Development of IME with Only One Switch for Physically Disabled Persons

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Abstract

It is essential for physically handicapped person to use auxiliary equipment for communication with others. We have developed a text input assistance application for mobile devices “RakuRaku IME” (“RakuRaku” means easy in English), the main user of this application is physically disabled person who cannot move his/her fingers and thumbs smoothly.

The effectiveness of the function has been confirmed by index defined by us. As the value of the index C approaches 1, it signifies that the input was performed without needless controls. A better interface might have a variety of elements, however to present the results of this study numerically, in this case we simply defined an index that emphasizes input speed.

We describe some features that we have implemented newly. One is the kana-to-kanji conversion function, which is implemented on the server. Settings of this app are often conducted by caregivers rather than the subject. Caregivers can manage the dictionary registration and priority of the word conversion on the server. The other is the setting function of character transition speed. We consider the character transition speed should be changeable.

We also reexamined text input processes. Character input is done through stepwise and hierarchical selection, however there are a few problems that impede improvement of input speed. To verify the effectiveness of this system, we have done several experiments with various conditions set. We examine these results and discuss future work.

Keywords: Assistive Technology, Human Interface, Android, Auto scan, Communication tools

1. Introduction

Smartphones and tablets have attracted a great deal of attention as equipment not only for non-handicapped person but also for disabled person. The main purpose of this research is, using the excellent features for communication with of these mobile devices, to improve the QOL of physically disabled person. The development of communication tools for the physically disabled person is also a significant research issue until now. One key issue is development and improvement of the text input interface. There are many constraints in the development of input interface for physically disabled person. This is because complex operations are difficult for him/her. We propose to use smartphones which have been popular in recent years. Our major goal is to develop a smartphone environment that is easy to use for physically handicapped people.

2. Basic Overview of RakuRaku IME

Here, we explain the input target character movement mechanism in detail. We explain the structure of Hiragana which is the basic character of Japanese. Figure 1 shows hiragana base characters and its transition to derived characters. Upper half of the figure shows hiragana base characters. The hiragana syllabary consists of 46 characters, 5 singular vowels (a, i, u, e, o) conceived as a 5×10 grid. Basic hiragana characters can change to derived hiragana characters (lower half part of the figure)

To input one of the 50 Hiragana characters, first the character set columns from “a” (あ) to “wa” (わ) are displayed, as shown in figure 1.

For example, when the desired “ha” (は) character shown in figure 2 is shaded red, the button is pressed and the display changes to that shown in figure 3 (left), on the right, however, all characters in the “ha” (は) column are displayed, and selection moves periodically from one character to the next. When the desired character “fu” (ふ) is shaded red, the button is touched again, as shown in figure 3 (right) and the display change to that shown in figure 4.

Selection moves between the normal character “ha” (は), the voiced sound “ba(ば)”, and the semi-voiced sound “pa”(ぱ). For characters such as “a”(あ), selection moves between uppercase and lowercase characters. One character is input after the button is touched while the selected character is shaded red. And the next character in the text can be input.

1st transition is the first character of the first row

Base Characters

わ	ら	や	ま	は	な	た	さ	か	あ
Wa	Ra	Ya	Ma	Ha	Na	Ta	Sa	Ka	A
	り		み	ひ	に	ち	し	き	い
	Ri		Mi	Hi	Ni	Ti	Si	Ki	I
を	る	ゆ	む	ふ	ぬ	つ	す	く	う
Wo	Ru	Yu	Mu	Hu	Nu	Tu	Su	Ku	U
	れ		め	へ	ね	て	せ	け	え
	Re		Me	He	Ne	Te	Se	Ke	E
ん	ろ	よ	も	ほ	の	と	そ	こ	お
Ng	Ro	Yo	Mo	Ho	No	To	So	Ko	O

2nd transition is each character on the selected column

Derived Characters

や	ば	ぱ		だ	ざ	が	あ
ya	Pa	Ba		Da	Za	Ga	a
	び	び		ぢ	じ	ぎ	い
	Pi	Bi		Di	Zi	Gi	i
ゆ	ぶ	ぶ	っ	づ	ず	ぐ	う
yu	Pu	Bu	tu	Du	Zu	Gu	u
	べ	べ		で	ぜ	げ	え
	Pe	Be		De	Ze	Ge	e
よ	ぼ	ぼ		ど	ぞ	ご	お
yo	Po	Bo		Do	Zo	Go	o

3rd transition from the basic character to the corresponding derived character (if it exists)

Fig. 1 Transition of "Hiragana" Character

Fig. 2 The developed software keyboard.

Fig. 3 Text movement of Step 2 in Fig. 2

Fig. 4 Movement of Step 3 in Fig. 2

Definition of Index for Ease of Input

To define ease of input as the index, the equation designed by Shirahama, Sakuragi and Kudou^(1,2). As the value of C approaches 1, it signifies that the input was performed without needless controls. A better interface might have a variety of elements, however, to present the results of this study numerically, in this case we simply defined an index that emphasizes input speed in equation (1). Figure 5 shows a diagram of the method for calculating the theoretical value and an example of the time to determine a single character expressed as a graph. Figure 6 shows the scenes using RakuRaku IME.

$$C = \frac{T}{(\beta - \alpha)t + as} \quad (1)$$

- C Ease of use
- T Actual measured value
- α Number of required touches
- β Number of required selection movements
- t Selection movement interval
- s Selection movement determination time

Fig. 5 Calculating theoretical value for determination time

Fig. 6 Character input experiments to mobile devices

3. Kana-to-Kanji Conversion and Character Transition Speed Adjustment

Caregivers can manage the dictionary registration and priority of the word conversion on the server. Character transition speed, which depends on the individual differences generally, also became changeable. Figure 7 is a usage history on the server. Figure 8 is a new setting screen for character transition speed, size of the beep sound and Enable switch for kana-kanji conversion.

X	ID	level	number	nickname	last modified at	Add new user
☒	000106	管理者	KK002	北九州高専の先生	2016年06月17日 15時52分	Add new user
☐	000162	生徒・児童	hamaken	白濱研究室	2016年07月14日 15時04分	
☐	000163	生徒・児童	hamaken2	白濱研究室2	2016年07月14日 15時30分	

Fig. 7 User's conversion history on Server

Fig. 8 New configuration item

4. Improvement on IME character input

To explore the IME's input improvement point, we visited the welfare equipment plaza Kitakyushu. We asked a collaborator, the patient of spinal muscular atrophy, to use the application to input the sentences. We explain the feedback items on the operation feeling obtained from the user this time.

4.1 Reorganizing the IME input hierarchy

We adjustment of input hierarchy of character. Table 1 and table 2

Tab. 2 shows first selection of character transition of conventional model and improved model, respectively. We could drastically reduce the number of initial transition candidate options from 17 to 4.

Although the input hierarchy increases by one, it is still expected to shorten the speed time. We solved this problem by reducing the hierarchy on hold and confirmed conversion.

Tab. 1 First selection transition (conventional model)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A	KA	SA	TA	NA	HA	MA	YA	RA	WA	C1	C2	C3	F1	F2	F3	F4
あ	か	さ	た	な	は	ま	や	ら	わ							

C1	comma, period, space	F1	conversion function
C2	numerical character	F2	confirm function
C3	symbolic-character	F3	delete function
		F4	complete function

Tab. 2 First selection transition (improved model)

1	2	3	4
A-NA (あ-な)	HA-MA(は-わ)	Character	Function

Fig. 9 Comparison of first selection transition string

5. Experiment on Performance Comparison

Experiments were conducted to compare the difference between the input performance of IME newly improved this time and the input performance of IME up to this year. Each IME used in the comparative experiment is shown in table 3. We prepared five kinds of applications, and measured the character input speed with each IME.

Tab. 3 Each IME used for comparison experiment

IME 1	Conventional IME
IME 2	Dictionary registration function
IME 3	Adjustment of input hierarchy of character
IME 4	Reduction of "Conversion" / "Hold"
IME 5	All the above elements (latest edition)

Experiments were conducted on 10 healthy volunteers, and the number of input errors and the number of input errors was recorded. Select transition interval is set to 1000 [ms] of the standard setting. Figure 10 shows the sentences used in the experiment and the number of characters and required transition times. We converted from "おひ" (o hi) to "お久しぶりです" (o hi sa shi bu ri de su) in the experiment procedure using the dictionary registration function.

Table 4 shows the number of characters and the necessary number of transitions used for calculation of index C. Table 5 shows the average input time and the average number of input errors in the experiment, respectively.

Tab. 4 Number of characters and the required number of transitions

IME	N	T
1	17	230
2	11	161
3	17	207
4	17	221
5	11	132

N : Number of characters (Hiragana)

T : Required number of transitions

お久しぶりです。お元気ですか？
(o hi sa shi bu ri de su, o ge n ki de su ka?)
(Long time no see. How are you?)

Fig. 10 Example sentence

Tab. 5 Average input times and numbers of input errors

IME	Input time [s]	Input errors [n]
1	281.00	1.70
2	210.40	1.20
3	250.70	2.50
4	253.40	1.50
5	161.10	1.20

As can be seen from table 5, these improvements have shortened the input time. All input times are shortened with each improvement factor, and latest version which includes every improvement are further shortened, therefore this result shows improvement of performance clearly. The average number of input errors is about 1 to 2 times, which has not changed much from the conventional number of times. We estimate that the reason why the number of mistakes in IME 3 is slightly higher is since the input procedure is significantly different from other IMEs.

Table 6 shows the usability index C for each version. Because the time required for inputting the quickest becomes the closer to the measurement time, the value of index C approaches from 0 to 1, and the theoretical ease of use becomes greater.

Tab. 6 Values of index C for each version

Version	Index C
1	0.826
2	0.835
3	0.742
4	0.951
5	0.892

In the version that divides the first selection into two lines from "A line to a line" to "A line to a line," the index C decreases slightly.

6. Conclusions

We added the functions to character input assistance application for physically handicapped persons, and obtained the following conclusions after verification and evaluation of its performance.

1. We improved conventional layout and improved operability.
2. We implemented kana-kanji conversion function which can be adjusted for each user on the server.
3. We succeeded in shortening the input time while maintaining the ease of inputting characters, because of improving the layout and adding functions.

Implementation of cancellation keys by long press operation, input position movement keys, a mode suitable for inputting numbers / alphabets, etc. is future tasks.

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