社団法人 情報処理学会 研究報告
IPSJ SIG Technical Report

2006－HI－121 (7)
2006／11／22

バングラ語ショートメッセージサービスのための より少ないキーストロークでのマルチタップ入力モデルに 関する提案

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今日、携帯電話はあらゆる年齢層の人々の間で普及しており、バングラデシュにおいても携帯電話利用者は日々増加している。しかしながら、携帯電話のインターフェースの大半は英語である。近年、2、3社のオペレータがバングラ語でのショートメッセージサービスを開始したが、バングラ語の仕組みとその文字の多さのため、携帯電話でのタイプは容易ではない。本論文は、より速く使い勝手の良い、効率的なマルチタップ入力法を提案するものである。現段階における評価は、キーストローク比較と文字入力によるユーザ実験により実施した。同実験結果から、現行のAKTELキー割り当てに比し、提案モデルではタイピング速度を15パーセント以上高速化できることが明らかになった。

A Proposal of Reduced Keystroke Multitap Input Model for Bangla Short Message Service

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Now a day, mobile phone is very popular to the people of all ages. Mobile phone users are increasing day by day in Bangladesh also. But the interface of mobile phone is mostly in English. Recently, few operators have introduced Short Messaging Services in Bangla. But typing in Bangla in mobile phone is not an easy task due to the structure and large number of characters in this script. The objective of this paper is to propose an efficient and user friendly Multitap input method. The evaluation at this point was done by keystroke comparison and user experiments by text entry. According to the result, we found our proposed model give over 15 percent higher tapping speed then present AKTEL key assignment.

1. Introduction

Now a day mobile phone is very popular to the people of all ages. In Bangladesh also, mobile phone users are increasing day by day. In Bangladesh the number of mobile phone subscribers has increased from 4.0 million to 10.02 million showing a growth of nearly 150 percent during the last one year [1]. But the interface of mobile phone is mostly in English. Bangla is the official language of Bangladesh and one of 18 enlisted languages in the Indian Constitution. It is the administrative language of the Indian states of Tripura and West Bengal and also one of the administrative languages of Kachar district, Assam. Bangla speakers more than 230 million today, make Bangla the seventh language after Chinese, English, Hindi-Urdu, Spanish, Arabic and Portuguese [2]. Recently, different mobile operators plan to introduce Bangla language in mobile phones. Few operators

could successfully introduce Short Messaging Services (SMS) in Bangla. Bangla SMS is becoming very popular day by day. But typing in Bangla in mobile phone is not an easy task. Part of the complexity arises due to the structure of the Bangla script and large number of characters in this script. AKTEL, a mobile operator in Bangladesh, implemented a Multitap input method in Bangla for mobile phone SMS [3]. It becomes very popular within short period of time. Grameen Phone Ltd., the largest mobile phone operator in Bangladesh, also introduced Bangla SMS using two dimensional matrix arrangements of the alphabets. One can either use the up-down-right-left keys or follow the table to create the desired message in Bangla. Alternatively, one will be able to type each independent Bangla letter using only two number-keys, the first one representing the row, and the second one the column [4]. CityCell initiated Bangla messaging using English alphabet called Romanization. The customer will write the text in English with Bangla format. In the return Message, the customer will receive the Message in Bangla [5]. But it sends the message as a picture.

2. Bangla Script

Bangla scripts consist of vowels, consonants and vowel signs. There are total 61 symbols. Moreover many ligatures (conjuncts) and few consonant symbols are also used in Bangla scripts. In the Bangla script there are eleven vowels with seven sounds - long and short. All the vowels in Bangla can be nasalized by using the nasal sign (ঁ) called "chondrobindu" (means moon dot). All the vowels in Bangla are independent and in the initial position of a word retain their original shape. There are 39 consonants in Bangla alphabets. The first vowel অ 'a' is implicit in all consonants. Each vowel has another shape called vowel-sign or signature to use with consonant. With the exception of the first vowel ("a") which has no vowel-sign and is always implicit in the consonant, they all change their shape when used with a consonant. The new shape, a vowel-sign (also known as a "-kar"), then might proceed, come after, be around or at the bottom of the consonant. If a vowel follows a consonant in a syllable, shortened vowel vowel-signs ('signatures') are used.

Vowels

অ(a) আ(aa) ই(i) ঈ(ii) উ(u) ঊ(uu)

ঋ(ri) এ(e) ঐ(ai) ও(o) ঔ(au)

Consonants

ক(ka) খ(kha) গ(ga) ঘ(gha) ঙ(nga)
চ(cha) ছ(chha) জ(ja) ঝ(jha) ঞ(nya)
ট(tta) ঠ(ttha) ড(dda) ঢ(ddha) ণ(nna)
ত(ta) থ(tha) দ(da) ধ(dha) ন(na)
প(pa) ফ(fa) ব(ba) ভ(bha) ম(ma)
য(za) র(ra) ল(la) শ(sha) ষ(ssa)
স(sa) হ(ha) ড়(rra) ঢ়(rha) য়(ay)
ৎ(t) ং(ng) ঃ(h) ঁ(c.b.)

Vowel-signs

া(aa) ি(i) ী(ii) ু(u) ূ(uu)
ৃ(ri) ে(e) ৈ(ai) ো(o) ৌ(au)

Consonant symbols

্য(zo-fola) ্র (ra) র্ (ref)

Some consonants have another shape called consonant symbol or –fola, which can be used with other consonants to make compound sound. Here are some examples of Bangla words using Consonants only (Table 1). Here we can see the examples of default vowel অ (a) associated with each consonant. Traditionally last consonant drops the implicit vowel অ (a).

Table.1 Bangla Words Using Consonants Only

কলম = ক + ল + ম	
Kalam = Ka + la + m	
ধন = ধ + ন	
Dhan = Dha + n	
নরম = ন + র + ম	
Naram = Na + ra + m	

Here are some more examples of Bangla words using other vowels or vowel-signs with consonants. Here for the character (kaa) in the word (kaak) users write the glyph for the vowel (aa) after the glyph for the consonant (k) and pronounce the (aa) after the (k).

কাক = ক + া + ক

Kaak = K + aa + k

But for the character (mi) in the word (aami) users write the glyph for the vowel (i) before the glyph for the consonant (m), but pronounce the (i) after the (m).

আমি = আ + ম + ি

aami = aa + m + i

Ligature (Juktakkhor): Ligatures or conjuncts are the amalgamation of two or more letters into one specific letter. In English for example "s" and "t" are two specific characters, produce one sound "st" when used together and are written as two letters next to each other. This is not the case in Bangla. For example ষ and ট together make a ligature ষ্ট and it sounds like sta. Table 2 shows some examples of ligatures.

Table.2 Examples of Ligatures

Formed by	Ligature	English	Example
ষ + ট	ষ্ট	st	শিষ্ট (shista)
ল + প	ল্প	lp	অল্প (alpa)
ন + ত	ন্ত	nt	জিবন্ত (Jibanta)

There are many ligatures in Bangla scripts. Although not all possible combinations of two consonants are used in writing, the number of allowed combinations is huge.

3. Mobile Phone Text Input Technique

The majority of the mobile phones are designed with the standard keypad (Fig. 1) which has 12 keys: 0-9,* and # [6]. Entering text from a 26 character alphabet using this keypad compels a mapping of more than one character per button of the keypad. A typical mapping has keys 2-9 representing either three or four characters, with space and punctuation mapped to the other keys. All the text input techniques that use this standard keypad have to somehow resolve the ambiguity that arises from this multiplexed mapping. Here, we shall briefly review Multitap technique for entering text with this standard keypad, and refer the reader to Soukoreff and MacKenzie [7] for a more comprehensive review for all the current input techniques that is beyond the scope of the present paper.

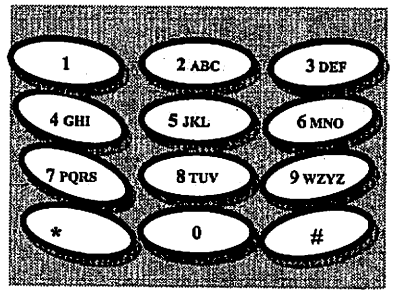

Fig.1 Standard 12-Key Mobile Phone Keypad

4. Multitap Input Method

One of the most common text entry techniques for mobile phones is Multitap, where users repeatedly press the key labeled with their desired character until it shows on the screen. For example, the characters abc are traditionally kept on the 2 key. Pressing the key 2 once shows a, twice b, and so on. In effect, multiple consecutive presses of the same key perform both between and within group selections. A problem arises when the user attempts to enter more than one letter from same key consecutively [8]. For example, pressing the 6 key three times could result in either o or mn. To overcome this, Multitap employs a timeout of 1-2 seconds on the key presses, such that no key presses during the timeout indicates completion of the current character. Entering mn under this scheme has the user press the 6 key once for m, wait for the timeout, then press 6 twice more to enter n. To minimize the time penalty this incurs, some versions add a "timeout kill" button that allows the user to forcibly avoid the timeout. Some phones use a combination of the two options. As for example, Nokia phones apply a 1.5 second timeout and a timeout kill using the down arrow key. The user can use any option. Though Multitap is simple and unambiguous, it can be slow, and has a KSPC rate of about 2.03 [9].

5. AKTEL Multitap Input Method

Mobile operator AKTEL has implemented Bangla Short Messaging Services (SMS) successfully. They have used Multitap input method. To use Bangla SMS, one will need to install "AKTEL Mayer Bhasha" software in one's handset. AKTEL Bangla SMS can be sent to any one, who has the software installed in his or her mobile. Both the sender and receiver must have the software installed in his or her handset. This software supports all of the MIDP 2.0 enabled mobile

sets. The length of the message is up to 150 characters.

Table.3 AKTEL Key Assignment for Bangla Alphabet

Keypad	Bangla Script
Button: 1	অআইঈউঊঋএঐওঔ১
Button: 2	কখগঘঙ২
Button: 3	চছজঝঞ৩
Button: 4	টঠডঢণ৪
Button: 5	তথদধন৫
Button: 6	পফবভম৬
Button: 7	যরলশষ৭
Button: 8	সহড়ঢ়য়৮
Button: 9	ৎংঃঁ৯
Button: 0	Space ◌ ◌ি ◌ী ◌ু ◌ূ ◌ৃ ◌ে ◌ৈ ◌ো ◌ৌ ◌্ ০
Button: *	, ? ! _ ( ) # । : - ; + *
Button: #	Ligatures

Letters are listed under buttons as shown in the Table 3 as they are organized in the Bangla alphabet. Typing of characters follows the conventional Multitap SMS system in all available handsets i.e. press button 2 once for "ka" , twice for "kha" etc.. The letters available under any button are listed at the bottom of the screen when that button is pressed, and the currently selected one is highlighted. Vowels are kept under button (1). Consonants are distributed through (2) to (9). Punctuations are under button asterisk (*). Vowel-signs and consonant symbols (-fola) are under button 0. Button hash (#) contains a menu of available 127 ligatures from which user can select one. User can select any of these to insert in the text. If the hash (#) button is pressed for long, the last two letters typed will be replaced by corresponding ligature, if it is supported. Else, the list of available ligatures will be opened.

Problems in AKTEL Multitap: The main problem of this model is too many characters are assigned under each key. Specially button (1) and (0) are highly overloaded. There are 12 characters under button (1) and 15 characters are under button (0). So it needs many keystrokes per character. Moreover, accessing the characters is sequential and linear. So, in the worst case it needs 15 keystrokes for one character under key (0).

6. Proposed Multitap Input Method

In our proposal, letters are listed under buttons as shown in the Table 4 and 5 as they are organized in the Bangla alphabet.

Table.4 Proposed Key Assignment for Bangla Script (Normal Mode)

Keypad	Bangla Script
1	অআইঈউঊ
2	ঋএঐওঔ
3	কখগঘঙ
4	চছজঝঞ
5	টঠডঢণ
6	তথদধন
7	পফবভম
8	যরলশষ
9	সহড়ঢ়য়
0	ৎংঃ◌়
*	◌া ◌ি ◌ী ◌ু ◌ূ ◌ৃ ◌ে ◌ৈ ◌ো ◌ৌ ◌্
#	। , ! ; ? # ' : + - * / ( ) = .

Table.5 Proposed Key Assignment for Bangla Script (Shift Mode)

Keypad	Bangla Script
1	১
2	২
3	৩
4	৪
5	৫
6	৬
7	৭
8	৮
9	৯
0	০
*	Ligatures
#	

In this method there are two input modes- normal mode and shift mode. Here our objective is to minimize the number of Bangla characters or symbols under any button. Except punctuations, vowel-signs and ligatures, typing of characters follow the conventional Multitap input system in all available

handsets i.e. press button 3 once for ক , twice for খ etc.. Punctuations, vowel-signs and ligatures are entered using arrow and fire buttons. First set of letters are distributed in normal mode (Table 4). Here, vowels are kept under button (1) and (2). Consonants are distributed through (3) to (0). Vowel-signs and consonant symbols (-fola) are under button asterisk (*). Punctuations are kept under button hash (#). Shift mode (Table 5) is activated by mode button. In shift mode Bangla digits are distributed to corresponding English numbered button, for example Bangla ১ is in button (1) and Bangla 2 is in button (2) etc.. Button asterisk (*) contains a two-dimensional list of ligatures from which user can select one. User can select any of these to insert in the text. If a hashant(্) is entered between two letters, they will be replaced by corresponding ligature, if it is supported. Space can be entered in both modes using right arrow at the end of the line. We did not use the Multitap timeout method to type two characters consecutively from the characters within the same button. To overcome this problem we used the right arrow key after one character to go to the next character within same button. Here the right arrow key means the end of the session of first character.

7. Experiments

In this research we performed two types of experiments. One is the keystroke comparison and another is the user experiments by text entry. In the keystroke comparison we selected ten common sentences in Bangla conversation and messaging. In the user experiments we selected a long message with seven sentences. Here we shall discuss the methodology of user experiments in details. In the text entry research most of the times presentation of the text to the participant is an important issue. When they are given a paper with a group of sentences to enter into the mobile phone, forces them to attend to the paper text, mobile screen and the mobile keypads. But entering a message into a mobile device in an office or at home, users typically do not attend to any paper text – usually they write their own. To simulate this scenario best many approaches are used. One option is presented text can be read aloud to the participants, but this approach may create problems [10].

Another option is to present participants with short messages that are easy to memorize. The participant reads each message and, when ready, enters it [11].

7.1 Participants

Six unpaid volunteers participated in this experiment. They ranged in the age of 26 to 35 with an average age of 30 years. All the participants were right-handed.

7.2 Apparatus and software

We developed a mobile phone simulation program for our input model in Visual Basic (Fig.2). We also use the simulation software of AKTEL. The software was installed in a laptop with Windows XP.

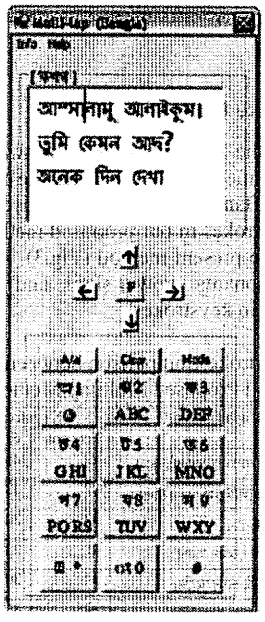

Fig.2 Experiment with Visual Basic Simulator

7.3 Selection of Bangla Message

When selecting message for user experiments we took some sentences from those of keystroke comparison. For text input, we selected a Bangla message of seven sentences about addressing and making appointment at a specified time. The types of sentences we selected were very familiar in Bangla conversation and messaging.

7.4 Procedure

Participants first completed a questionnaire about their experience about computer, mobile phone, SMS and gave their opinion about Bangla SMS. Participants were then given training and instructions about the simulation software and both the Multitap input models. They were allowed to write different

messages in Bangla in each simulator. Then they were given the text message to read a number of times. Examiners answered any questions. Then participants were informed that their speed and accuracy would be measured, and they should type as rapidly as possible, and correct any errors they find. The experimenters used a stopwatch to keep time. When typing was finished by participants experimenters stopped the stop watch and record the time. Time was recorded for both the short messages and full message. Finally, all the participants answered a post-experiment questionnaire indicating their opinions about Bangla SMS and appropriateness of the models for it.

8. Results

8.1 Keystroke Comparison

To compare the keystrokes between two methods to write Bangla message we selected the following ten messages in Bangla (Table 6). In most of the cases required keystrokes in our proposed method are much lower than the present method (Fig.3). All the letters vowels, consonants, vowel-signs and punctuations were counted in keystrokes.

Table.6 Keystroke Comparison between the AKTEL and Proposed Multitap Method

No.	Bangla Message	Keystrokes	
		Present	Proposed
1	আস্‌সালামু আলাইকুম।	82	48
2	ওয়ালাইকুম আস্‌সালাম।	89	53
3	হ্যালো।	32	20
4	তুমি কেমন আছ?	41	38
5	আমি ভাল আছি।	34	30
6	তোমার খবর কি?	39	31
7	অনেক দিন দেখা হয়না।	60	53
8	ঠিক আছে।	21	17
9	নতুন মোবাইল ০১৭২১৮৩৬৪৯।	128	54
10	৩০-০৬-২০০৭ বিকাল ৫:৩০।	157	58

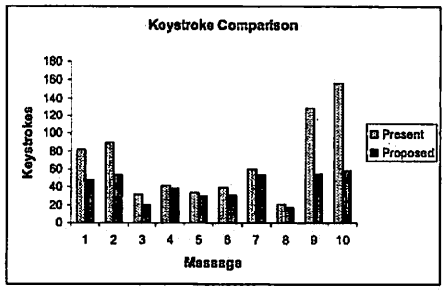

Fig.3 Keystroke Comparison between Two Methods

8.2 Tapping Speed Comparison

We selected the following Bangla message for user experiments (Fig.4). It contains seven sentences.

(1) আস্‌সালামু আলাইকুম। (2) তুমি কেমন আছ? (3) অনেক দিন দেখা হয়না। (4) ৩০-০৬-২০০৭ দুপুর ১২ টায় এসো। (5) এই মোবাইলে ০১৭২১৯৭৪৫৩৬ ফোন করো। (6) আমি ভাল আছি। (7) ভাল থেকো।

Fig.4 Bangla Message for User Experiments

We compared the tapping speed for each sentence and also for the full message. For most of the users the tapping speed for each sentence is better in our proposed model. Fig.5 shows the average tapping speed comparison of the users for each individual sentence. For full message the tapping speed of our proposed model were always better for all the users (Fig.6).

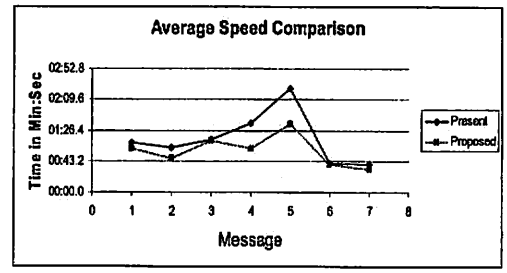

Fig.5 Average Tapping Speed for Each Sentence

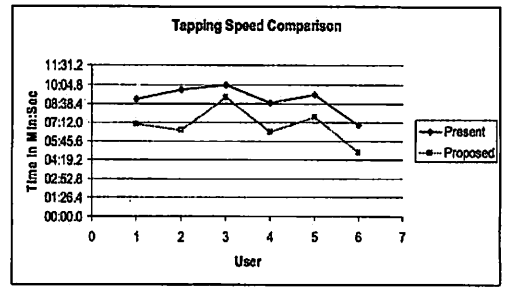

Fig.6 Tapping Speed of Each User for Full Message

9. Conclusion

We measured the speed and keystrokes of typing Bangla message for AKTEL and our propose model. We found that our propose model requires less keystrokes (15% above) for the selected messages. Also, the speed of entering the texts was better in our model. If the uses of numerical digits increase, the speed and performance of our model increases rapidly. Also if the uses of vowel-sign and consonant symbol increase, the performance of our model also increases. One disadvantage we found in our model is that to enter vowel-sign we need one extra key press than its physical position because it needs a select operation to choose. One limitation of this research is that we used computer for user experiments. If we could use mobile phone to test the speed then the result would be more realistic and the experiment would be more interesting one. We plan to make experiments on actual mobile devices in the near future in order to get native users' feedback. In future we like to use the ranking of the current usage of Bangla letters for designing mobile phone input model. Romanization of Bangla is becoming popular in Bangladesh. So we like to work for Romanized input in mobile phone in the future.

10. Acknowledgement

This research is supported by Prof. URANO Lab., Graduate School of Global Information and Telecommunication Studies (GITS), Waseda University, Saitama, Japan. We are grateful to AKTEL Ltd. for publishing their information and hosting the software on the website.

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