are correctly aligned. Some triplet examples are shown in Appendix A. There may exist errors from the original patents in the sentences since some of them are OCR-ed, e.g. “either naturally occurring of artificially produced” should be “either naturally occurring or artificially produced” in the English sentence of the third triplet in Appendix A.

We also note that most sentences are not translated directly between Chinese and Japanese

[12] Here the total number does not include the number of titles, which are directly treated as parallel.

[13] http://chasen.naist.jp/hiki/ChaSen/

Table 4. Numbers of English-Japanese sentence pairs

| | RAW | 1. DICT | 2.FL | 3. TM (Final) |
|---|---|---|---|---|
| Abstr. | 460K | 130K (28.2%) | 126K (27.4%) | 125K (27.2%) |
| Claims | 3.8M | 3.3M (86.8%) | 2.4M (63.2%) | 2.1M (55.3%) |
| Desc. | 21.1M | 6.7M (31.2%) | 3M (14.2%) | 2M (9.5%) |
| Total | 25.36M | 10.13M (39.9%) | 5.52M (21.8%) | 4.23M (16.7%) |

but via English, and thus the translations between Chinese sentences and Japanese ones sometimes seem incomplete or non-native.

### 6.4 Discussion on Augmenting the Trilingual Corpus

We had attempted to directly align Chinese and Japanese sentences in the Chinese-Japanese bilingual patents at the beginning. However, the results obtained were not satisfactory partly because of the lack of a good Chinese-Japanese bilingual lexicon suitable for alignment purpose. The publicly available bilingual lexical resources obtained tend to provide detailed definitions and explanations for each term. Such elaborate information does not represent the translated terms in actual usage in the patent texts. As a result, sentences cannot be well aligned based on such resources.

Another possible direction is to make use of the Chinese-Japanese sentence pairs in the current trilingual corpus established to compile a Chinese-Japanese bilingual lexicon via bilingual term extraction (e.g. Kupiec, 1993; Ha et al., 2008; Lu and Tsou, 2009). After the new lexicon is built, we can directly align Chinese and Japanese sentences from scratch again, anticipating more bilingual sentences to be mined and aligned. In return, the new set of increased bilingual sentence pairs can contribute to more trilingual sentence triplets through pivoting. This creates a cycle of value-adding stages: trilingual sentences after pivoting -> bilingual terms -> more bilingual sentences -> more trilingual sentences through pivoting. This iterative approach may also be generalized to multilingual corpora involving even more languages, but the complexity and computation cost may grow soon.

## 7 Conclusion

In this paper, we describe how a high-quality trilingual parallel corpus has been mined from comparable multilingual patents harvested from the Web. One million high-quality Chinese-English sentence pairs have been provided to the participants in the Patent MT evaluation at NTCIR-9, and more bilingual or even trilingual patent parallel corpora can be made publicly available to the research community.

Since there is considerable potential of constructing large-scale high-quality parallel corpora, based on the 1.8 million PCT patent applications and their corresponding national ones, for a wide variety of language pairs involving English, Chinese, Japanese, Korean, German, etc., we are continuing our work on cultivating even larger multilingual patent parallel corpora which may involve three languages and beyond.

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## Appendix A. Chinese-English-Japanese Sentence Triplet Examples

| Patent Publication Numbers | | | Sentence Examples | | |
|---|---|---|---|---|---|
| EN | CN | JP | English | Chinese | Japanese |
| WO00 00039 | CN13 10585 | JP2000-556633 | The present invention relates to a process and product for promoting weight loss in overweight dogs, and more particularly to a process for supplementing a canine diet with L-carnitine to promote weight loss, improve body composition, and enhance satiety in the animal. | 本发明涉及用于促进体重过重的狗减重的方法和产品，更具体地，其涉及补充带有L-卡尼汀的犬饮食以促进体重降低、改善身体构成并提高动物的饱满感。 | 本発明は、太り過ぎのイヌにおいて、体重減少を促進する方法、及び、産物、及び、より具体的には、体重減少を促進し、体の組成を改善し、また、動物において飽満を増強するために、イヌの食餌に L−カルニチンを補足するための方法に関連している。 |
| WO00 00039 | CN13 10585 | JP2000-556633 | In order that the invention may be more readily understood, reference is made to the following example which is intended to illustrate the invention, but not limit the scope thereof. | 为了能够更容易地理解本发明，可以参考下列实施例，它们是为了说明本发明，但不限制其范围。 | 本発明をさらに容易に理解することができるために、本発明を説明することが意図されるがその範囲を限定しない以下の実施例に対して参照を示す。 |

| | | | | | |
|---|---|---|---|---|---|
| WO00 00107 | CN13 04298 | JP2000-556693 | The biocompatible material for the leaflets, rim strip and posts includes both biological material or synthetic polymers which could be either naturally occurring of artificially produced. | 用于小叶、边缘磨带和支架的生物等效材料包括生物学材料或人造聚合体，它们是自然存在的或人工合成的。 | 葉状部、リムストリップ、およびポスト用の生体適合性材料は、自然に生成されるか、あるいは人工的に製造されるかのいずれかであってよい、生物学的材料または合成ポリマー（高分子）の両方を含む。 |
| WO00 00132 | CN13 11653 | JP2000-556718 | Similarly the flange may be provided in any shape and preferably has a symmetrical shape preferably comprising a plurality of lobes (13). | 同样，凸缘可以采取任何形状，较佳的是具有对称的形状，该形状最好包括多个突出部分(13)。 | 同様にフランジは任意の形で提供されるが、好ましくは複数のローブ（１３）を備えた対称形をとることが好ましい。 |
| WO00 00231 | CN13 35782 | JP2000-556816 | It is one object of this invention to provide a method for producing apertured film covers for use in a fluid absorbent material such as feminine care products, surgical drapes, fenestration reinforcement, absorbent pads and the like having aperture regions having a higher wettability than at least a portion of the top surface thereof. | 本发明的一个目的是提供一种制造用在流体吸收材料，例如女性护理制品、手术被单，穿孔加强物、吸收衬垫和类似材料中的有孔薄膜外罩件的方法，该流体吸收材料具有孔区域，该孔区域具有比至少一部分顶表面高的可润湿性。 | 本発明の１つの目的は、女性用ケア製品、外科用ドレープ、開窓術用補強材、吸収体パッドなど、その上部表面の少なくとも一部分よりも高い濡れ性を持つ開口領域を備える、流体吸収体材料に使用される穿孔フィルム・カバーの製造方法を提供することである。 |