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Improving mobile multi-tap text entry for Arabic language

Qasem A. Al-Radaideh [a,*], Kamal H. Masri [b]

[a] Department of Computer Information Systems, Yarmouk University, Irbid 21163, Jordan
[b] Gulf College, Masqat, Al-Khuwair, Oman

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ABSTRACT

Classical mobile phone keypads which consist of 12 buttons are commonly used to write short text messages through two common methods, the multi-tap and the predictive text entry. For the Arabic language mobile keypads, all Arabic letters are distributed over the 8 buttons of the keypad where three or more letters share the same button. In this paper, a new text entry environment is proposed. The environment includes two proposed improved approaches for Arabic language messages to make the multi-tap text entry method faster and easier. The first approach is based on the idea of remapping the distribution of Arabic letters on the keypad according to the frequency of letters. In the second approach, a bi-Gram based method is used to predict the next letter to be typed automatically. The proposed approaches are evaluated using a corpus of 1514 real Arabic text messages. Several experiments were conducted to evaluate the proposed text entry environment. The results of the experiments have showed that using the proposed remapped keypad is faster and consumes less effort in comparison to the classical keypad.

1. Introduction

With the advances of Information and Communication Technology, the International Telecommunication Union (www.itu.int) has reported that the number of users of cellular phones (mobiles) now exceeds 4 billion worldwide. One of the main services provided by mobile phones is the Short Message Service (SMS). The SMS service is used by people of different ages, which allow them to send or receive text messages of up to 160 English characters, or up to 70 Arabic characters per one message. The number of SMS messages sent has increased from approximately 4 billion in Jan 2000 to 24 billion in May 2002 [1,2]. A report published by the International Telecommunication Union, estimated that the number of text messages that were sent globally on New Year's Eve was 43 billion messages.

As for Jordan, which has a population of around 6 million, Al-Ghad Newspaper has reported that Jordanians have sent more than 1.8 billion SMS messages in the year 2009 [3]. On the commercial side, Nokia (www.nokia.com), which is considered one of the biggest mobile manufacturing companies, reported that the text messages service is achieving high revenue. Eldridge and Grinter [2] have reported that the reasons for teenagers in preferring to text one another using SMS are that it is cheaper, quicker, easy to use, and more convenient than other communication methods.

The majority of classical mobile phones use a 12-button keypad to allow users to type text and numbers. The 26 letters of English alphabets are arranged on the 2 through 9 numeric keys, with three to four letters on each key. For the Arabic language, however, letters are spread over the same keys, but with 3 to 5 letters per key. Fig. 1 shows a typical mobile keypad that supports both Arabic and English language alphabets.

To type a text message using the mobile phones keypad layout, there are several different ways. The most frequently used methods are the multi-tap entry method and the predictive text entry method. The main limitation of these methods is due to the layout of the keypad that most mobile phones have. This layout makes the text entry of an SMS to require several keystrokes at the time where reducing the average number of keystrokes required per character to type a text message is the main challenge for researchers working in this area. Because of this limitation, these two methods have been studied and several researchers have tried to improve them [1,4–6].

1.1. The multi-tap method

This method is the most commonly used method for text entry on mobile phones [7]. Using this method, the user presses the key that contains the required letter repeatedly until the requested letter appears on the screen. The number of taps required depends on the position of the letter on the key. As shown in Fig. 1, for instance we notice that the letters “a”, “b” and “c” are located on the numeric 2-key. In this case the numeric 2-key is pressed once to get the letter “a”, twice to get “b”, and three times to get the letter “c”. For example to enter the word “play”, the user has to press the sequence “75552999”.

* Corresponding author.
E-mail addresses: qasemr@yu.edu.jo (Q.A. Al-Radaideh), kamalo_cis@yahoo.com (K.H. Masri).

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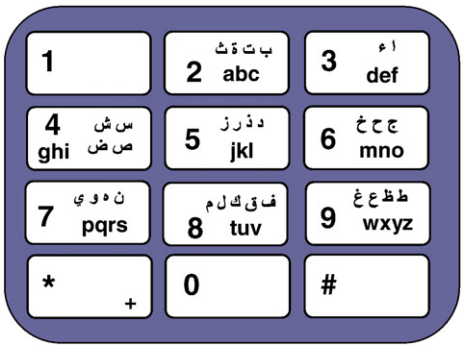

Fig. 1. The keypad layout of a common mobile phone.

For an Arabic language SMS message on the other hand, to enter the word "يلعب" (play), which consists of the four letters "ي", "ل", "ع", "ب", the user has to press the sequence "777788889992".

Two main limitations for using the multi-tap text entry method were reported in the literature [8]. In the first one, frequently used letters may need more taps than infrequent ones. For example the letter "q" requires only 2 taps while the letters "r" and "s"; which are more common, require 3 and 4 taps respectively. The second limitation, known as the segmentation problem, occurs when the mobile text entry system needs to determine whether the sequence of keys pressed correspond to one or more letters on the key. To resolve this issue, users have to wait for a timeout or press a timeout kill key before entering the next letter [8].

1.2. The predictive text entry method

In this method, a user presses on the key that contains the required letter only once, regardless of the position of this letter on the key. To assemble a meaningful word, the system uses a *trie* data structure based dictionary [9]. As an example, to enter the word "play", the user has to press the sequence of keys "7529" only, and for the Arabic word "يلعب" it requires the sequence of keys "7892**" to be pressed. The (*) key is called the next key and is required to get the intended word since the sequence "7892" leads to several words. This method has been evaluated by MacKenzie [10] and the results have showed that to enter text using the predictive method would require on average less keystrokes than the multi-tap method.

The predictive method has also some limitations. The first one, called the number of word clashes, which means that the number of words that share the same key sequences. In this case, these words will appear to the user as a list and the user can choose the desired word by pressing the next key (*) repeatedly until the desired word is found or the end of the list is reached. If none of the words is desired, the user can spell the word using the Multi-tap method. An example of key sequences and their possible English words are presented in Table 1. The second limitation which has been noticed by [8] indicates that common used words need the next key to be pressed than uncommon words.

Table 1
Words sharing same key sequence.

Key sequence	Possible words
2273	Case, card, care, base, bare, bard, cape, acre
4663	Good, home, gone, hood, hoof, hone, goof
2665	Cool, cook, book
63	Of, me
46	Go, in

The third limitation of this method is that a user cannot enter a non-dictionary word, and that the method also does not accept compound words. It is quite common that SMS text messages contain several non-dictionary words like the word "hiz", "mano", and "plz". In this case, a user has to switch to multi-tap mode to type non-dictionary words.

The most popular implementation for the prediction method called the T9 dictionary was developed by the Tegic Communications Company (www.tegic.com, www.t9.com) and is attached to most text messaging entry systems. Other implementations including the eZiText system by Zi Corp (www.zicorp.com) and the iTap by Motorola have included the word completion utility (www.motorola.com). The three implementations allow users to insert new words into the dictionary. Several researches have focused on the predictive text entry and have provided solutions to improve the limitations of this method; one of these methods is called *Keymap* and was presented by Kenneth and Springael [11].

1.3. The Arabic keypad layout: the motivation

The classical Arabic language keypad in most mobile phones was designed based on the alphabetical order of Arabic letters where on each key there are 4 to 5 letters. Letters are distributed over the numeric 2-key till the numeric 9-key (From right to left) where the numeric 3-key holds the 8 variations of the "ا" (Alif) and "ء" (Hamzah) letters: "ء, ئ, ؤ, ى, آ, إ, أ, ا ", while the remaining keys hold from 3 to 5 letters. The placement of letters through buttons, however slow the text entry because it requires several keystrokes to get to the required letter. For example, the number of keystrokes (*ks*) for each form of the different variations of the "ا" (Alif) is: ("ا" (1 *ks*), "أ" (2 *ks*), "إ" (3 *ks*), "آ" (4 *ks*), "ى" (5 *ks*), "ؤ" (6 *ks*), "ئ" (7 *ks*), and the "ء" require (8 *ks*)). This problem arises because the Arabic alphabets consists of 36 letters and their variations; the 28 base letters: "ا, ي, و, ه, ن, م, ل, ك, ق, ف, غ, ع, ظ, ط, ض, ص, ش, س, ز, ر, ذ, د, خ, ح, ج, ث, ت, ب ", the other 7 variations of the "ا" (Alif) and "ء" (Hamzah) letters, and the other shap of the letter "ت" (Ta) which is the letter "ة ".

This paper proposes a new text entry environment for an Arabic mobile keypad. The proposed environment uses two techniques to improve the Arabic mobile text entry way. The first technique is based on the idea of remapping the Arabic alphabets on the keypad to produce a new Arabic mobile keypad layout with new placement of alphabetical characters over the keypad 9 numeric keys. This is accomplished depending on the frequency of the Arabic letters based on a real corpus of Arabic messages. The second technique is a bi-gram based model which is used to predict the next letter to be entered during the writing of text messages.

2. Related work

The multi-tap method, regardless of its two limitations presented earlier, remains the prevailing standard used on mobile phones, and remains the main mobile text entry method [12]. MacKenzie and Soukoreff [4] have evaluated the multi-tap method and found out that it requires 2.034 KSPC (keystrokes per character) when entering English text. They have concluded that it is worth to think about reordering and remapping letters on the keypad according to their frequency. This has encouraged several researchers to focus on the remapping and reordering of letters on the keypad to enhance the multi-tap method.

Kenneth and Springael [11] have proposed a new keypad layout called *Keymap* to improve text message entry when using the T9 dictionary. The *Keymap* is based on two main objectives: (1) The cost of typing messages should be minimal (this includes the total number of keystrokes required to type message) and (2) The cost of word clashes should be minimal. The first objectives is achieved by assigning as many letters as possible on the same key, and the second objective is achieved by proposing new placements of letters that