A New X-Dimension Keyboard for Mobile Devices

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Abstract—This paper proposes a new design of mobile device keyboards. This new design aims to improve the usability and efficiency for Chinese input and mobile gaming. The keyboard is featured by having buttons on multiple sides. We name the keyboard x-dimension keyboard after this feature. In addition, it has been applied for the Chinese patent(201120011190.9).

Index Terms—mobile device, keyboard

I. INTRODUCTION

Nowadays, our lives rely more and more on mobile devices and applications. Mobile applications range from business to gaming. Keyboard input on mobile device takes a big portion of mobile device usage. According to the government statistics, the estimation of the number of mobile users in china is 889~927 million this year[1,2]. Due to the specialties of Chinese language, a good design of keyboard particularly for Chinese language users can have a great impact on those people’s life.

Almost all mobile devices use QWERTY alike keyboards. QWERTY keyboards were designed to fit the typing in of Latin languages. Chinese is different from Latin languages on various aspects. To name one, Chinese language users usually use pinyin as the major input method which has a different order than the alphabetic order of Latin languages. Also, traditional QWERTY keyboard has been known to be an ill design resulting in low typing speed, fatigue-inducement, and no reference to learnability[3]. Many researchers have put their efforts on optimizing the character arrangement of the keyboard by taking into account the co-occurrence frequency of characters in words, typing ergonomics, and word disambiguation effectiveness[4,5,6]. The x-dimension keyboard newly meliorates the setting of buttons to enhance the efficiency and convenience for Chinese users.

Most keyboards for mobile devices are one-sided, resulting that only thumbs are working while other fingers are free[7]. This will cause over-worked thumbs and even muscular strain[9].

In the case that mobile devices are used as gaming devices, the buttons and controls aren’t as quick or smart as mouse, which influence the gaming experience[9]. Inspired by handheld game Consoles’ side buttons[10], the new type of x-dimension keyboard put several buttons on top, bottom and back sides to improve game functionalities.

A. Design of x-dimension keyboard

1) The front area: This area(Fig. 1) is divided into three parts, middle area, left area and right area. There are eight keys in both the left and right areas—two columns and four rows.

2) The top area: The top area is showed in Fig. 2. Five keys reside on the top side of the device-- two on the left, the other three on the right. From left to right are esc, ctrl, shift, alt, backspace, which function the same as those on the computer keyboard. Besides, the shift key is in red, the alt key is in purple. This is a user-friendly design to show the users that if they want to use the letters, punctuations in red or purple, they need to press the shift key or the alt key.

3) The back area: The back of the device, which is showed in Fig. 3 is divided into two area—left and right. The left part, which is designed to be controlled by left hand, consists of a five-direction-stick[11] and two buttons. The upper button functions as left key, and the lower button functions as right key. The right part, which is designed to be controlled by right hand, is a three-by-three number keyboard with zero on the bottom. On the number keyboard, there are also directions and other supplementary marks. On each of the keys from 1 to 9, except key 5, there is one arrow on the key, representing up, down, left, right, upper left, lower left, upper right, lower right. Besides, +, -, *, /, =, #, totally six marks are respectively on the key of 2, 8, 4, 6, 5, 7. The marks are in...
purple. To switch to use these marks, users need to press the alt key.

![Figure 4. The bottom side of the new x-dimension keyboard](image)

4) The bottom area: As showed in Fig. 4, the space key is the only key on the bottom side of the device. The space key is designed to be controlled by the pinky fingers of both hands.

B. Setting of keys

1) Separate initial consonant and compound vowels: Keys are arranged by initial consonant and compound vowels except the key of enter, which is a combination of two middle keys of the columns near the screen. That is to say, the a, o, e, i, u, v(ü), and y, w are all on the right side of the screen, other initial consonant are on the left side. The reason for this arrangement will be explained in the discussion part.

2) Three in one key with different colors:
   a) Button: Each button has two letters and one punctuation on it. Exceptionally, the button on the right bottom has three punctuations and no letters on it. The combination of three letters or punctuations on one button is arranged according to the order of pinyin.
   b) Color: The letters and punctuations on a same button are in different colors—black, red or purple. They can be used with the shift key or the alt key. For instance, if users need to use letters or punctuations in red, they should press the shift key which is also in red.

II. DISCUSSION

A. Advantages and innovation

1) Four dimension design: When users hold mobile devices with this keyboard, thumbs are on the two sides of the front side, index fingers can touch both top side and back side of it, and middle fingers and ring fingers are on the two sides of the back side. At the same time, pinky fingers can reach the bottom side easily. The fact is that different fingers have different strength and dexterity, and the pinky fingers are the weakest among five fingers. Taking it into consideration, the bottom side of the keyboard only holds one long space key which is designed to be controlled by pinky fingers. Unlike the pinky fingers, index fingers are more dexterous, so they control two areas—top side and back side. That is, index fingers can not only operating buttons on the top side, but also assist the middle fingers and ring fingers with direction and number keys on the back side. The number keys, a touch system, can be pressed without looking at them, because they are arranged from 1 to 9 in order. The direction keys are also arranged the same as the real directions, so users don’t need looking at them when operating these keys. Put the number and direction keys on the back side not only enhances the efficiency but also makes more room for the front side, and makes use of all fingers to work in cooperation.

2) New type of keyboard designed by applied frequency and rule of the Chinese pinyin: On the front side of the mobile device, keys on the left side are initial consonants, and keys on the right side are vowels and consonants. This design not only highlights the rules of pinyin, but takes hit frequency of pinyin letters into account. Six compound vowels take about 50% of the hits and the other keys take the other 50%[13]. This leads to designers separating compound vowels and consonants into left and right sides. One benefit is the balanced workload of both hands. Furthermore, right hands are generally more dexterous than left hands, hence there is one more key of enter and a mark in the right side for right hand.

3) Quicker game control: Since there are direction keys and a five-dimension stick on the back side, when playing mobile device games, the operation will be greatly improved, and the experience is closer to dedicated gaming devices.

4) Healthy fingers: As a result of x-dimension design, thumbs are not working alone. All fingers are working in cooperation, relieving the burden of thumbs and exercising other eight fingers. In fact, using one figure with high frequency moves for a long time will cause finger joint anchylosis, arthritis, and other health problems[14,15]. In contrast, using all fingers will strengthen microcirculation of fingers and promote fingers’ or wrist’s health[16,17].

5) Simple operation and adaption for new users: Users only need to hold this mobile device in the right way. The basic operation mode is the same as other keyboards. Furthermore, keys on the back side is a touch system. Also, little fingers are designed to press a very simple and big button.

B. Works to do

This new design is yet to be verified by adaption and user experience experiments. The probable problems may be brought up in real operation are not known now. It needs a not too big scale of try out and an afterwards improvement to be better promoted into larger mobile user group[15].

III. CONCLUSION

Since common keyboards for mobile devices have several places to improve, this paper proposed a general innovation background of a new keyboard for mobile
devices. The common keyboards are unsuitable for Chinese language users[19,20]. Besides, they are one-sided, and unfit for playing games. The paper elaborated the x-dimension design and key arrangement in detail. Also this article analyzed and discussed the advantages, disadvantages, and innovations of this new design. In addition, the new x-dimension keyboard has been applied for the Chinese patent (201120011190.9).

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