Implementation of AAC System for Persons Suffering from Speech Disorders

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Abstract: This study is generally purposed to develop a mobile augmentative and alternative communication system (hereinafter referred to as "a mobile AAC system"). Also the device is aimed as a mobile AAC system for helping communication of persons who suffer from speech disorders in a free and convenient manner. One thing firstly considered for a successful AAC system is selection of vocabularies. For this purpose, the above researchers collected utterances in actual situations to select vocabularies of higher frequencies. For generation of sentences by maximizing the use of limited space in the AAC system, this study specifically presents a method of predicting predictions. This method includes selecting vocabulary and classifying it by domains so as to meet the characteristics of the mobile AAC communication, using a noun thesaurus for semantic analysis, and building a sub-category dictionary. Predicting predicates by selecting symbols in accordance with this method is tested and the utility thereof is confirmed.

Keywords: AAC system, speech disorders, vocabulary of higher frequency, predicate prediction

1. INTRODUCTION

Recently people are increasingly interested in AAC systems for persons suffering from speech disorders. As such persons successfully participate in education, social activities, religion, leisure, occupation, etc., necessity is required for changing the way of their communication. One of the most influential elements that affect on the necessity for changing is the development of technology. Development of such technology affects on successful communication of the people who have serious communication disorders, and remarkably on the AAC field for the people whose communication cannot be satisfied using spoken language.

Therefore, selection of the first vocabulary is considered very important when developing such an AAC system [1]. This is because poor vocabularies or improper selection of vocabularies from the AAC system may cause increased frustration of the AAC system users[2][3]. Various prediction methods are sometimes applied for allowing the AAC system users to use the system more easily[4][5]. Accordingly, in this study, the researchers constructed a database by collecting and analyzing actual utterances, selecting vocabularies of higher frequencies and using a lexical thesaurus and a sub-categorization dictionary on the basis of the selection, and it was intended to develop a system to predict and recover the grammatical morphemes such as auxiliary words or endings of words, complements, annexed words and conjunctions to present a relevant sentence by assuming that they will be omitted at the time entry.

Recovery of omitted parts in a sentence and prediction of utterance belongs to an area that is very difficult to study in natural language processing such as semantic interpretation and discourse understanding[6][7]. It is considered necessary to carry out the research on the basis of the results of research and the database previously established for understanding of vocabularies and meaning, interpretation of dialogic style sentences by this research team[8].

2. METHOD

2.1. Vocabulary Selection and Establishing a Database

It is to divide a relevant area into different sub-areas depending on situations such as features of user's age or disorder level, places, topics, etc., to collect and analyze vocabularies in order to allow the users to use them easily in a specific place or situation that frequently occurs because icons are used in this research to define the relevant area. It is necessary to collect and analyze vocabularies used by the persons suffering from speech disorders from a different point from the existing Korean processing research, in that the persons suffering from speech disorders are chief users.

In order to construct a vocabulary database which is the first step of developing the AAC system, the researchers collected spontaneous utterances during break times in schools and in daily living in order to collect vocabularies used frequently by ordinary people. The researchers chose nine types of conversational situations in restaurants, shopping centers, transportations, theaters, video shops, hospitals, banks, schools, and at home, related to ordinary living. In this research, total11,092 vocabularies were analyzed from the situational utterances by 24 schoolchildren and 20 adults at schools, etc. by recording their utterances. The ratio of the vocabularies of higher frequencies to the entire vocabularies was then measured.

2.2 Connection of Vocabularies and Semantic Icons

It is necessary to define semantic icons for each relevant area through consideration of ambiguity and multiplicity of meaning of vocabularies of natural language, and through analysis of the user interface of efficient icon arrangement. The researchers carried out the research by using the system of this study, analyzing the relationship between vocabularies and icons, designing proper icons corresponding to the vocabularies database and efficiently arranging them in each area. An example of icons corresponding to the vocabularies database is shown in the Fig. 2.1.

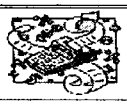
icon	noun	predicate
	receipt/N	pay/V
	trousers/N	wear/V
	car/N	ride/V

Fig.2.1 Example of icons corresponding to the vocabularies database

We dealt also in actual sentence taking the mother change of the predicate part into account to the prototype, and an example to become a sentence generation in the icon user interface is as follows.

1) When is the examination?

 + □□□□ + ?

2) Do you have the red bag?

 +  + + ?

3) Borrow the writing note-book.!

 +  + + !

2.3.Creating a sentence through prediction of vocabularies

The AAC system is a tool to help communication by generating a sentence if a meaning icon is pressed, but has a special restriction that it is impossible to express all vocabularies with meaning icons possibly without changing pages. Therefore, for a given sentence, the system was made by constructing a database through interpretation of lexical meanings for respective vocabularies to allow predicates to be selected through a popup menu when a user presses a noun meaning icon as an entry, the meaning of the predicate being matched to the noun.

In general, grammatical morphemes such as auxiliary words or endings of words and the components such as conjunctions or predicates are omitted at the time of entry. The study of predicting and recovering such vocabularies is the key part of this research. To this end, it is necessary to apply the syntax theory by sentence units for the study of morphemes that are primary units of omission and the recovery of omitted parts in a sentence. It is also necessary to use the result of word sense disambiguation study in the meaning of vocabularies for settling multiplicity or ambiguity of meaning on a vocabulary basis. In this study, the researchers intended to develop a sub-categorization dictionary that is a Korean argument structure and a thesaurus that is a hierarchical structure between concepts, to develop an algorithm for settling ambiguity of meaning of vocabularies using the dictionaries and to apply it to this study.

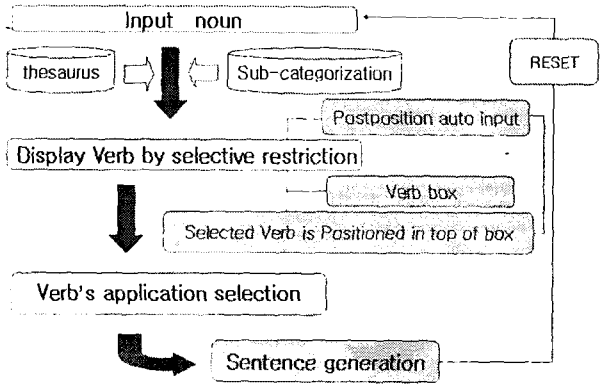
The Korean language is called as a 'situation-centered language', since situation, meaning and context play a more important role rather than syntactic characteristics. Predicts are modified by complements to specifically express a situation. The use of complements are restricted depending upon the situation expressed by predicts, which is called "sub-categorization." Thesaurus refers to a dictionary that shows a hierarchy of the vocabulary including predicts and words meaningfully related thereto. The vocabulary is arranged by separating a sentence into an input part and a predicate prediction part. A semantic symbol corresponding to a noun is formed by morphemes. As for nouns, a semantic symbol for each noun is provided, thereby building up database based on concepts.

In order to predict predicates, required is a step of deriving what is desired to be expressed by matching the meanings of the vocabulary, as represented in a noun thesaurus, and the situations expressed by predicates, as contained in a pattern dictionary, with the semantic dependency. This is referred to as a "limited selection, " and predicates are predicted by the limited selection. Field for predicate application enables making various sentences and changing basic predicate forms to desired application forms.

A sub-categorization dictionary is build up based on the thesaurus, sentence pattern and predicate application forms. The sub-categorization dictionary includes basic forms of predicates, application form, and nouns related to predicates, and postpositional words, together with the meanings thereof. The sub-categorization dictionary is based on the reference numbers of sentences, application forms of predicates, and postpositional words to be added to nouns that are inputted. Thesaurus dictionary of nouns and sub-categorization dictionary are build-up and predicates for an inputted semantic symbol are presented by the limited selection. .In this research, the researchers comprehended characteristics and trends of using vocabularies by collecting and analyzing vocabularies for persons suffering from speech disorders.

On the basis, the researchers constructed a vocabulary database and various electronic dictionaries such as a sub-categorization dictionary that can be readable by machines. On the basis of the vocabulary dictionary, the researchers defined icons for intuitively transferring meaning to a system user. The mostly

often-used predicates are located on the very top of the pop menu. The predicate prediction algorithm for this process is shown in the following Fig.2.2.



. Fig. 2..2. Flow of Sentence generation

3. RESULTS

As a result of analyzing the ratio of vocabularies of higher frequencies to the entire vocabularies, it was shown that ten vocabularies of the first higher frequencies occupied 20%, 25 vocabularies of higher frequencies did 34%, and 50 vocabularies of the next higher frequencies did 58%, respectively, in the entire vocabularies. The result is shown in Fig.3.1.

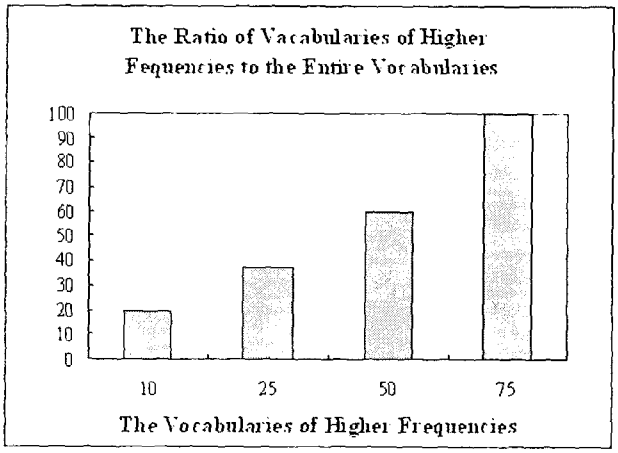


Fig.3.1. Ratio of Vocabularies of Higher Frequencies to the Entire Vocabularies

With respect to the frequencies of utterances of parts of speech , the result showed that verbs were used 1,378 times, nouns 790 times, pronouns 676 times, adverbs 582 times and adjectives 289 times, which means that verbs were most frequently used. This is a datum that proves that prediction of verbs is more useful than that of other parts of speech in the AAC system. The result of constructing a database through such semantic analysis of vocabularies and predicting verbs in the AAC system is shown in Fig.3.2.

After we select the key point vocabulary with a situation higher frequency vocabulary, we constructed the data base. As a stage example of icon language interface of AAC system, the result of output which implements AAC system is as follows

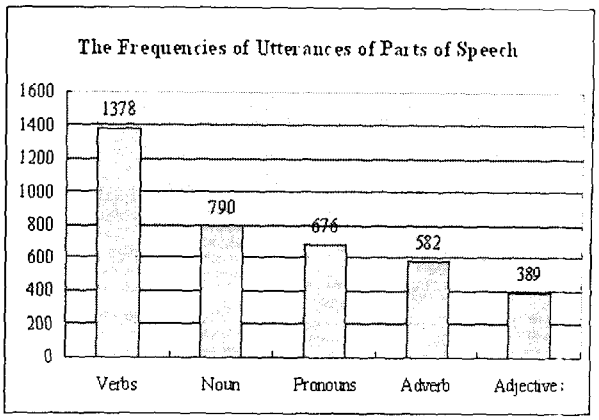


Fig.3.2. Frequencies of Utterances of Parts of Speech

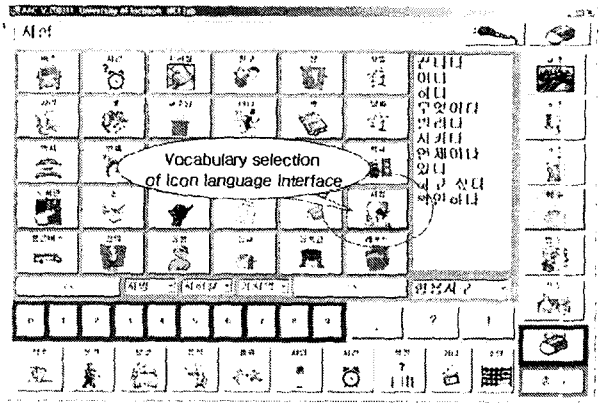


Fig.3.3. Selection of vocabulary icon

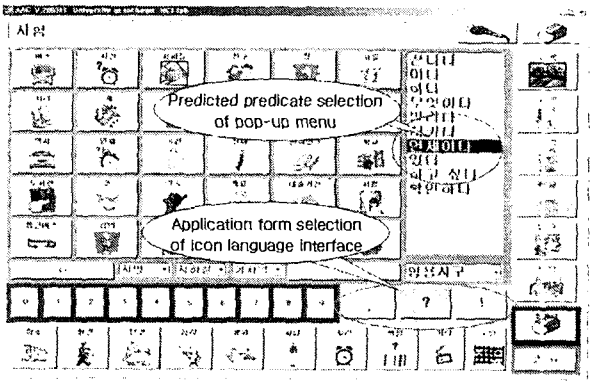


Fig3.4. Application forms selection with predicate prediction

To do the communication each other the sentence like "When is the examination?" We are handled to the stage following and are outputted.

Stage1: Choose a school domain in initialization monitor.

Stage2: Select examination icon vocabulary with the Fig.3.3.

Stage3: Specify the result of suitable predicate predicting about an icon noun vocabulary with the Fig3.4.

Stage4: Select predicate application forms with Fig. 3.4 for rather correct communication.

Stage5: The sentence is outputted finally with Fig 3.5 and the sentence to TTS.

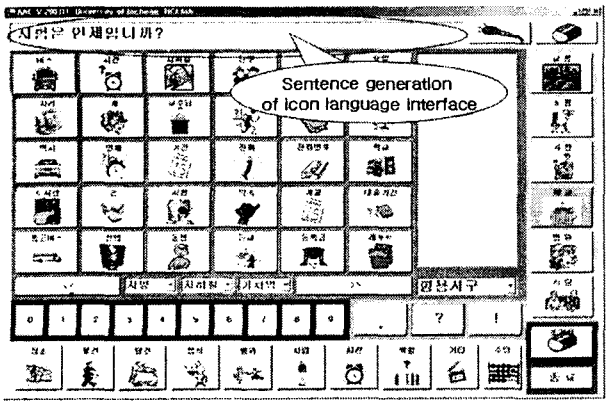
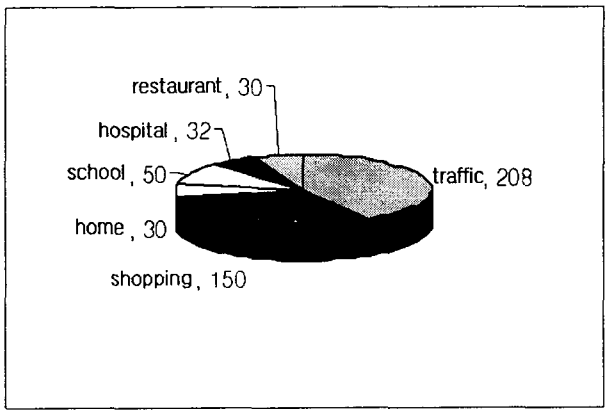


Fig.3.5. Generation of the sentence and output after predicted.

In order to verify practicability of this program, the researchers met persons suffering from speech disorders, trained them to use the program and applied it to various situations. Fig.3.6 is the result that sentences in domain for about five hundreds situations are freely generated by three non-speaking persons. The unit is the number of sentence. The result is showed that the domain is presented highest in the frequencies of usage is traffic and shopping. The result shows that the more the purpose of service what non-speaking persons want service is evident and the more the domain is frequently used, gets the higher frequent usage.

Fig.3.6. Practical average use of non-speaking persons



in each domain

5. CONCLUSIONS

A significance of this study is that this study was performed by actually visiting schools and other sites to record spontaneous dialogues and presented vocabularies of higher frequencies and frequencies of respective parts of speech. It was common in all researches that a small number of vocabularies of higher frequencies can be represented if the number of entire vocabularies is larger. The result of investigation that predicates are most frequently used as compared to the frequencies of use of other parts of speech fortifies that it is more efficient to select predicates of higher frequencies, to use the predicate prediction method and for the user to generate a sentence in an AAC system to help his/her communication. Also the program can be advantageously used by a patent suffering from a temporary speech disorder or the speech disorder people having an accident in addition to the ordinary persons suffering from speech disorders.

It is considered that semantic interpretation of Korean and discourse understanding and the sentence creation technology obtained by this research can be used in the current various systems in the natural language processing field. It is also considered possible to develop an information search and index system on the currently available morpheme analysis or syntax analysis level, a machine translation system, a question-answering system, etc. into a semantic analysis level in order to achieve development of more natural language systems. It is also considered possible that the matching technology of Korean vocabularies to icons will be able to implement remarkable technical development in developing icon systems having touch screen interfaces such as a guide system, a reservation system, etc, widely used at present, in addition to the portable terminals for handicapped persons.

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