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An Audible Bangla Text-Entry Method in Mobile Phones with Intelligent Keypad

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Abstract

Communication through mobile device is the most effective and fastest way that becomes a part of our daily life nowadays. Particularly, Short Message Service (SMS), is one of the most popular and relatively cheaper application of cell phone. In Bangladesh, there has been an enormous growth of mobile users and in this context, it is quite reasonable that people like to send SMS with their own language. Taking these challenges, a few initiatives were taken to introduce Bangla text in Mobile phones, more specifically, in messaging. But unfortunately, Bangla SMS is not popular yet in our country due to the presence of large number of characters and complex script. In fact, it is very much difficult to map Bangla characters efficiently on a mobile with 12 keys only. That's why, it motivated us to design an intelligent mobile keypad layout, which significantly reduces the number of keystrokes than existing methods, and remove difficulties of entering text. We eliminate traditional multi-tapping on a single button and introduce two key press technique, by arranging characters in two-dimensional matrix. Using this keypad the system becomes faster, reliable and flexible. Predictive text input method is also added in the system for further speeding up messaging. Moreover, our text-entry system ensures accessibility to visual impaired people by avoiding disambiguation caused by multi-tapping and introducing audio feedback for inserting each Bangla characters, which is not supported by existing systems. Finally, after analyzing the result on different sample SMS data, we showed that, our proposed keypad with the predictive input system reduces the number of key presses than the common Bangla keypad by 60.34%.

Keywords: A Mobile Keypad, Text Entry, Bangla SMS, Predictive Text Input, Visual Impaired.

I. INTRODUCTION

Nowadays, the mobile phone is an essential communication device for many people in Bangladesh. Though its main purpose is making calls, a number of other uses are also getting increasing popularity. Like many other countries, short Message Service (SMS) is now used frequently by the mass population of Bangladesh [1]. This growth is related to the fact that, SMS is cheaper and more importantly, it neither disturbs the receiver nor requires an immediate answer.

Although the number of mobile phone users are increasing surprisingly in both rural and urban area, very few of them are able to use all the features, as the interface of mobile phones is mostly in English. A few mobile phone operators have successfully introduced SMS in Bangla, however, not so much evidences have found in achieving popularity. Still people in Bangladesh are generally sending SMS in Bangla using English alphabet. The main challenge of Bangla SMS is that, it is very difficult to map a large number of characters using a standard mobile keypad. To address this problem, in this paper, an efficient mobile keypad is proposed with predictive text input facility, so that the number of key presses can be reduced significantly. Moreover, a considerable number of people in our country are visually impaired. They cannot participate in SMS, contributing to frustration and social exclusion. To enable them in writing SMS voice feedback support is included in the system. On the other hand, people with little literacy can use this software to write Bangla SMS with the help of voice feedback, which can ultimately become a very significant step for appealing mass people in mobile computing environment. They may use several SMS based services like mobile Banking, bill pay, quizzes, advertisements, news, etc. where mobile devices can become input devices accessible from remote area.

The rest of the paper is organized as follows: Section II focused on Background and present state of the problem, in Section III we explain our proposed system, Section IV provides experimental results and analysis and finally, Section V concludes the paper.

II. BACKGROUND

In the last few yeas, the mobile device's memory and processing power increased exponentially, however, input and output capability is still much more limited. The problem is severe for Bangla language, because it is really a challenging task to map 50 alphabets, modified vowels, consonants, and joint characters with only 12 keys on a mobile. To address this problem, a number of text-entry methods in mobile devices have proposed. Moreover, A few mobile operators have released their Bangla SMS software.

A. Existing Bangla Keypad

Common Bangla layout: This keypad is based on alphabet ordering which is currently used by some mobile phone manufacturers (Figure 1). It is quite simple layout but requires excessive keystrokes for inserting a single character. For example, to enter the Bangla word 'মিএসই', this keypad needs 19 [*+3+5+8+3] keystrokes [2].

Figure 1: Generalize keypad layout

Bangla keypad based on phonetics: Bangla phonetic keypad for mobile employs the idea of mapping the Bangla characters under the similar sounding to equivalent English characters [2]. A simple calculation depicts that each English character has to be assigned to at least two Bangla characters. To overcome this problem, it has taken two adjacent Bangla characters (with a few exceptions) as a cluster (Figure 2). However, the keypad design suffers from the problem of excessive key pressing, especially for the short vowels which are the used very frequently.

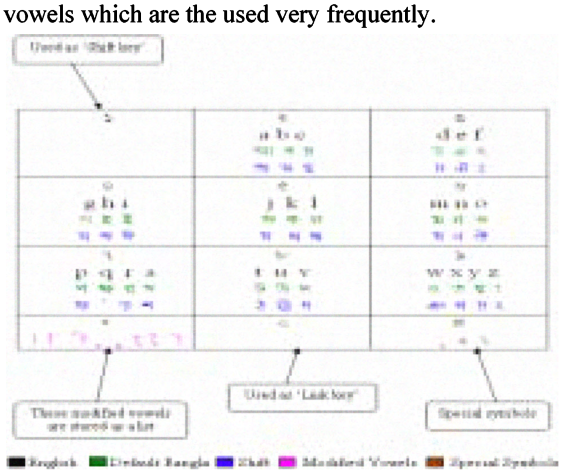

Figure 2: Mobile keypad based on Phonetic [2]

Ergonomic keypad: This keypad layout tries to minimize the finger movement by placing the characters in such a way that most frequent characters are appeared in the most comfortable zone [3]. The keypad is divided into three zones: (a) most comfortable zone, (b) medium comfortable zone and (c) least comfortable zone. The most comfortable zone consist off 1, 2, 4, 5, 7 and * keys. The medium comfortable keys are 3, 6 and 8 .The least comfortable keys are 9, 0 and #. However, in the paper it was assumed that the keypad would be used by right-handed people. But many people use the keypad using left hand or even by both hands. In such cases it may not have a very significant effect.

Frequency based two-layer multitap input method: In this method, characters are ordered in such a way that the most frequent letter appears with one keystroke, the next frequent letter in second keystroke and so on [4]. But since the mappings of characters are changing frequently user may feel it very uncomfortable to find out a particular character.

A few mobile operators have released their Bangla SMS software but have not achieved sufficient popularity yet. The major problems associated with most of the existing systems are, needs of excessive key pressing, difficulties in memorizing character mapping and lack of comprehensiveness. AKTEL, a mobile phone operator in Bangladesh implemented a Multitap input method in Bangla for text-entry. It is a One-Layer Multitap (OLM) [4] method. In this method, all the Bangla scripts and symbols are kept in one layer. To use Bangla SMS, one will need to install "AKTEL Mayer Bhasha" [4, 7] software in one's handset. SMS can be sent to any other, who has the software installed in his/her mobile. But it is overwhelmed with the key pressing. For example, to insert the letter '১', it needs 12 keystrokes. GrameenPhone Ltd. introduced Bangla SMS named "Amar Bhasha" [4, 8] by two-dimensional matrix arrangements of the alphabets; they reduced key presses significantly but some extra key presses are needed for entering joint characters and it does not provide predictive text input. Citycell [4, 9] introduced Bangla SMS using English alphabet called Romanization. The customer will write the text in English with Bangla format and in return, he will receive in Bangla. Actually it is a picture message. Pictures are 72*14 or 72* 28 pixel. But only 25 characters are allowed to use for a single message.

B. Predictive Text Input Method

Predictive input technologies use language knowledge to predict what text the user is going to enter. Letter anticipators predict the next letter based on the prefix entered by the user. Hybrid systems combine the letter anticipators and the word completers. T9 (Text on 9 keys) is the most widely used predictive system on mobile phones [5]. There was an attempt in Bangla also [6] where user can finish a word according to the suggested word(s) generated by the system that starts with the prefix characters. However, this system may need unnecessary key pressing to choose less frequent words that are appearing at the bottom.

C. Text-Entry System for Visual Impaired

Existing text-entry systems cannot be used by blind users since these are strongly rely on visual feedback for their correct operation. On the other hand there are some Braille devices which are large, heavy and cumbersome to use in mobile context. With the enormous growth of mobile phones and applications it is urgent to provide for blind individuals the ability to operate such kind of devices. Recently, in English a few works have done successfully to develop text entry system in mobiles compatible for blind people. "BloNo" is a mobile text entry interface for the visual impaired based on a vowel navigation based text-entry method and speech synthesis feedback [10]. Besides text-entry based applications, BloNo provides the necessary feedback to navigate through menus and access applications. But in Bangla no such attempt has taken yet.

III. SYSTEM ARCHITECTURE

A. The Proposed Keypad Layout

The prime objective of our proposed keypad is to minimize keystrokes needed for inserting text as much as possible. Moreover, it is also necessary avoid multi-tapping on a single key. More importantly, keypad layout is also needed to be user friendly and easy to memorize. To ensure these criteria, we employ the idea of using two key technique applied on the two dimensional matrix with the alphabets i.e., to enter a letter user selects corresponding the row and column from the matrix. Thus, maximum two key presses needed for entering Bangla characters. Our proposed keypad design is shown in Figure 4. Whenever a key is pressed, the system decides which row is selected (shown on the key no.) and shows all the letters along with their column number at the bottom of the user interface. Then the next key press required is to select the column (shown as prefix before the character) and thus the character [row][column] is displayed. However, if a certain time is elapsed after the row is selected first column of that row i.e., character [row][1] is automatically selected for ensuring further reduction of key presses. For instance, according to the matrices arrangement in Figure 3 (denoted by solid line) enter the character 'ফ', user need to choose row 5 and column 2. However, to enter 'ট' it requires only pressing key 3. In the keypad, 1,2,3,4,5,6,7 are used for entering consonants. In the key 8,9,* are used for entering modified vowels, modified consonants and a few special symbols (ঃ ঃu ,etc).

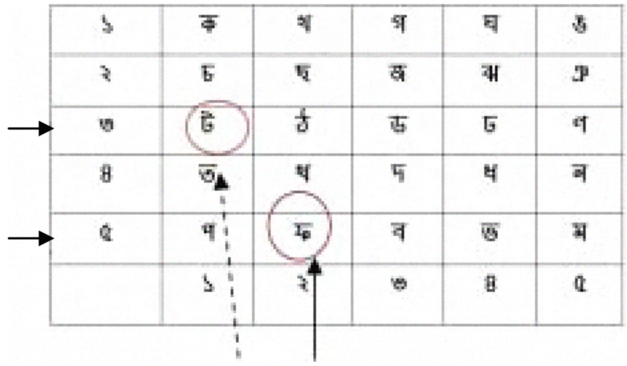

Figure 3: Two key technique using Two Dimensional Matrix (showing a portion of the matrix)

Shift Key: In Key 8 we used for modified vowels by default, because in messaging Bangla modified vowels are used much frequently than vowels. To change it in vowel character mode one needs to press '0' two times consecutively. But single press of '0' is used for entering space. According to Unicode rules these modified vowels should used after entering any consonant.

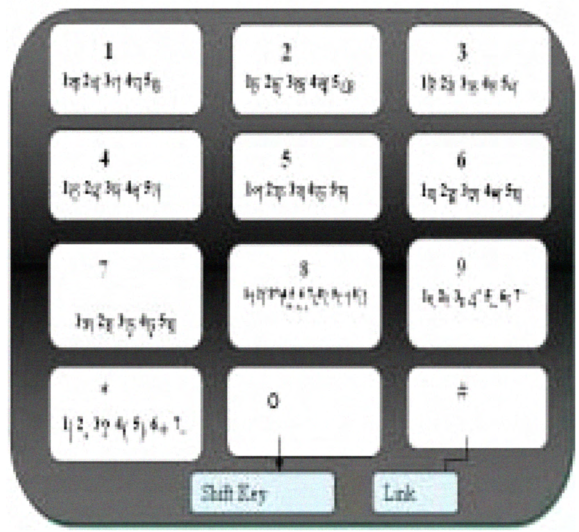

Figure 4: Proposed system keypad (Each key denotes row, each prefix before any character denote corresponding column)

Link Key: '#' is used for entering the ligature (Juktakhhor) as well as link key for entering numeric character. For a single press it get ready for working as ligature and for the next key press it is used for entering numeric characters. After pressing the '#' key it will serves as link key. Then the next need to character that associated with the previous regular will be pressed.

B. Text Entry Method

To accomplish our goals, a new text-entry method is developed. The flowchart of the method is shown in Figure 5.

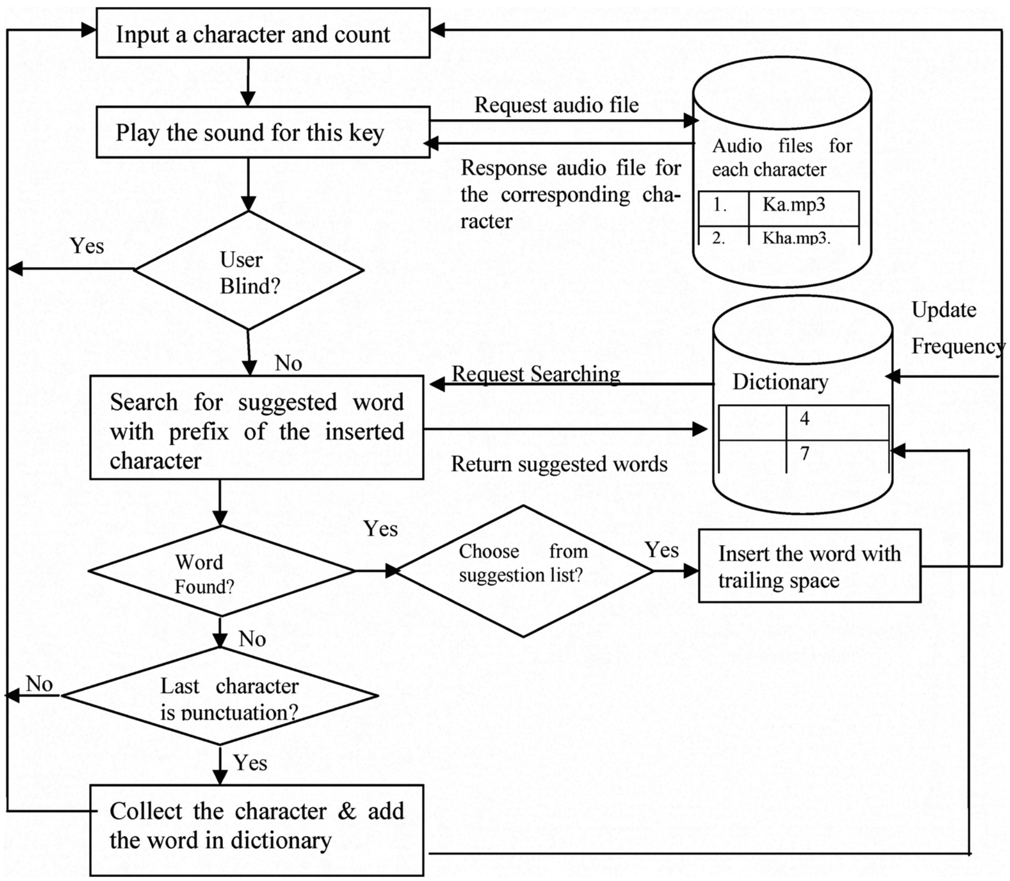

Figure 5: Complete flowchart of text entry method

According to the flowchart after selecting a character using appropriate key it is shown on the screen and the corresponding audio file is played for the visual impaired person. However, for visually capable people the predictive text-entry system searches on the dictionary according to leading character(s). If word(s) found with prefix of inserted characters, display the suggested list. User can scroll the words and choose the word to insert it. If the users select the word from the list, the word will insert with trailing space.

B. 1 Predictive Text Input

Our predictive text input system allows user to choose from a list of possible words starting with the inserted prefix. Moreover, it also automatically updates the frequency of words in the dictionary according to the user's message and later uses it to generate the priority of the suggested words. At the initializing stage, a Dictionary that contains a list of words along with their frequency is created from a collection of Bangla SMS. But since word frequencies may vary from user to user, we propagate the intensification of the predictive input system by increasing the frequency accordingly, as user composes more messages. After inserting any punctuation symbols, we assume that a new word has appeared and the word is added in the dictionary if it is not existed.

Algorithm for Predictive Input:

1. Initialize the dictionary D with words extracted from collected SMS along with their frequency.
2. FOR each input of character
3. IF the character is punctuation mark indicating the end of a word THEN
4. IF the word not exists in D THEN add it to D and set its frequency to 1.
5. ELSE increase the frequency of the word in D by 1.
6. ELSE Generate a list of all word(s) starting with the prefix input characters and
8. Sorted the words according to the decreasing order of frequency.
9. Allow the user to choose from the suggestion word list.
10. IF user selects any word from suggestion list THEN
11. Append the word in the text
12. Increase the frequency of the word in D by 1.
13. END FOR

B. 2 Audible System

It is easy to understand that, when audio file is played, user receives voice feedback before accepting any letter, therefore reducing entry mistakes. This is the most important issue for blind people as they totally rely on audio feedback, performing the text entry task successfully and increasing the motivation to improve the writing skills. To play the audio we collect the utterance of all the characters as .MP3 format audio file. There are 61 .mp3 file representing audio for all the vowels, consonant and numbers. The audio files have the size between 4 Kb to 7Kb, so that, they can be loaded very quickly and audio feedback can be provided instantly. When a key is pressed, the system searches on the resource directory for the corresponding audio file. Then it plays the audio file of the corresponding character and renders the character.

IV. EXPERIMENTS AND ANALYSIS

A. Experimental Setup

In completing our research work we use Java 2 Micro Edition (J2ME) [11-13] programming language. For implementing audible input we use J2ME MMAPI [14] (Mobile Media API) and WMA (Wireless Messaging API) [14] for wireless messaging. In the predictive input system, we use J2ME RecordManagement [13] for storing words and their frequency. We develop our system with latest graphical interface design tool for J2ME named LightWeight User Interface Toolkit (LWUIT) [15] and Unicode was used for representing characters instead of pictures. We tested our software on Nokia – 3110c which is a S-40 series java supported hand set with MIDP 2.0.

B. The User Interface

At the startup of the software we use four options to choose. These are "Write message" allies "বার্তা লিখ", "Inbox" allies "বার্তা পড়", "Help" allies "সাহায্য" and "Exit" as "বের হও". So, choosing the "write message" option user enters on new interface where user can write message, send message, add new words.

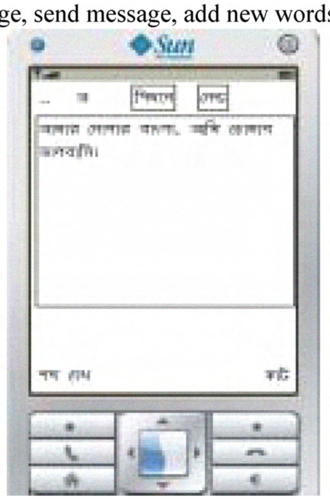

Figure 6: Writing interface of the Software

At the top of the screen, a label is denoting users typing mode. 'অ' represents the normal mode i.e., it is the default setting for operating the software. 'ত্ত' mode represent is the shift mode is used for entering ligature (Figure 6). The keypad act as a numeric keypad in "১" mode. In this mode, it needs only single press to enter a digit. In figure 7 we see that a list of word is suggested after user press the character '© য'. User either can scroll the word from the list or can press the index no of the word to append it in the text. For example pressing '6' will implies selection of যদি.

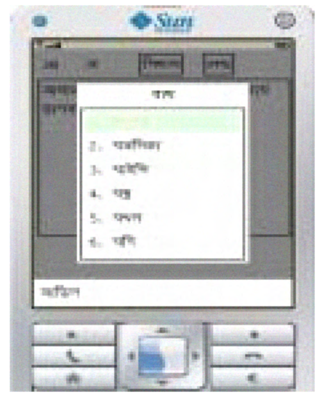

Figure 7: Predictive input interface

C. Experimental Result

Tests were made after collecting about 100 messages from various persons to ensure the nature of data to be more heterogeneous. Then we calculate the number of keystrokes needed for entering those messages according to the proposed method and other previous methods. In Table 1, we show a portion of the comparison of key presses for entering words, between our proposed text entry process and conventional process. Figure 8 compares keystrokes needed in several methods for some sample messages, where message length ranges from 8 to 20.

Table 1: Comparison of key presses required for several words between proposed system and existing systems

Sl No	Word	Generalized keypad	Phonetic keypad	Proposed keypad	Proposed keypad (with predictive)
1.	আমি	10	4	6	4
2.	আজ	5	2	4	4
3.	আমার	10	7	5	4
4.	না	7	3	4	4
5.	[illegible]	12	14	7	6
6.	কখন	8	7	5	4
7.	[illegible]	12	11	7	5
8.	কেমন	12	11	7	5
9.	আছ	4	5	4	4
10.	পড়া	5	6	5	3
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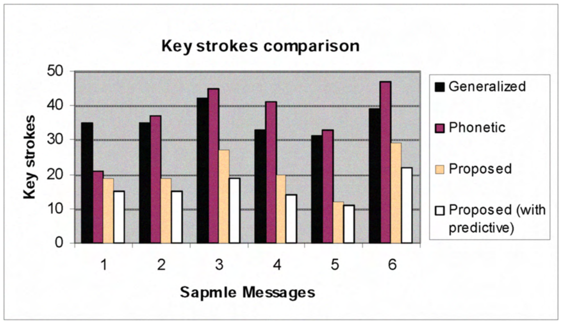

Figure 8: Keystrokes comparison among several methods for 6 sample messages

Figure 9 depicts the performance comparison on the basis of average key presses per word. Among them Phonetic input method requires larger number of keystrokes than others. Our proposed keypad with predictive input system reduces 60.34% and 70.82% key strokes than generalized keypad and Phonetic keypad respectively. It is apparent from Figure 9 that, our proposed keypad layout with predictive input is much more feasible way of entering text in mobile devices.

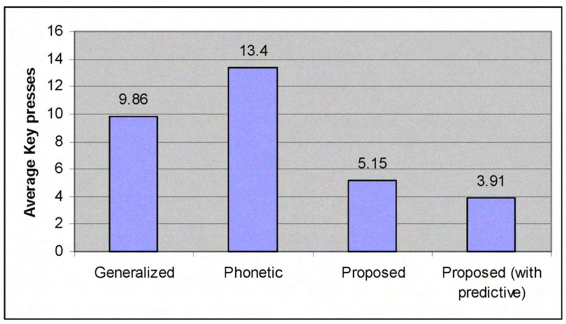

Figure 9: Comparison of average keystrokes per word

In order to test the accessibility of visually impaired people, five users were first instructed about the text entry method in details. Then they were requested to write down a few sentences. All the users were able to write the message with reasonable time delay (around two words per minute) and error rate (7.24%) was fairly acceptable. In general, all the users were more or less satisfied with the messaging system and gradually improved their performance.

V. CONCLUSION

The experimental results show that the number of keystrokes reduced considerably using the proposed keypad layout and outperforms generalized and phonetic keypad. Moreover, when predictive input system is added, messaging becomes even faster. The idea of audio feedback system is highly significant in terms of providing accessibility to not only visually impaired individuals but also the less literate people. We believe that, this comprehensive text-entry system can considerably improve the human computer interaction in enormous growth of mobile computing environment in the context of Digital Bangladesh.

There may be some possible improvements that can be applied to our system. As future work, we will try to combine transileration facility in our text-entry system. Moreover, there is no option to read the SMS by a visual impaired user at the receiving end. Introduction of a speech synthesizer for end user mobile phone is our another future plan.

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