Design of a Face-to-Face Multilingual Communication System for a Handheld Device in the Medical Field

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Abstract. In the medical field, a serious problem exists with regard to communication between hospital staff and foreign patients. For example, medical translators cannot provide support in cases in which round-the-clock support is required during hospitalization. We propose the use of a multilingual communication support system called the Petit Translator between people speaking different languages in the hospital setting. From the results of experiments performed in such a setting, we found the following: (1) by clicking the conversation scene, the interface can retrieve the parallel text more efficiently than the paper media, and (2) when a questioner appropriately limits the type of reply for a respondent, prompt conversation can occur.

Keywords: parallel text, machine translation, handheld device, speech-to-speech translation, medical communication.

1 Introduction

The need for multilingual communication in Japan has increased due to an increase in the number of foreigners in the country. When people communicate in their nonnative language, the differences in language prevent a mutual understanding among the communicating individuals [1, 2]. In the medical field, this can create a serious problem when it comes to communication between hospital staff and patients. Currently, medical translators accompany patients to medical care facilities, and the number of requests for such translators is increasing. Medical translators cannot provide support at all times, however, especially in cases where round-the-clock support is required or in the case of hospitalization. Hence, a system that supports accurate multilingual communication is required.

We have developed a support system for multilingual medical reception termed M^3 [3]. In this study, we cover the hospital setting, in which members of the medical staff and foreign patients communicate with each other in various places throughout the hospital. We feel that such a setting calls for a translation system. We propose the use of a multilingual communication support system, called the Petit Translator, between people speaking different languages during hospitalization. This system uses parallel

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texts for accurate multilingual communication and machine translation for daily conversation. In this study, we describe the development of the Petit Translator and offer an evaluation of the system.

2 Related Works

Parallel texts are lines of text in 1 language paired with translations of that text in another language. In other words, parallel texts are accurate translations pre-paired in advance that are meant to improve the efficiency and accuracy of medical treatment [4]. Face-to-face communication systems using parallel texts are now in use. One of these is a support system using speech-to-speech translation for foreign travelers [5]. Another topic of research is a tool that supports communication between speakers of different languages and uses parallel texts for speech recognition [6]. In systems such as this, the user inputs speech and the system outputs a translated sentence; however, the system cannot output sentences that have not been previously registered. Speech translation systems using phrase translation for communication in the medical field have also been proposed [7, 8]. Even these systems, however, provide insufficient support for the medical field.

3 Petit Translator

The Petit Translator supports 5 languages: Japanese, English, Chinese, Korean, and Portuguese. It can operate on Android Devices (a smart phone). In the following, we present the functions of the Petit Translator.

3.1 Voice Translation Function

The speech translation function is one that translates the spoken word into another language, and creates the sound and characters. Figure 1 shows the system configuration of the Petit Translator.

1. Voice input function
The voice input function converts the voice into characters. We use a voice input function because it is difficult for users to input characters manually on a small screen. We use Google voice recognition for the voice input function.
2. Translation function (Similar parallel text retrieval and machine translation)
The translation function retrieves the parallel text and carries the machine translation concurrently. Figure 2 shows the result of the translation. The system shows the result of the parallel text retrieval and machine translation on the same screen (Figs. 2 (2) and (3)). A user can use the machine translated sentence when no results have been found by the system. The system shows the back-translated sentence to check the accuracy of the machine translation (Fig. 2 (3)). We use the Web service Language Grid [9] to retrieve the parallels texts.
3. Voice synthesis function
The voice synthesis function synthesizes the voice from the parallel text or result of the machine translation. We use the voice synthesis service of Language Grid. In the

hospital, there are places where precision equipment is prohibited. Therefore, it is difficult to communicate through characters or by using a screen. In these cases, a medical staff member can communicate with a patient using the voice synthesis function.

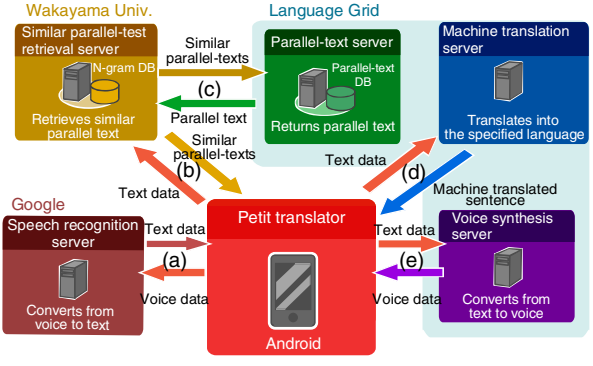

Fig. 1. System configuration of the Petit Translator

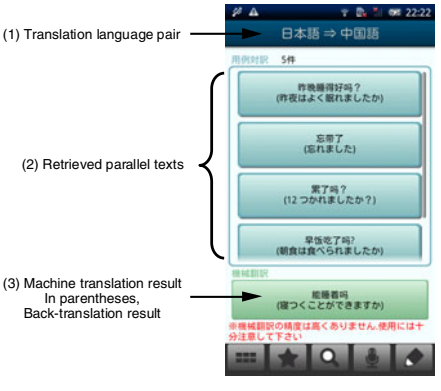

Fig. 2. Screenshot of the result of translation

3.2 Response Function

The response function is a function that allows the patients to respond when the system is shown. Figure 3 shows a screenshot of the response function.

1. Function for a questioner

When a medical staff member selects the translation result, that result is shown on the screen for the respondent. He or she can show the screen and synthesize the voice (Fig 3 (3)).

2. Function for a respondent

A respondent can answer the question using the “yes” or “no” buttons (Fig. 3 (4)). When a respondent needs to answer in detail, he or she can use the machine translation to input text for a detailed response (Fig. 3 (5)).

3.3 Scene Retrieval Function

The scene retrieval function is a function to make a short list of the parallel texts by selecting the conversation scene. The time of the input can be saved by clicking the conversation scene.

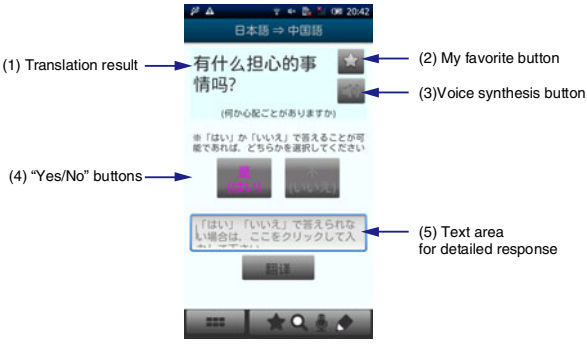

Fig. 3. Screenshot of a response screen

4 Experiment

4.1 Purpose of the Experiment

The purpose of the experiment was to verify the efficiency of the Petit Translator. We compared a case in which the Petit Translator was used with a case in which a multilingual leaflet and an electronic dictionary were used between a medical staff member and a foreign patient. We used a multilingual leaflet that was provided by the Mitsubishi Tanabe Pharma Corporation. We compared both the efficiency and accuracy.

4.2 Subjects and Procedure

A total of 18 subjects (9 Japanese and 9 Chinese) participated in the study. All were students at Wakayama University. One Japanese subject and 1 Chinese subject participated in each experiment. There were 9 experiments altogether. None of the Japanese subjects had a smart phone, but 3 of the Chinese subjects had one.

All of the Chinese subjects could speak Japanese and read simple Japanese in daily life. The experiment assumes that the conversation is between users who do not understand each other. Therefore, we prohibited using Japanese in the experiments. Both subjects wore earphones to prevent hearing a Japanese voice.

4.3 Tasks of the Experiment

We allocated the Japanese subjects to the role of medical staff member and Chinese subjects to the role of patient. In the experiments, which used each system, there were 5 tasks respectively. Table 1 shows the contents of each task. The task was initiated

Table 1. Tasks of the experiment

Task			Reply method	
	Japanese subject (as a medical staff member)	Chinese subject (as a patient)	Petit Translator	A multilingual leaflet and an electronic dictionary
(1)	Please confirm whether the patient ate breakfast.	Answer the question.	Medical staff member: Ask the question using the scene retrieval function. Patient: Answer using the "Yes" or "No" buttons.	They communicate with a medical leaflet and an electronic dictionary only.
(2)	Please tell the patient to take 2 types of medicine before he or she sleeps.	Description of the instruction	Medical staff member: Give instructions using the scene retrieval function. Patient: Write down the instructions.	
(3)	Please ask the patient to confirm that he or she is worried about something.	Please answer that you are worrying about hospital fees.	Medical staff member: Ask the question using the scene retrieval function. Patient: Answer using a text area for detailed response (machine translation).	
(4)	Please ask the patient to confirm whether there is pain somewhere.	Please answer that you have a stomachache with a pricking sensation.	Medical staff member: Ask the question using the general retrieval function. Patient: Answer using a text area for detailed response (machine translation).	
(5)	Please ask the patient to describe a symptom that he or she has suffered and the period he or she suffered it.	Please describe the symptom you suffered and the period you suffered it.	Medical staff member: Ask a question using the machine translation. Patient: Answer using a text area for detailed response (machine translation).	

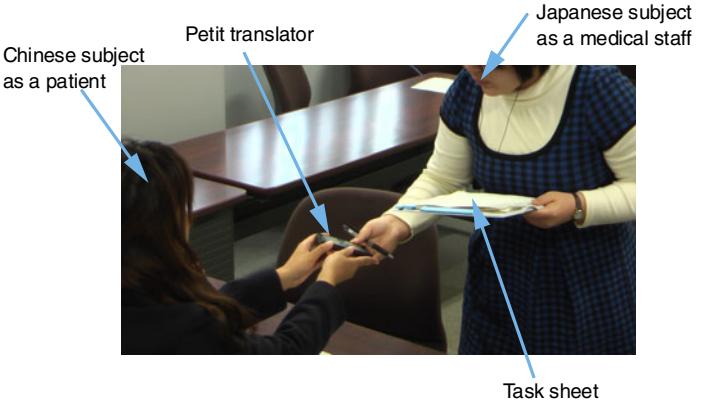

Fig. 4. A photograph of an experiment using the Petit Translator

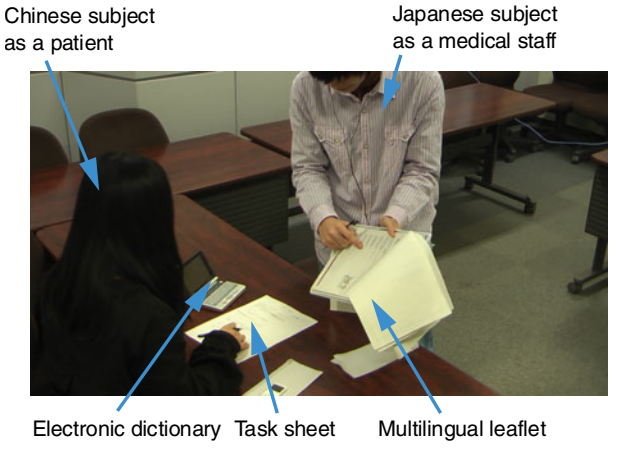

Fig. 5. A photograph of an experiment using a multilingual leaflet and an electronic dictionary

by a Japanese subject. Each task was completed when the Chinese subject had responded to the Japanese subject's question. When the 5 tasks were completed, the system (the Petit Translator or a multilingual leaflet and an electronic dictionary) was switched, and the 5 tasks were performed again. Figure 4 shows a photograph of an experiment using the Petit Translator. Figure 5 shows a photograph of an experiment using a multilingual leaflet and an electronic dictionary. Before the experiments, the subjects practiced the operation of the Petit Translator and the electronic dictionary. They also browsed the multilingual leaflet.

5 Discussion

5.1 Time to Accomplish Tasks

Table 2 shows the time required by the Japanese and Chinese subjects to accomplish the tasks. In order to discuss the time required to accomplish the tasks, we have divided the Japanese subjects from the Chinese subjects.

1. Time required by the Japanese subjects to accomplish the tasks

The Petit Translator can accomplish tasks (1) and (2) in less time than a multilingual leaflet and an electronic dictionary. With tasks (4) and (5), however, the Petit Translator requires more time than a multilingual leaflet and an electronic dictionary. When using the Petit Translator with tasks (4) and (5), the subject needs to input a retrieval word. The subjects took a long time to do this because they were inexperienced in inputting using a software keyboard.

Three of the 9 Japanese subjects used the voice input. Three used the voice input only once because they did not get a good result. The other 6 subjects answered, “I don’t hear my voice easily because I used earphones for the experiment. So, I didn't use the voice input.”

2. Time required by the Chinese subjects to accomplish the tasks
The Petit Translator requires more time than a multilingual leaflet and an electronic dictionary to accomplish tasks (3), (4), and (5). We found that the user interface of the Petit Translator has some problems. Moreover, the Chinese subjects have experience in using an electronic dictionary, and use one often. Therefore, the time required to accomplish the tasks is shorter when using the multilingual leaflet and the electronic dictionary than when using the Petit Translator.

Table 2. Time required by the Japanese and Chinese subjects to accomplish the tasks

		Japanese subject (as a medical staff member)		Chinese subject (as a patient)	
Task	Type	Average (sec)	SD (sec)	Average (sec)	SD (sec)
(1)	Petit	35	44	<1	<1
	Leaflet	67	48	<1	<1
(2)	Petit	54	51	-	-
	Leaflet	102	47	-	-
(3)	Petit	63	38	137	198
	Leaflet	53	21	34	20
(4)	Petit	116	62	85	47
	Leaflet	66	75	33	24
(5)	Petit	236	73	162	120
	Leaflet	170	88	81	35

- SD means standard deviation.
- Task (2) for the Chinese subjects was to write down the instructions.
- Petit stands for the Petit Translator.
- Leaflet stands for a multilingual leaflet and an electronic dictionary.

5.2 Efficiency of Conversation

After the experiment, we asked the subjects to fill out a questionnaire. We used a 5-point Likert scale (1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree) and a free description for the evaluation. Table 3 shows the results of the questionnaires of the Japanese subjects who acted as medical staff members. We found that they were able to tell their intentions to the patients quickly using the Petit Translator (Table 3 (1)). In the free description, we obtained the comment, "I was able to present the content to the patient with sentences by using the Petit Translator."

Table 4 shows the results of the questionnaires of the Chinese subjects who acted as patients. However, we found that no significant difference was seen with the Chinese subjects (Table 4 (1)).

Table 5 shows the results of the questionnaires regarding searching for parallel texts. We found that using the Petit translator is easier than using a multilingual leaflet and an electronic dictionary in searching for parallel texts (Table 5).

In the free description, we obtained the comment, "When I used the electronic dictionary, it was necessary to look up some of the words, which was troublesome" and "It takes time to look for a parallel text with shuffling through the multilingual leaflet." Regarding the scene retrieval function, we obtained the comment, "It was easy to have looked for because it was classified by the scene. "

5.3 Accuracy of Conversation

We found that the Chinese subjects could understand the intentions of the medical staff easily (Table 4 (2)).

Some Japanese subjects guided the Chinese subject to receive the expected response from him or her. For example, they had passed the Petit translator to the Chinese subject with the keyboard had been displayed when a detailed response was expected. In the free description, we obtained the positive comment, "Only 1 item came out on the screen, and I answered it easily." The Japanese subjects understood the patients' intentions well using both systems (Table 3 (2)).

Table 3. Results of the questionnaires of the Japanese subjects as medical staff

Question	Type	Evaluation (people)					Median
		1	2	3	4	5	
(1) I was able to express my intention to the patient quickly.	Petit	0	3	1	5	0	4
	Leaflet	2	4	1	2	0	2
(2) I quickly understood the intention that the patient expressed.	Petit	1	0	2	2	4	4
	Leaflet	0	3	1	5	0	4

- Petit stands for the Petit Translator.
- Leaflet stands for a multilingual leaflet and an electronic dictionary.

Table 4. Results of the questionnaires of the Chinese subjects as patients

Question	Type	Evaluation (people)					Median
		1	2	3	4	5	
(1) I was able to express my intention to the medical staff member quickly.	Petit	0	2	4	2	1	3
	Leaflet	0	4	4	0	1	3
(2) I quickly understood the intention that the medical staff member expressed.	Petit	0	1	0	5	3	4
	Leaflet	0	3	4	0	2	3

- Petit stands for the Petit Translator.
- Leaflet stands for a multilingual leaflet and an electronic dictionary.

Table 5. Results of the questionnaires regarding searching for parallel texts

Question	Evaluation (people)					Median
	1	2	3	4	5	
(1) It was easy to look for the parallel texts by using the Petit translator.	0	1	1	2	4	4.5
(2) It was easy to look for the parallel texts by using a multilingual leaflet and an electronic dictionary.	4	4	1	0	0	2

- One person did not respond to question (1), so the answer total for question (1) was 8 people.

6 Conclusion

We have developed a multilingual communication support system called the Petit Translator for use between people speaking different languages in the hospital setting. There are 3 main cases in which translation is needed in the hospital setting: (1) for use throughout the hospital, (2) when a requested conversation requires accuracy, and (3) when quick correspondence is necessary. Therefore, the system provides 3 types of features: (1) portability, (2) the combined use of parallel texts and machine translation, and (3) the use of easy input methods for word retrieval (voice input and button click input).

From the results of experiments done in the hospital setting, we obtained the following results:

(1) By clicking the conversation scene, the interface can retrieve the parallel text more efficiently than the paper media.
(2) When a questioner appropriately limits the type of reply for a respondent, prompt conversation can occur.

We are planning to introduce the Petit Translator to some hospitals in the near future.

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References

1. Aiken, M.: Multilingual communication in electronic meetings. ACM SIGGROUP, Bulletin 23(1), 18–19 (2002)
2. Tung, L.L., Quaddus, M.A.: Cultural differences explaining the differences in results in gss: implications for the next decade. Decision Support Systems 33(2), 177–199 (2002)
3. Miyabe, M., Fujii, K., Shigenobu, T., Yoshino, T.: Parallel-text Based Support System for Intercultural Communication at Medical Receptions. In: Ishida, T., R. Fussell, S., T. J. M. Vossen, P. (eds.) IWIC 2007. LNCS, vol. 4568, pp. 182–192. Springer, Heidelberg (2007)
4. Wang, B., Cheng, X., Bai, S.: Example-based phrase translation in Chinese-English CLIR. In: The 25th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval, pp. 435–436 (2002)
5. Ikeda, T., Ando, S., Satoh, K., Okumura, A., Watanabe, T.: Automatic interpretation system integrating free-style sentence translation and parallel text based translation. In: The Workshop on Speech-to-Speech Translation: Algorithms and Systems, pp. 85–92 (2002)
6. Imoto, K., Sasajima, M., Shimomori, T., Yamanaka, N.: A multimodal supporting tool for multi lingual communication by inducing partner's reply. In: The 11th International Conference on Intelligent User Interfaces (IUI 2006), pp. 30–332 (2006)
7. Rayner, M., Bouillon, P., Dalsem, V.V., Isahara, H., Kanzaki, K., Hockey, B.A.: A limited-domain English to Japanese medical speech translator built using regulus 2. In: The 41st Annual Meeting on Association for Computational Linguistics 2 (ACL 2003), pp. 137–140 (2003)
8. Chung, J.W., Kern, R., Lieberman, H.: Topic spotting common sense translation assistant. In: CHI 2005 Extended Abstracts on Human Factors in Computing Systems, pp.1280–1283 (2005)
9. Ishida, T.: Language grid: an infrastructure for intercultural collaboration. In: IEEE/IPSJ Symposium on Applications and the Internet (SAINT 2006), pp. 96–100 (2006)