

SIMULTANEOUS JAPANESE-ENGLISH INTERPRETATION BASED ON EARLY PREDICTION OF ENGLISH VERB

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Simultaneous machine interpretation is one of the most ambitious applications of natural language processing. Incrementality in language translation is an inevitable property in such an application. This paper describes a technique for translating spoken Japanese into spoken English incrementally. Generally speaking, it is very difficult for a machine translation system to incrementally transfer from Japanese to English because of the difference in the word-order of them. To overcome the difficulty, the technique utilizes some novel ideas: 1) predicting the verb early, 2) putting a phrase in another position, 3) changing the voice, 4) controlling the intonation, and 5) generating a repair expression. According to the technique, the system can generate the corresponding English sentence synchronously with the input of spoken Japanese. An experimental system of incremental Japanese-English spoken language translation has been made. An experiment on the system has shown the technique to be effective.

Key words: simulatneous interpretation, spoken language translation, incremental interpretation, verb prediction.

INTRODUCTION

Spoken language translation has been an important research topic in recent years. A cross-lingual speech conversation through a spoken language translation system demands that the system should also engage in the conversation without preventing its coherence. Our intuitions suggest that the system should behave like an simultaneous interpreter.

In order to develop a simultaneous interpreting system, working synchronously with a spoken language input, a technique for translating natural language incrementally is strongly required [7, 6, 13]. Towards such an ambitious application, some attempts have been recently made so far. Kitano has proposed a technique of incremental sentence production for modeling simultaneous machine interpretation [8, 9]. As well, Amtrup has introduced chart-based incremental transfer framework for processing head switching in German-English machine translation [1]. Furuse and Iida has developed a technique of incremental translation utilizing transfer patterns [5], and Mima et al. has extended it by introducing simultaneous interpreter's know-how [14]. Furthermore, Matsubara and Inagaki has achieved *fine-grained incrementality*¹ in English-Japanese machine translation [10, 11].

One of the points to be considered in developing an incremental spoken language translation system is the difference in word-order between the source language and the target language. Since there exists an inevitable trade-off relation between *incrementality* and *accuracy*, the difference might cause to lose the synchronization between

¹*Fine-Grained Incremental Interpretation* means that the processor analyses each small part of a sentence, such as each word or morpheme, immediately it is encountered. In contrast, *Coarse-Grained Incremental Interpretation* occurs if the processor waits until larger chunks of a sentence are encountered [2].

TABLE 1. Comparison between Japanese and English

<i>item</i>	<i>Japanese</i>	<i>English</i>
1) position of the predicate	around the end of a sentence	after the subject
2) flexibility of word-order	flexible	strict
3) interrogative expression	end of a sentence	head of a sentence
4) negative expression	end of a sentence	after the subject
5) subjective case ellipses	very frequent	very few

the input and the output of the system. For example, translation of Japanese into English causes the system the following problems:

- Generating English sentences according to the word-order of Japanese sentences, the system cannot output a correct and understandable translation result (**low-quality problem**).
- Generating a standard English sentence for a Japanese sentence, the system cannot output the most of the English sentence until the Japanese verb is inputed. Because the verb in English appears at an early stage though that in Japanese does at the end of sentences. (**low-immediacy problem**)

These are fatal to simultaneous machine interpreting between languages which are different in word-order. The above studies, however, have ever given little attention to them.

In this paper, we describes a technique for translating spoken Japanese into spoken English incrementally. The technique utilizes five novel ideas: 1) predicting the verb early, 2) putting a phrase in another position, 3) changing the voice, 4) controlling the intonation, and 5) generating a repair expression. According to the technique, the system can generate the English sentence synchronously with the input of spoken Japanese. We have made a prototype system of incremental Japanese-English spoken language translation. The system is composed of four stages: parsing, transfer, generation and prediction. An experiment on the system have made us confirm the effectiveness of the technique.

This paper is organized as follows: Section 2 shows the ideas to generate English incrementally. Section 3 explains the technique for predicting the English verb early. Section 4 describes an overview of the system. Sections 5 reports on an experimental result.

1. INCREMENTAL ENGLISH GENERATION

Incremental translation means to transfer a source language, according to its appearance order, to a target language. Its feasibility much depends on the degree of the difference in word-order between both languages. Table 1 shows the structural differences between Japanese and English. The key to success of exceedingly incremental Japanese-English translation is to overcome the difficulty on these differences. The following in this section describes the technique for coping with 1),2) and 3) in Table 1.

1.1. Early Prediction of English Verb

As Table 1 shows, the verb position in Japanese, which is widely different from that in English, is around the end of a sentence. Therefore, the Japanese verb is not decided until the Japanese sentence is inputted entirely. For example, in a Japanese sentence:

(1) *kare-wa*(He) *Chenmai-e*(to Chiengmai) *densha-de*(by train) *iki-mashi-ta*(went).
(He went to Chiengmai by train.)

the predicate “*iki-mashi-ta*” is generated in the end.

However, we may be able to predict the verb using the other components of a sentence to some extent. In particular, the improvement of the predictability can be expected in the limited task domain because the variation of the verbs is restricted. Predicting the verbs from the noun phrases in an early stage, the system can execute translation processing with less delay.

1.2. Replacing Word-Order

We can say that the position of an adverb and an adverbial phrase are flexible to some extent though that in English is usually strict. Therefore, the system might output the corresponding English immediately with the input of a Japanese adverbial phrase. As an example, let us consider the following simple Japanese sentence:

(2) *kesa*(in this morning) *ken-wa*(Ken) *sanpo-shi-ta*(took a walk).
(Ken took a walk in this morning.)

As soon as the adverbial phrase “*kesa*” is inputted, the system outputs an English prepositional phrase “in this morning”. We would like to emphasize that an English sentence

(3) In this morning, Ken took a walk.

is correct and understandable as the translation result of (2).

1.3. Putting Sentences into the Passive

Since the subjective case is omitted very frequently in Japanese, the mechanism to complement it is necessary in order to generate that in English. However, by putting the English sentence into the passive voice, the omitted subjective case is not necessarily translated. Translating the Japanese objective case as the English subjective case, the system can put off the output of an English verb.

1.4. Using A Rising Intonation

An interrogative phrase usually appears in the head of a sentence in English, like “Do ...?”. On the other hand, that in Japanese appears in the end, like “... *ka*?”. Therefore, the system can not decide whether it is affirmative or interrogative until the whole of a Japanese sentence is inputted. In an English conversation, by producing a sentence with a rising intonation, whether it is interrogative or not can be indicated with no such the phrase.

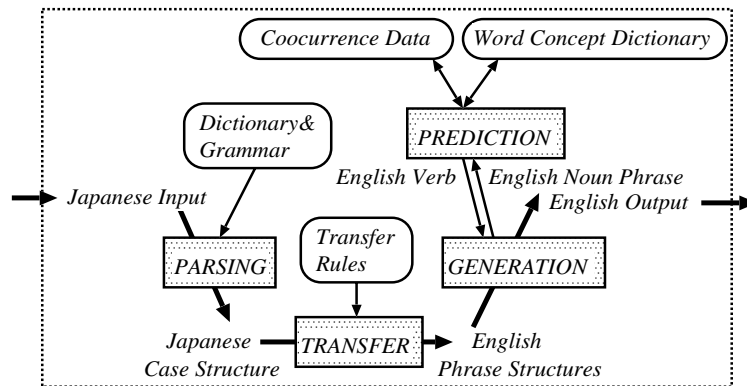


FIGURE 1. Configuration of incremental Japanese-English translation system

1.5. Utilizing Repair Expressions

None of the above ideas 1)-4), which can be considered to be effective for incremental Japanese-English translation, necessarily bring correct results. In this paper, we regard an incorrect English fragment as a kind of error expressions produced by the system. That is to say, the system makes it correct by generating repair expressions even if it produces incorrect fragments.

2. AN OVERVIEW OF THE SYSTEM

Figure 1 shows the configuration of incremental Japanese-English spoken language translation system. The system, which works in a phrase-by-phrase basis, is composed of four stages: parsing, transfer, generation and prediction. The parsing stage makes Japanese case structures of inputs for every additional phrase. The transfer stage makes English phrase structures by applying transfer rules to them [12]. The generation stage outputs English fragments according to an English generation procedure based on the ideas shown in Section 2.

The prediction stage utilizes all noun phrases in English phrase structures and work according to the following procedure: 1) conceptualizing the noun phrases using EDR Word Dictionary [3], and 2) extracting an English verb with the most high frequency in cooccurrence data for ATR Dialogue Database [4].

3. EXPERIMENT

An experimental system of incremental Japanese-English translation has been developed in GNU Common Lisp 2.2.2 on a Unix workstation. In order to analyze four dialogues whose task are travel application on the telephone in ATR Dialogue Database [4], we have made a dictionary consisting of 540 words. We have registered 1,883 rules expressing cooccurrence relations between noun phrases and verbs concep-

TABLE 2. Experimental result on translation accuracy

item	error cause	utterances	rate(%)
correct		140	54.1
incorrect	ellipsis of subject	79	30.5
	parsing error	33	12.7
	syntactic ambiguity	7	2.7

tualized using EDR Word Dictionary [3] as cocurrence data to predict the English verb. In the experiment, we have used 259 utterances by Japanese speakers. An open-test experiment about verb prediction, providing 53.1% of prediction accuracy, shows the technique to be usable for early English verb prediction. Table 2 shows the translation results including error causes. The English sentences generated correctly according to the ideas explained in Section 2 account for 57.1 % of all correct English sentences, and we can confirm the technique to be effective.

4. CONCLUDING REMARKS

This paper has described a technique for translating spoken Japanese into spoken English incrementally. To overcome the difficulty on different word-order, the technique utilizes some ideas: 1) predicting the verb early, 2) putting a phrase in another position, 3) changing the voice, 4) controlling the intonation, and 5) generating a repair expression. According to the technique, an experimental system of incremental Japanese-English spoken language translation has been made. An experiment on the system has shown the technique to be effective for incremental Japanese-English translation which can generate acceptable English sentences.

The current prototype system can cope with only simple and grammatical Japanese sentences. Complex or ungrammatical sentences, however, appear very frequently in spoken Japanese. We would like to go on to develop a technique for incrementally parsing of spoken Japanese language.

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