Different Input Systems for Different Devices

Optimized Urdu Touch-Screen Keypad Designs

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Abstract

We live in the age of touch screen gadgets. The future trends also show promising growth for them. Currently available input systems developed for standard PCs have room for improvement in efficiency, visibility and usability etc. particularly for Perso-Arabic scripts e.g., Urdu. In addition, small touch screen devices expose users to health hazards. We put forth Ergonomics in prime focus to reduce potential health hazards. We proposed distinct touch-screen keypads for different devices that are practically applicable for fast, correct and easy composing. We computed the estimated input time and tap-counts using automated procedure to compare contemporary keypads with our proposed keypads. Our experiments on a considerably large Urdu corpus reveal results of ample significance. Our optimization technique for arrangement of alphabets and unique interface for data input is extendable and equally applicable to other natural languages.

1 Introduction

NLP has numerous applications at the "Characters level" as shown by Figure 1. These include Romanization, Transliteration, Script Generation, Input System and/or Interface Designs etc. This research targets on the Interface Designs. We have come up with novel keyboard and keypads for text input on various types of touch-screen devices such as mobile phones, tablet PCs and completely touch screen PCs.

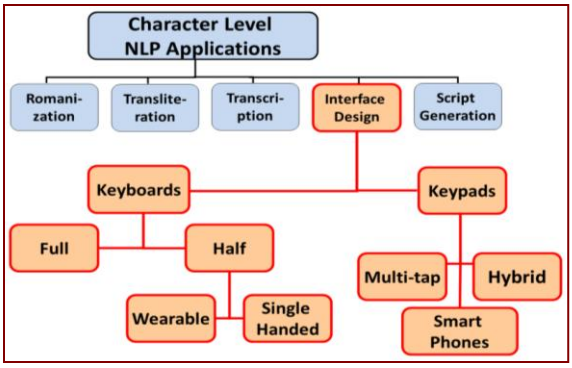

Figure 1: Character Level NLP Applications

Urdu is the 2nd largest Arabic script language according to the number of speakers (Lewis and M. Paul, 2009; Weber 1999). However its little presence on the internet does not qualify its rank. Among its major causes is the limited platform support and meager interface designs for composing write-ups in Urdu. Designing optimized Urdu keypads for small screen widgets is a knotty problem since Urdu has a relatively large alphabet set. Various sources and/or authors report different number of letters in Urdu letter set i.e. 38 to 58 (Ijaz and Hussain, 2007; Malik et al. 1997; Habib et al. 2010). Arabic loan low frequency Ligatures and Diacritics are Used in religious texts. Ligatures are fixed blocks of letters each represented by a Unicode. Diacritics are small macrons like characters used for correct pronunciation of letters in a word.

We used unigram and bigram frequencies in a large corpus and developed novel Urdu touch-screen keypads as shown in Figures 2, 4 and 5. Letters with highest unigram frequencies are selected as base letters of our keypad for small touch-screen devices as shown in Figure 2. Arrangement of letters is based on their bigram frequencies. Figure 3 illustrates its mechanism of displaying the hidden high frequency neighboring letters when a key is pressed. On the contrary, the keypad in Figure 4 is ordered and based on type-face shape property of individual letters. This keypad is designed for tablet PCs but it can also be used in smaller devices. Unigram letter frequencies are also used in arrangement of keys for large touch screen systems such that the highest frequency letters are typed by the strongest typing fingers. Experiments revealed promising results; explained in section 3.1.

At present, more and more data is being generated and uploaded using touch-screen smart gadgets that come in various shapes and screen sizes such as tablet PCs and mobile phones etc. Recently, there have been zero button touch screen laptop systems in the market e.g., the Acer ICONIA. The current trends and types of new gadgets being introduced in the market sug-

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gest the growth of touch screen systems in the days to come.

Different interfaces suit different devices for users composing different natural languages. Full keyboard replica designs with base and shift versions e.g., QWERTY and Dvorak etc. cause usability as well as visibility problems; hence not viable for small touch-screen systems. Besides, small screen devices bring about health hazards to the user. Eyesight weakness, RSI (Repetitive Strain Injuries) and CTS (Carpal Tunnel Syndrome) etc. are only a few health hazards caused by the technology/devices that we use.

For example, in case of eyesight, the closer objects put greater strain on muscles converging the eyes retina (Ankrum, 1996). Stress on convergence system of eyes is crucial factor for strain (Jaschinski-Kruza, 1988; NASA, 1995) Thus we need to keep hygiene in prime focus during design and development of input systems, particularly for small touch-screen devices. We tried to develop touch-screen keypads that would be health friendly having much visibility and usability coupled with crafty arrangement of keys that is ideal for fast, correct, easy and efficient composing.

2 Proposed Keypads

2.1 Motivation for new keypad designs

Apart from the conventional QWERTY and Dvorak keyboards, there are a number of keypads used for text entry e.g., Muti-tap, odometer-like, touch-and-flick, Septambic keyer and Twiddler etc. (Wigdor, 2004).

Existing on-screen Urdu keyboard is replica of Microsoft Windows QWERTY type keyboard. For Mobile phones, Multi-tap T9 replica keypads are in use. The working of existing Urdu Multi-tap keypad is explained in the Table 1. The columns show the characters that will be typed when the corresponding key (numeral in row header) is tapped/pressed a specified number of times.

VII	VI	V	IV	III	II	I	Tap/Key
	ث	ٹ	ۃ	ت	پ	ب	2
	ئ	ء	ۂ	ؤ	آ	ا	3
			ض	ص	ش	س	4
ژ	ز	ڑ	ر	ذ	ڈ	د	5
			خ	ح	چ	ج	6
	ۓ	ے	ی	ھ	و	ن	7
ں	م	ل	گ	ک	ق	ف	8
			غ	ع	ظ	ط	9

Table 1: Multi-tap input table for T9 keypads

Full sized QWERTY like keyboards are not feasible for touch screen devices, in particular devices with small screen where limited screen area needs to be used astutely. This issue becomes more challenging when we design keypads for languages with a large number of alphabets. The trade-off issues in size and position of keyboard, editor, and buttons etc. require great care at design time. A good design must comply with the five principles of Ergonomics; safety, comfort, ease of use, productivity/performance and aesthetics (Karwowski, 2006).

Keeping the above points in view, we propose the following two keypads for small size touch screen devices and one keypad for large size touch screen devices.

2.2 Proposed keypad for small size touch screen devices (Smart phones)

Figure 2 shows the base image of proposed frequency-based keypad for touch screen mobile phones. The individual characters are selected based on their unigram frequencies in 55-million characters corpus. The arrangement of characters is done on the basis of their corresponding bigram neighborhood frequencies. The letters in the base version, as shown in Figure 2, are not arranged in alphabetical order in Urdu. For the sake of easy understanding, all the remaining Urdu letters are shown in small font on the corresponding edges of each button. The button on the lower left will be used for space, delete, carriage return and changing language etc. Similarly the three diamond-like small buttons can be used for showing the extremely low frequency ligatures, diacritics and for numeric characters.

Comparison statistics of various keypads have been tabulated in section 3.1. The base form of keypad shows the most frequently used Urdu letters. The bigram neighborhood statistics reveal that this non-alphabetic arrangement of Urdu letters alone gives additional 17% improvement in composing Urdu text. Other statistics related to comparison of different keypads are explained in section 3.1.

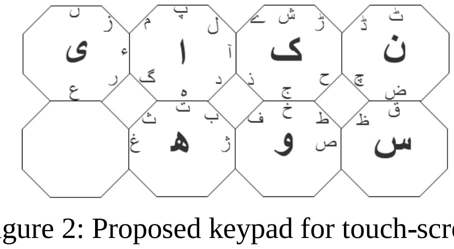
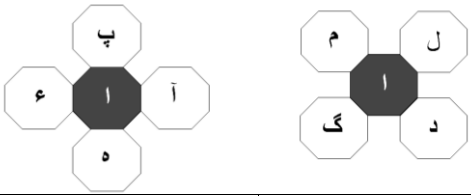


Figure 2: Proposed keypad for touch-screen mobile phone

In the event of a “button press” a single button can expand up to 8 neighbors showing the 8 new letters. These 8 letters consist of 4 horizontal and vertical neighbors and 4 diagonal neighbors. Beginners will need to look at the screen to select the correct neighboring letter. However experienced users can “touch type” in order to type their desired letter(s). The individual button sizes are big enough for blind touch and/or thumb typing. The size of buttons and their dimensions are flexible and can be adjusted according to the device on which the keypad is to be deployed. The event of a “button press” is illustrated in Figure 3.



Horizontal and Vertical Neighbors	Diagonal Neighbors

Figure 3: Illustration of a button press event

2.3 Proposed keypad for middle size touch screen devices (Tablet PCs)

Urdu letters can be grouped based on their shapes and their alphabetical order can still be preserved. The similar shaped letters have been grouped on a single button in our proposed keypad for Tablet PCs as shown in Figure 4.

There are 10 buttons for typing Urdu that show the corresponding letters in native alphabetical order with some letters shown on the edges of buttons. All the letter typing buttons are shown on a single row called the home row. Unlike hardware keyboards, it is very difficult to return fingers to exactly the same position on a touch-screen keypad. Thus we arranged all the letters on a single row so that the user doesn’t need to lift the entire hand in order to type a letter. The user will keep both hands all the time above the single/home row. The user just needs to touch and flick in order to type a certain letter. The little finger of right hand will type the rightmost button on the keypad while the little finger of the left hand will be used to type the leftmost button on the keypad. The four middle buttons will be typed using the index fingers of both hands. The reason for this is that the index fingers are the strongest typing fingers (Krestensson, 2009).

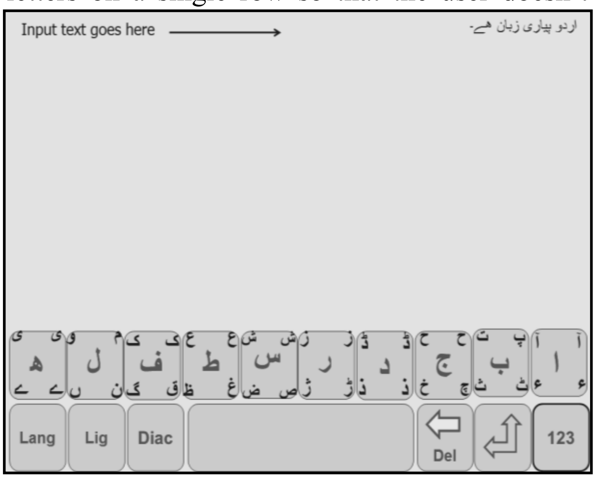


Figure 4: Proposed keypad for Tablet PCs

The lower row includes some special buttons such as Lig (Ligatures) and Diac (Diacritics).

2.4 Proposed keypad for large size touch screen devices (PCs)

Figure 5 shows our frequency based full keyboard layout. The current layout of Urdu keyboard used in touch screen devices is a replica of Microsoft Windows OSK (On-Screen Keyboard) with standard base and shift versions. Urdu has no concept of lower and upper case alphabets.

Figure 5: Urdu letters with their corresponding positions on QWERTY keyboard

The contemporary OSK keyboard has room for improvement in that some high frequency letters are typed in combination of Shift-key, the last thing a user will need. Similarly, the keys/buttons arrangement is not frequency based. We propose frequency based full keyboard layout as shown in Figure 5. Along with other proposed keypads, its detailed performance examination with human subjects will be done in near future. However the new layout has eliminated the Shift version of Microsoft Windows replica. We also re-arranged the position of keys based on the frequencies of individual letters such that the most frequent letters should be typed by the strongest typing finger i.e. the index finger.

Additional issues related only to the touch-screen keyboards such as the inter-keys distance will also be investigated and proper accommodating solutions would be put forward. Similarly the neighborhood of some standard keys might also be required to change. One such example is the neighboring keys of the “Backspace/Delete” and the “Enter/Return” keys.

3. Experiment

We carried out experiments on a general genre corpus of size 15,594,403 words. We estimated the performance of proposed keypads for small touch-screen and Table PCs. Existing Touch-screen systems start word prediction as soon as the user types the first letter. For words with length up to two letters, this seems to bring hardly any improvement to the typing speed. On the contrary, it makes the system more complex and larger in size putting more load on CPU. We recommend that word prediction should start after the second letter has been typed by the user. Out of 15,594,403 words, 4,784,234 words are less than or equal to two letters in length. Hence for the experiments of this study, we used a reduced corpus of size 10,810,169 words. In practice it is faster to type on touch-screen than on multi-tap systems. Research that studies comparing the performance of touch screen and multi-tap systems could not be found. Thus for this study, we assumed “a touch” equal to the “a tap”.

3.1 Comparison

We compared the performance of proposed keypads with the existing counterparts. The reduced corpus size and assumption of “touch=tap=1 sec” puts the bias in favor of the existing systems. However, we still achieved results that show substantial improvement over the existing systems. The comparison of time required to type the corpus using existing Multi-tap and our proposed keypads are tabulated in Table 2.

	Multi-tap (existing)	Touch Screen	Tablet PC
Seconds	263,380,598	135,249,436	120,096,926
Days	**3048.4**	**1565.4**	**1390**

Table 2: Comparison of time required to type the corpus

	Multi-tap (existing)	Touch Screen	Tablet PC
	170,580,560	80,818,830	73,242,564
Improvement		**52.62%**	**57.06%**

Table 3: Comparison of number of taps/touches required to type the corpus

The comparison of the number of taps/touches has been summarized in Table 3.

Table 4 shows the comparison on keypad sizes between the existing and proposed keypad layouts. The table shows that all the Urdu letters can be typed using reduced size keypads with almost half number of touch-taps. Hence the proposed keypads are more suitable for fast and time saving text input.

	Multi-tap (existing)	Touch Screen	Tablet PC
	154	83	80
Improvement		**46.10%**	**48.05%**

Table 4: Comparison of Keypad sizes

4. Conclusion

We proposed different types of keyboard and keypads for different types of touch-screen devices. The comparison analysis shows promising results. In addition to considerable improvement over existing keypads, our proposed designs are flexible because the size and dimensions of keypads, buttons, and editors can be adjusted according to the device on which the keypad is deployed. Similarly our keypads offer greater usability because Urdu letters include all the letters of Arabic and Persian. Hence these layouts are equally usable by the Arabic and Persian users. The keypads are optimized for Urdu but with minor additions, our input systems are extendible to other Perso-Arabic languages as well. Our optimization technique for arrangement of alphabets and unique interface for data input will be extendable and equally applicable to other natural languages and various sizes of touch screen devices.

5. Future directions

We intend to carry out thorough testing of our keypads by human subjects. We shall perform evaluations for our keypad for large size touch screen devices also. Additionally, we want to extend our keypads to include other Perso-Arabic languages such as Punjabi, Pashto, Dari and Potohari etc. Another possibility to exploit this study can be in the design of single finger operated keypad and single hand operated keyboard for touch screen devices.

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