AN IMPLEMENTATION OF A PARTIAL PARSER IN THE SPOKEN LANGUAGE TRANSLATOR

Nam-Yong Han, Un-Cheon Choi and Youngjik Lee

Electronics and Telecommunications Research Institute (ETRI)
Yusong, P.O. Box 106, Taejon, 305-600, KOREA

ABSTRACT

We describe characteristics of the partial parser and evaluations of the output of the spoken language translator with concept-based grammars. This translator translates the Korean utterance generated by a speech recognizer which recognizes spontaneous speech into an English/Japanese utterances through a concept analysis approach. The parsing fails to parse input utterance when the parser finished to medium level tokens because the successful parsing results come from only when all concepts except for the highest top level tokens are reduced into the ones of the highest top level tokens. At this time, the partial parser is ran to analyze those medium level tokens without parsing fail. We obtained 55.2% for the recognized data as the translation rate of meaning based on *intention* before applying partial parser to the spoken translator, and now obtained 79.1% after applying partial parser.

1. INTRODUCTION

The recognized utterances by a speech recognizer may have many problems like insertion of meaningless words, substitution and deletion of keywords, etc. If we have to translate the recognized utterances into target utterances using the syntactic analysis approaches rather than semantic ones, we would have some problems of analyzing the source utterances and generating the target ones syntactically. We, therefore, adopt concept-based approach [3] to analyze input utterances of our translator. We think this approach will cope with ungrammatical phenomenon of a spontaneous spoken language rather than some syntactic approaches. We extract only concepts from input utterances which may be include some errors, and transfer the concepts to the generator. And then English/Japanese utterances are generated using those concepts. In this paper, we describe characteristics of the partial parser and evaluations of the output of the spoken language translator.

2. OVERVIEW OF THE TRANSLATOR

2.1 System Overview

The translation components of our concept-based spoken machine translator (Figure 1) consist of pre-processor module, full parser and partial parser modules of own language, and generator module of target languages [2, 4, 5].

2.2 Preprocessor Module

Although one word usually represents one concept in the case of English, One *Eojeol* (*Eojeol* in Korean: word-phrase in English) usually does not represent one concept. We, therefore, need to separate one *Eojeol* into free form (morpheme) and bound form (function word) in which both forms in Korean have different meaning. For example, let's have the following phrases: *samwol sailbuteo oilkaji* (from 4th to 5th March). The *sailbuteo* (from 4th) and *oilkaji* (to 5th) of the phrases consists of 2 words (*Eojeol*), but the number of the including concepts in the *sailbuteo* and *oilkaji* words is 4. So, The previous two phrases are divided into 4 words, *sail* (4th), *buteo* (from), *oil* (5th), and *kaji* (to) using the *basis-words dictionary* in the pre-processing stage. Namely, the key-words which dominate meaning of an utterance like *sail*, *buteo*, *oil*, and *kaji* are entries of the *basis-words dictionary*. And a word, if it includes an entry in the *basis-words dictionary*, is separated into two or more forms based on the *basis-words dictionary*.

2.3 Full Parser and Partial Parser Modules

The parsing grammar (parsing grammar1 in Figure 1) specify patterns which represents concepts in the travel planning task domain and are made by hand through analysis of transcribed text data which is made from spontaneous speech dialogues. The patterns are composed of words and other grammars for constituent concepts. Each element in a pattern may be specified as optional or repeating. Each concept, irrespective of its level in the hierarchy, is represented by a separate grammar file like CMU's Phoenix. These grammars are compiled into Recursive Translation Networks [3]. At present, the full parser and the partial parser are applied to the input utterances simultaneously.

The goal of the translator using concept grammars is not translation from Korean to English/Japanese precisely. We just extract some concepts without syntactic information from input utterance and translate it target language using concepts. Namely, although the meanings of some phrases are slightly different each other, if the concepts of the phrases are similar to each other then the phrases are processed as same concept in our translator. Therefore, the result of translation is focused on context of dialogues. E.g., the meanings of "마음에 드네요(*I love it)*", "그때면 참 좋겠습니다(*That sounds great on that day)*", and "제게 딱 맞는 것 같은데요(*That sounds suitable for me)*" are slightly different. But, these phrases are translated as "*That's good*" in the case of English generation because the phrases are the entries of the same concept grammar.

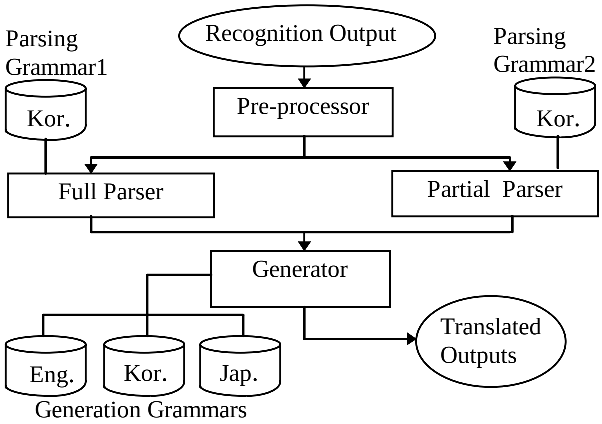

Figure 1. Block diagram of the concept-based spoken translator.

In full parsing, the successful parsing results come from only when all concepts except for the highest top level tokens are reduced to the ones of the highest top level tokens using concept grammars. Although some part of the input utterance is partially reduced to some medium concept levels and parsing procedure is finished, the parser fails to parse the utterance if the partially parsed concepts are not reduced to the ones of the highest top level concepts. So, we added a partial parsing function to the full parser. The goal of a partial parser is minimizing parsing fails of the translator. Namely, we implement a translator which translates even the partially parsed concepts to target languages.

The implementation method of partial parser is as follows. We, first, create another highest top level concept, called *primitive* (parsing grammar2 in Figure 1). Then, all concepts except for well defined concepts in the already existing grammars are added to the *primitive* concept grammar. The added concept grammars to the *primitive* concept grammar are almost bottom level concept grammars and at the same time dominant words to represent travel arrangement domain.

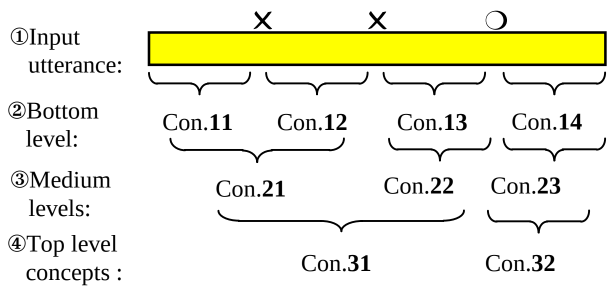

Figure 2. Configuration of the concepts hierarchy. The symbol ✕ means no permitting for skip, and ❍ means permitting for skip.

Figure 2 shows the configuration of our concept grammars' hierarchy. Some positions of the input utterance of Figure 2 are also denoted both as ✕ for no skip permitting about some phrase and as ❍ for skip permitting. Namely, only phrases which position between the highest top concepts are able to skip. And other phrases which position between any concepts except for the highest concepts are not permitted for skip. So, if some unknown phrase exists on position denoted as ✕ in these configuration, the parsing can not continue any more. It fails to parse for input utterance. To avoid parse fails for those situation, there are two methods. First [3], there is some special symbol (*) which means optional in grammars. If the *con.**11*** or *con.**21*** is marked by special symbol (*), any phrase is permitted on the position denoted as the first left ✕ and the second left ✕ because of ignoring the concepts, *con.**11*** and *con.**21***.

However, if the ignored phrases can be translated to target language then we can expect performance improvement in a point of view for the intention transfer rate. Second, to do this, we created the highest top level concept grammar, *primitive*, and added almost bottom level grammars to it [4]. With these situation, the added tokens are almost dominant words considered key words in the traveling domain. If some ignoring or parse failing part in parsing stage due to an unexpected insertion between concepts (denoted as ✕ in Figure 2) takes place, the ignoring or parse failing part which can not translate without *primitive* concept is directly translated to target language using the newly created concept grammar, *primitive*.

We believe that if the partially parsed concepts which fail to parse in the full parsing stage are also transferred and translated to the target concepts and languages, the performance of a spoken language translation system will be improved. And the improved results will be shown in Section 4, Results and Analysis.

2.4 Generation

Target language generation is easily accomplished because the input strings are reduced to the concept level(s). It is not necessary to have another generation routine to generate target language like conventional approaches. Only the generation grammars of target languages are necessary. We, namely, do not analyze source text morphologically and syntactically. The generation procedure of the system is a simple left-to-right processing of the parsed text. The generation grammar, which is also a concept grammar, of each language consists of a set of its own language phrasings of each token, including tables for such variables as months of the year and days of the week.

3. EVALUATION METHODS

In [1], to evaluate speech translation systems, the evaluation method is divided into the case of speech to text translation and the case of speech to speech. And in the case of speech to text, like ours, the evaluation categories are broadly 3 classes, *clearly useful*, *borderline*, and *clearly useless*. Each class is similar to our ***A***, ***B***, and ***C*** roughly.

We evaluate translation rate of meaning based on both *key-word* and *intention*, slightly unlike [1], of an utterance for two kinds of input data. One is a transcribed text data and the other is a recognized data. First, the translation rate of meaning based on *intention* of an utterance means that transfer rate of intention from the speaker's intention of an utterance of

Korean-to-English and Korean-to-Japanese. To measure the understandability of the speaker's intention, we graded output quality on three levels:

A*: user understands the speaker's intention perfectly.*
B*: user understands the speaker's intention despite of minor errors.*
C*: user can not understand the speaker's intention.*

We hypothesized that both ***A*** and ***B*** on three levels will be evaluated as successful in transferring of intention.

The *key-word* translation rate, second, means how many key-words of an input utterance are translated into English or Japanese successfully. If four key-words of five key-words are translated into English or Japanese correctly, the performance of *key-word* translation rate is 80%. At this time, the *key-words* are defined by an expert who developed the Korean concept grammars for the spoken language translator.

Table 1: Some examples of source and target utterances and some evaluation results(The K-W means Key-Word, the In. means Intention) for Korean-to-English translation case.

Some translation examples	Evaluation	
	K-W	In.
- 네 미국에 여행갈려고 하는데요. 어떠한 여행상품이 있죠?[1] - Yes. I'd like to tour America. What kind of tour package do you have?	100%	A
- 예 예약은 미국 여행사에서 자세히 문의하시기 바랍니다.[2] - Yes. Further information would you please call a travel agency in USA.	66.7%	B
- 예 감사합니다. 그럼 좋은 방을 준비해 놓겠습니다.[3] - Thank you very much. Then. Room.	50%	C

[1]: Yes. I plan on going to America. What kinds of tour packages are available?
[2]: Yes. Please call a travel agency in the US for all the information.
[3]: Yes. Thank you very much. Then I'll have a room ready for you.

Table 1 shows some Korean utterances, generated English sentences, and examples of evaluation results. We do not evaluate Japanese output because the word order of Korean and Japanese is very similar to each other, so Japanese generation grammar is the same as Korean generation grammar except for character code sets.

The underlined words in the Table 1 are key-words defined in this paper. The *K-W* column of Table 1 means the rate of success of key-word translation. For example, the second example ([2]) in Table 1 shows that the key-word translation rate is 66.7%. This means that two key-words of three key-words are evaluated as successful in translating from Korean to English. The *In.* part of Table 1 is an evaluation result of the transfer rate of the speaker's intention. We evaluate ***A*** and ***B*** as successful in transferring of meaning.

4. RESULTS AND ANALYSIS

4.1 Before applying Partial Parsing

We used two kinds of data to evaluate Korean-to-English translation results. One is a transcribed text data (300 utterances) from 300 dialogues, which is not used for making concept grammars, of 590 dialogues. The other data set is a recognized one (283 utterances) from the speech recognizer. For these data, we evaluated both translation rate of meaning based on *key-word* and translation rate of meaning based on *intention*. Table 2 shows the evaluation results for them.

Table 2: The performance comparisions of the spoken language translator whether the partial parser applied or not.

Sorts of Data	Key-word translation		Intention transfer	
	Before	After	Before	After
Trans. [1]	79.5(2.0)	85.5(2.8)	76.5(5.1)	78.5(4.0)
Recog. [2]	56.9(3.7)	85.9(1.5)	55.2(3.0)	79.1(5.2)

[1]: The data size is 300 utterances.
[2]: The data size is 283 utterances.
Before: The partial parser is not applied.
After: The partial parser is applied.
The numbers between parentheses:The standard deviation.

The *Key-word translation* part in Table 2 shows how many key-words of an input utterances are translated into English words successfully. The translation rate for the transcribed data is 79.5% and 56.9% for the recognized data in the *Before* column of the *Key-word translation* column in Table 2. The main difference of the evaluation results for the transcribed and the recognized data seems to result from the translation failing for recognized data which takes place errors much more frequently comparing to the transcribed data. At this stage, we also tried translation without ignoring utterances judged as recognition failures. The parser fails to parse the utterances if the partially parsed phrases do not reduce to the ones of top level concepts because of some recognition errors although the partially parsed phrases is reduced to some medium level concepts. The translation from Korean to English, therefore, is not accomplished. We need partial parser for translating partial phrases which do not reduce to the ones of the top level concepts.

The *Intention transfer (Before)* part in Table 2 shows the translation rate of meaning based on speaker's intention for the transcribed data (76.5%), and for the recognized data (55.2%) before applying partial parsing. It is also tried translation without ignoring utterances judged as recognition failures.

4.2 After applying Partial Parsing

Table 2 (*After* columns) shows the improved results for both data, transcribed and recognized data, based on the *key-word* translation rate and the *intention* transfer rate after applying partial parsing to our spoken language translator. The translation rate of meaning based on *key-word* is improved from 79.5% to 85.5% for the transcribed data, and from 56.9% to 85.9% for the recognized data. In these results, the performance of the translator for the recognized data is especially more elevated. This means that the parser does not fail to parse the input utterances although the partially parsed phrases do not reduce to the ones of the top level concepts. Namely, the partial phrases can be also translated to English words. There is another interesting phenomenon between the result of transcribed data and the result of recognized data. The key-word translation result for the recognized data is not very low anymore. It is obtained from the partial parser's function in our concept-based spoken language translator.

The translation rate of meaning based on *intention* is also improved from 76.5% to 78.5% for the transcribed data, and from 55.2% to 79.1% for the recognized data. In these results, the performance of the translator for the recognized data is especially more upgraded like the result of translation rate based on *key-word* from 56.9% to 85.9%. This means that the partial parser improves the performance of the translator based on *intention* as well as the performance of the translator based on *key-word* translation. We also tried translation without ignoring input utterances judged as recognition fails in this partial parsing stage.

4.3 Considerations of Recognition Failures

Table 3 shows the performance comparisions of the translator whether the recognition failures of input utterances counted or not for recognized data set. The differences of percentages (the *After* column in Table 3) after applying partial parser to the translator are small (average of difference is about 4.8) than ones (average of difference is about 17.8) before applying partial parser. It, therefore, proves that the partial parser has an obvious effect for parsing of spontaneous styled utterances.

Table 3: The performance comparisions of the translator for recognized input data whether the recognition failures of input date counted or not.

Sorts of Data	Key-word translation		Intention transfer	
	Before	After	Before	After
No counted	56.9	85.9	55.2	79.1
Counted [1]	74.5	88.3	73.2	86.3

[1]: The values mean the results of translation ignoring input utterances judged as recognition failures.

5. CONCLUSION

In this paper, we describe characteristics of the partial parser and evaluations of the output of the spoken language translator with concept-based grammars. We evaluate translation rate of meaning based on both *key-word* and *intention* of an utterance for two kinds of input data. One is a transcribed text data and the other is a recognized data. This translator is the component of our SLT (Spoken Language Translation) system [2]. This translator translates the Korean utterance generated by the speech recognizer into English/Japanese using the concept analysis approach rather than the syntactic approach. We, at present, do not evaluate Japanese output.

We added partial parsing function to the spoken language translator and obtained improved performance. The performance of the translator in the case of applying full parser is weak. This performance is especially very low for the recognized data because of some recognition errors. The performance of the translator which added partial parsing function, however, is improved much more. And we also evaluate the outputs of the translator according to whether the recognition failures of input utterances considered or not. Table 2 and Table 3 show the improved results for both data, transcribed and recognized data, based on the *key-word* translation rate and the *intention* transfer rate.

And the full parser and the partial parser are applied to the input utterances simultaneously at present. But the partial parser will be applied only when the full parser does not parse input utterances any more, in the future. The reasons of this approach is that although the performance of the translator is improved to high, some fragments in the translated output can be taken place due to partial parser to make readability hard.

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6. REFERENCES

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