Expansion of the System of JSL-Japanese Electronic Dictionary: An Evaluation for the Compound Research System

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Abstract. We have developed the JSL-Japanese Electronic Dictionary System in which Japanese meaning of a signing was looked in and the corresponding signing video movie was displayed. Our system finds out the target sign through analyzing the phonological components of the sign. We failed to find "e-mail" or "medical doctor" in JSL which are daily used words, because these sings are compounds and the system did not include a compound searching system in it. This paper shows how we developed an enlarged model of the dictionary and result of the evaluation test.

Keywords: sign, Japanese, phoneme, dictionary, compound, database.

1 Introduction

There are many books named sign language dictionary in the market, most of which are Japanese-Japanese Sign Language (JSL below) dictionaries. We find only a few books of JSL-Japanese dictionaries titled *Sign-Japanese Dictionary* [1] and its enlarged version *Enlarged Sign-Japanese Dictionary*[2], and *Practical Sign Dictionary for New Introductory Course of Sign Language*[3]. As for electronic ones, we find only three kinds[4][5][6][7], however, they are not available in the market. The Web version of *Enlarged Sign-Japanese Dictionary*[8] is a pilot version and its content is a part.

In such a situation, a learner can look in the corresponding sign of a Japanese word but not a meaning of a sign. It is equivalent to the situation of a Japanese learner of English without English-Japanese dictionary, even if they have a Japanese-English dictionary.

The four skills of language learning are to be listening, speaking, reading and writing and listening (or 'reading' in sign language) is basic (there is no literal reading and writing in sign language). In sign language learning, sign-Japanese dictionary is not popular and sign language learners are disadvantageous to other language learners at present.

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In the available JSL-Japanese dictionary, we start from choosing a handshape of a sign, and then go to choosing movement or location. That makes us to find a wrong answer if we fail to choose a proper hand. In the printed books, a movement of a sign is showed by a picture which makes us to catch it correctly.

In order to solve the problems, we have developed JSL-Japanese Electronic Dictionary System (EDS below) [9] by which they can look in a meaning of a sign through a phonemic description and capture it correctly using sign movie.

Many signs refer to a single meaning but sometimes there are some combinations of more than two signs means by a single meaning, that is, a compound. We see many of the medical signs and words in e-mail are compounds. Compounds are often used in an actual communication but no EDS includes a compound searching system at present. Therefore we enlarged our system to enable to search a compound effectively and we examined its usability in this paper.

2 Phonemes and Compounds in JSL

A word or a sign is composed of a single or plural syllables, which are the combination of a handshape, a location and a movement or two of those. These elements have no meaning and differentiate a word or a morpheme, so that they are considered to be equal to 'phoneme' of a vocal language in sign linguistics. They are called phoneme in this paper, too.

In Japanese, there are many compounds consisted of plural words, such as *medama-yaki* (fried egg), *tako-yaki* (octopus ball) or *tai-yaki* (fish shaped pancake) and so on. In JSL there also are many examples of compounds such as E-MAIL (KEYBOARD+LETTER) or DOCTOR(PULSE+MAN).

Though they are often used, there was no searching system of compounds in JSL EDS that caused us not to look in the word. We developed it. Here refers the old system below and its enlargement.

3 The Old EDS

Here are the specification of our old EDS [9], and its concept chart in Fig.1 and a sample GUI in Fig.2

1. A user can search a sign intuitively through a phonemic keyword as a handshape, a location or a movement. We offered a specific tab for each phoneme and he can select a phoneme of a sign from any phonemic entry, Handshape, Palm Orientation, Location or Movement.
2. Each time a user select the phoneme, the candidate list of signs which contain the phoneme is indicated at real time. In the initial stage, every phoneme is selected and a full list is indicated. A user deletes the unnecessary phonemes and the candidate sign become limited.
3. If a user clicks a word on the list, a movie of the sign is presented and its phonemic description and a picture of the handshape are presented on the Explanation window as in Fig. 3.

Besides the phoneme, *katakana* (phonemic system of Japanese) is included as a keyword. This enables the EDS as Japanese-JSL dictionary. He can input the *katakana* in the textbox to find a proper sign of completely agreed, partial agreed, head agreed or tail agreed.

This EDS contains the some 2,600 words in *Practical Sign Dictionary at a Glance*[11].

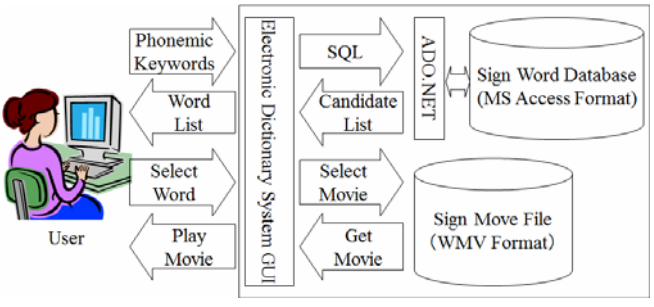

Fig. 1. Conception Chart of the Old EDS

Fig. 2. The GUI of the old EDS

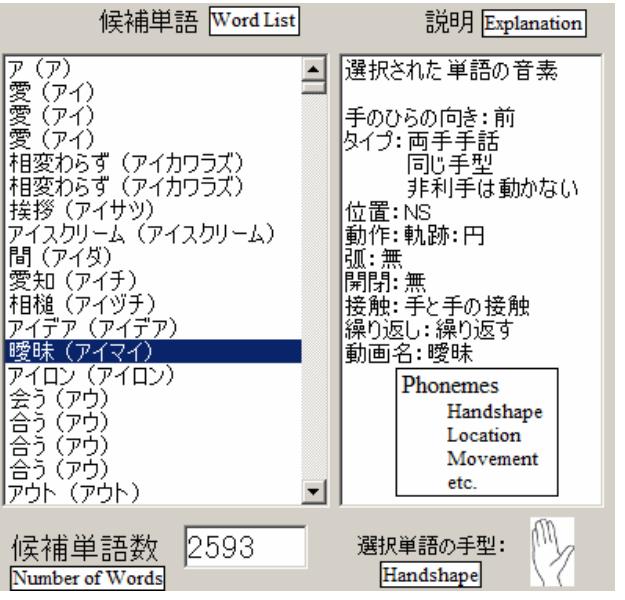

Fig. 3. Explanation of Word

4 Design of Enlarged EDS

4.1 A Guideline for Searching Compound

Here is a guideline of enlargement of searching compound.

1. We provided another database of words which form the compounds to search it in EDS.
2. In JSL-Japanese dictionary, he can search a word through a phoneme selection as he did in the old EDS, and in the next step, he would find a list of compounds using the word.
3. When he looks in Japanese-JSL dictionary, both words and compounds are displayed as a single list. The concept chart is shown below in Fig.4 and our developmental environment in Table 1.

Table 1. Development Environment

OS	Windows XP
Development Language	Visual Basic 2008
Database Format	Office Access 2007
Library	ADO.NET

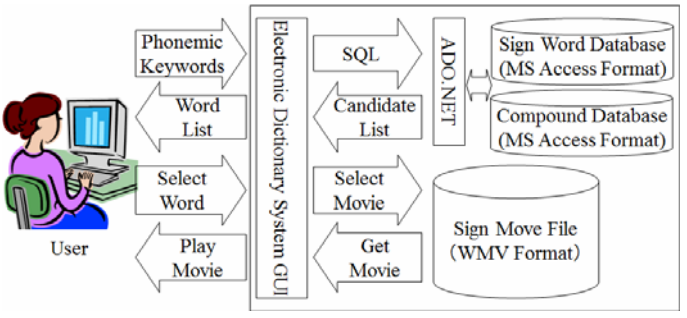

Fig. 4. Conception Chart of the EDS

4.2 Create Database

The database of compounds is created by Access by Microsoft format. The data were adopted from the entries and their descriptions in *Practical Sign Dictionary at a Glance*[11]. The recorded numbers of compounds are about 300 and the name of entry and its consisting words (four at maximum) are the elements.

Moreover, the etymology, synonym, sample sentence, collocation and other information in detail, or explanatory description, reference and others are recorded both in word database and in compound database.

4.3 Revised GUI

We have changed the GUI of the old EDS to display a compound list. In the old EDS as shown in Fig.3, a list of words which include the phonemes selected by a user. We added a tab for compound in the list. When a word of the list was selected, the compounds including the word are displayed on the tab (Fig.5 and 6). For example, when we find MAN after searching, being clicked (Fig.5), the phonemic description of MAN is indicated in the Explanation window and if the sign has some compounds, the list of them including the sign in the Compound Tab. When we click a compound, the corresponding sign movie is displayed and its explanation is presented at the same time. The process is shown in Fig.6.

We can search a compound by any word consisting it. For example as DOCTOR in Fig.6, we can search it by either MAN or PULSE. This makes us to search a compound sign from any information of a sign.

In the old EDS, Japanese phonemic description of a word, its phonemic information and existence of compound were indicated in the Explanation window. We changed it with only Japanese phonemic description and consisting words indicated in the compound searching, because if we display the all phonemic information of the all consisting words, it is entangled and ambiguous to catch up what to what.

The movies of a compound is displayed when clicked, as in the same as in the word searching.

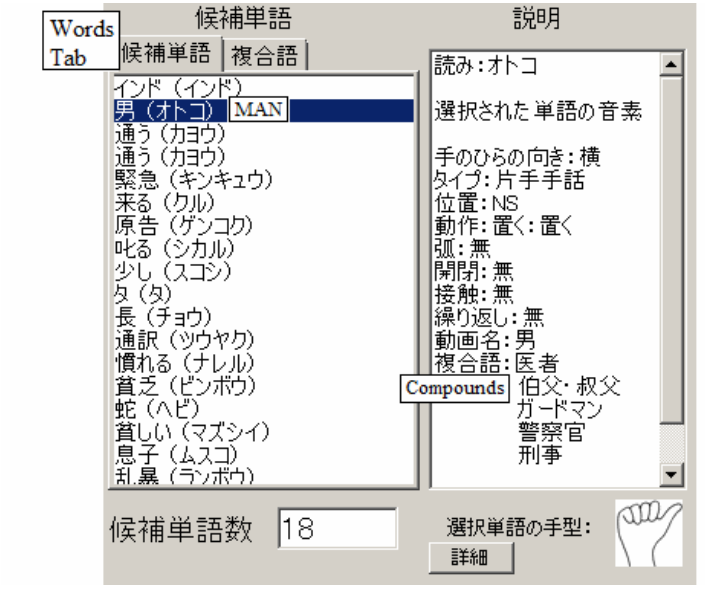

Fig. 5. Compounds Tab

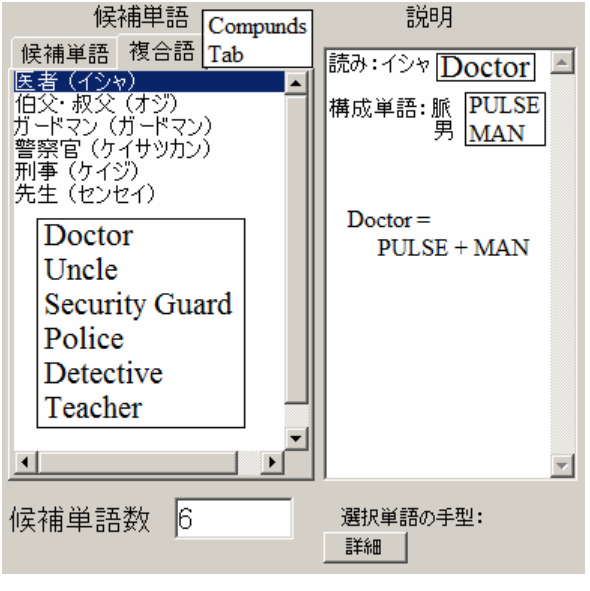

Fig. 6. A List of Compounds and its Explanation

4.4 Using as Japanese-JSL EDS

Our system can be used as Japanese-JSL dictionary, though we explained above how to search a Japanese meaning of a sign through sign phonemes. You can input

katakana of Japanese for keyword in the text box as in searching a sign word, then a list of compounds is displayed and the compounds are displayed on the list of candidate signs at the same time. A user does not know in advance whether a target word is a single sign or a compound. He might miss it if we separate it into Word Tab and Compound Tab. It also avoids the entangled manipulation.

5 Evaluation and Consideration

5.1 Evaluation Experiment

We performed an evaluation experiment for the enlarged version of our system. The purposes of the experiment are if the use could find a compound, and when he could succeed it, how long he would take a time comparing to when he had searched a simple word. We researched the usability of the system by how the users operated it and by questionnaires sheets.

In the experiment, we showed the user a sign movie and check how long he took to look in the word using our new system.

The user saw the sign movie and found a proper phoneme he thought, then input it into the system, and finally searched out the answer. We recorded his time to get the final answer, the number of the final candidate words, and in the case of compound, which word of the compound he used. We checked three simple words and one compound word. As for time, we judged he failed when he took longer than 6 minutes according to the result of our previous experiment [9]. However in this experiment, almost all the user finished it within 3 minutes. Checking the situations of longer than 3 minutes, he took a wrong search key and no candidate was displayed and he initiated the system and restarted it. That means when the user takes longer than 6 minutes, he would take wrong phoneme.

The subjects were ten boys of 15-16 years old who knew nothing about sign language. The reason why we used them was if there were someone who knows a bit of knowledge of our target compound as *Ao-Mori* (name of the place, literally, Blue Wood), the operation and the time would be significantly different from others.

Table 2. Experimental Results

Word	Info. \ Subjects	A	B	C	D	E	F	G	H	I	J
BROTHER	Time[sec]	*	65	159	21	131	25	125	181	63	116
	Views	3	1	2	4	2	1	4	2	2	2
	Number of Candidate Words	*	2	32	5	1	5	2	5	5	2
BICYCLE	Time[sec]	124	142	125	113	209	51	178	210	148	145
	Views	2	2	2	4	4	1	5	4	4	4
	Number of Candidate Words	32	37	29	28	17	216	5	99	28	20
BOOK	Time[sec]	189	210	*	123	178	*	270	*	*	206
	Views	1	3	4	4	2	4	5	6	3	2
	Number of Candidate Words	59	42	*	54	22	*	23	*	*	81
Compound Ao-Mori	Time[sec]	356	178	354	138	*	171	*	*	*	*
	Views	3	4	4	8	5	3	9	8	6	4
	Number of Candidate Words	48	24	33	37	*	219	*	*	*	*
	Number of Candidate Compounds	1	3	1	3	*	3	*	*	*	*
	Keyword	Mori	Ao	Mori	Ao	Mori	Ao	Ao	Ao	Ao	Ao

Therefore we gathered the subjects ignorant to sign language and lectured them briefly a phonemic system of sign language, then performed the test. This kept the subjects the same level of literacy for phonemes. Moreover they are well trained to computer literacy and skillful to computer manipulation. In the lecture for sign phonology, they were trained to use the new EDS using some example words and compounds and it assumes that they are well trained to use it. The result is shown in Table 2. The subjects are shown in alphabets. The asterisk means failure in 6 minutes. Consideration of the result is shown below.

5.2 Consideration

1. The comparison of hit rates for simple words and a compound
   The rate of success to find out the target word is; BROTHER: 90%, BICYCLE:100%, BOOK:60% and the average is 80%. As for compound, the average is 50%. We explained the subjects the process of searching compound in advance but many failed. We asked them why.

- failed to recognize a movie as a compound
- could recognize it as a compound but could not find out the word boundary
- took a time to input all the information of the words consisting the compound
  They took a compound for a single word and input all the phonemes to fail.

2. The number of candidate words
   The average number of candidate words is 34.0 and 72.2 for compounds. Subject F did not limit very much since he searched with different approach to other subject. He checked each signing movie when he obtained 200 candidates. Other subjects checked it when they reached to some 30 candidates. But the subject F took about half of the searching time of other subjects, It means it takes less time to check each movie than to think phonemes. It must be more effective for the user who is ignorant to sign language to check each movie than to analyze the phoneme.

   The subjects thought it difficult to input the phonemes of arm movement. There are too many items to input in the arm movement and some are hard to do so intuitively.

3. Searching time
   The subjects were ignorant to sign language in our experiment. Most of those who took a time failed to analyze the phonemes and they restarted to input them. Seeing the case of English learners, it is hard for the very beginners without any learning to use a dictionary. We think it is natural for the user not to deal the dictionary with ease, as in the case of this experiment.

   However, it is important to catch the phoneme when we read signing. We expect the time will be shortened if we improve the system in which it gives an user an advice to check points when he watch a sign movie.

4. Searching compound
   The result of the experiment shows a low rate of compound search. As the subjects said, whether the target signing was a word or a compound was ambiguous and they could not check the compound tab. As in Fig. 5, when they click a word, a list of compound was displayed on the Explanation window, but they did not notice it. They paid attention to movie, not to Explanation window after clicking. That was a part of reason why.

6 Future Problems

1. A List of Compounds
   The result of the experiment shows the low success rate of searching compounds. As some subjects told, one of the reasons of the low rate is that they could not differentiate whether the target signing was a simple word or a compound. The same thing can be said to an English-Japanese dictionary. When we want to look in "over-easy, sunny side-up, fried egg or hot dog", we would not succeed in it until we know whether it is a simple word or a compound. If we would look "hot" or "dog" separately, we could not understand the meaning correctly, even though many dictionaries show it under the title of "hotdog", that is, it is better for us to know that "hot dog" is a compound.
   In order to solve this problem, we focus to the peculiar way to use EDS. A user checks the movie when he looks in a signing, as we explained in the former section. The EDS shows a list of compounds on the lower screen when the movie is displayed which will make him easy to check a compound.
2. Revising GUI for the Sign Language Learners
   Our system was created for the sign researchers at the beginning, and it is true that it is not easy to handle for a sign learner in general. For example, inputting a phoneme, every item can be designated and it is precise. As a result of experiment shows, a user usually inputs a handshape and some movements and checks it through the movie. We would like to put the phonemes in order.

7 Conclusion

We enlarged our EDS to enable to search compounds in JSL-Japanese Dictionary, and estimated it in this paper. It proved that the enlarged version was more effective but the result of the evaluation experiment showed the success rate for compounds were lower than that of simple words. The reason maybe a user cannot differentiate a word for a compound. And it is a problem for a user that it is nuisance for him to input the phoneme. We showed some solutions for it.

The EDS is useful to find a meaning of a sign even if a user remembers it ambiguously, using and checking its movie. It is more advantageous than a printed dictionary.

We will renew and enlarge our EDS in the near future.

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