Evaluation and Improvement of Qwerty Keyboard Layout Based on Chinese Character Pinyin Input Method and Finger Operation Ability

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Abstract: At present, more than 90% of Chinese people use Pinyin input method when inputting Chinese characters. In order to improve the work efficiency of related personnel and reduce work fatigue, the traditional QWERTY keyboard is improved. The staff's finger work ability was studied experimentally, and statistical methods were used to analyze the frequency of letters used by common Chinese characters under the Pinyin input method. The traditional QWERTY keyboard was evaluated under the perspective of matching finger ability and frequency of letter use, and suggestions for improvement were made. Program. The traditional QWERTY keyboard is not suitable for Chinese people who mainly use pinyin input method. The improved new keyboard scheme has certain practical value for improving Chinese characters input efficiency.

1. Introduction

With the deepening of informatization, more and more work needs to be completed by computer. As the most important input device for computer work systems, the quality of the keyboard has a huge impact on people's work efficiency. At present, the QWERTY keyboard is mainly used in the world. The keyboard is designed according to the frequency of alphabet usage in English countries [1]. At present, more than 90% of Chinese people use Pinyin input method for Chinese character input. Under the new situation of Chinese network new vocabulary replacement and increasing popularity, this keyboard does not conform to the usage habits of Chinese people. Therefore, from the perspective of improving the efficiency of human-computer interaction, it is very necessary to improve the key layout of the QWERTY keyboard.

Domestic scholars have conducted a lot of research on the layout and use of keyboards using human factors engineering principles combined with human physiological and psychological factors. Mou Weimin [2] analyzed the types of keyboards and the ergonomic indicators of the evaluation; Duan Tianhong [3] improved the commonly used keyboards from the perspective of ergonomics; Chu Jie [4] investigated health-care people through surveys and experimental methods The machine keyboard has been optimized for parameters and ergonomics, added keyboard holders, re-selected the colors and materials of the keyboard, and initially completed the design of a new integrated office keyboard; Wang Liping [5] also evaluated and evaluated from the perspective of ergonomic research Optimized the layout of letters in the main keyboard area, the layout of function keys and edit positioning keys, and the layout of digital auxiliary keyboards of the QWERTY keyboard; Lu Demou [6] divides the keyboard efficiency area through statistical keystroke records, combining the user's input habits and keyboard efficiency domain The current button layout has been improved; Zhang Junlin [7] compared the existing keyboard layouts with consideration of many factors such as operator habits, different usability of different fingers, and different text messages. These studies mainly consider the external factors of the keyboard and the internal factors of the user to improve the keyboard, hoping to achieve the purpose of improving efficiency. Finger work is common in human society. With the widespread use of computers, the role of hands and fingers is more obvious in the field of computer applications.

Human hands, especially fingers, have become the main organs in human-computer interaction. Many scholars have carried out research on the function, shape, and structure and work performance of fingers[8-9]. Therefore, it is very effective and feasible to study the typing speed and the layout of the computer keyboard considering the relevant factors such as the speed, accuracy, and flexibility of finger movements.

Based on this, the author will evaluate the QWERTY keyboard from the perspective of matching the two characters based on the frequency of use of the Chinese Pinyin input method and finger work ability, and put forward suggestions for improvement, with a view to improving the staff that mainly focus on Chinese Pinyin input Work efficiency and reduce operating fatigue.

2. Experiment-Based Analysis of Finger Work Ability

2.1. Experimental Design

2.1.1. Experimental Approach

In this experiment, the response time of the keystrokes was used as the evaluation index of finger work ability. Since only the index finger, middle finger, ring finger and little finger of the both hands are used to strike the letter keys during the letter input process, the reaction time measuring instrument separately measures the reaction time of these eight fingers in this experiment. Set "left index finger, left middle finger, left ring finger, left little finger, right index finger, right middle finger, right ring finger, right little finger" as x1, x2, x3, x4, x5, x6, x7, x8, respectively. Because the experimental equipment (EP202/203 for reaction time measuring instrument) used in the research institute cannot achieve color control, four colors of red, yellow, green, and blue will appear randomly during the experiment. Therefore, a pre-experiment is required to analyze ho w the color effect on finger reaction time before the formal experiment.

2.1.2. Experimental Subjects and Equipment

90 undergraduate students in Sichuan Normal University were selected as the test subjects. The proportion of men and women accounted for 50% and the age was 18-22 years old. All subjects had normal color vision and no previous medical and psychological history. They were right-handed. The experimental equipment is EP202/203 reaction time measuring instrument (East China Normal University Science and Education Instrument Factory).

2.1.3. Experimental Procedures

The pre-experiment arranged for 10 subjects to use fixed fingers to react to different colors of light, and record the results.

The day before the formal experiment, inform the subjects and ask them to rest fully to ensure they are full of energy during the experiment. Ninety subjects were randomly divided into three groups, and the experiment was conducted separately for each subject. Before the formal experiment, adjust the sitting position of the subjects to ensure that the subjects are in a comfortable and wide-view environment. The experiment officially began, after confirming that the subjects were completely clear about the experimental process and requirements. Both hands are measured twice, each time four colors appear randomly 20 times, and the subject presses the corresponding button according to the color of the tester lamp that lights up during the reaction to complete the measurement. Each participant must complete 3 tests, each test separated by 10 days.

2.1.4. Data Collection and Collation

During the reaction, the measuring instrument records each reaction time, and the SPSS software performs classification processing, and uses the 3 times standard deviation method to eliminate abnormal data.

2.2. Preliminary Experiment Results

Ten subjects were randomly selected as a small sample for pre-experimentation, and the

collected data were used to analyze the effects of red, yellow, green, and blue light on finger response. Table 1 shows the results of analysis of variance.

Table 1. Analysis results of the effect of color on finger response

	Sum of square	Degrees of freedom	Mean square	F	P
Between groups	0.016	3	0.05	0.342	0.795
Within groups	0.570	36	0.016		
Total	0.586	39			

The results showed that the difference between the groups was not significant ($p=0.795>0.05$), indicating that different colors had no effect on the response of the subjects.

2.3. Analysis of Finger Work Ability

The response time data of 90 subjects were classified and grouped to analyze the difference between the mean values of the response time (work ability) of different fingers. The results are shown in Table 2.

Table 2. Difference analysis of 8 types of finger response

	Sum of square	DF	Mean square	F	P
Between groups	1.823	7	0.203	2.782	0.003
Within groups	581.795	14392	0.073		
Total	583.618	14399			

The results show that there are significant differences in the ability of different fingers to work ($p=0.003<0.05$).

According to the average response time of the 8 types of fingers, from low to high (the lower the response time, the faster the speed, the stronger the ability to work). The results are shown in Table 3.

Table 3. Mean value and sorting of 8 types of finger response

Sort	Variate	Finger	Average value
1	x_5	Right index finger	0.4291
2	x_6	Right middle finger	0.4344
3	x_1	Left index finger	0.4423
4	x_7	Right ring finger	0.4436
5	x_2	Left middle finger	0.4514
6	x_3	Left ring finger	0.4519
7	x_8	Right litter finger	0.4586
8	x_4	Left little finger	0.4749

3. Statistical Analysis of Alphabet Usage Frequency Based on Pinyin input Method

3.1. Respondents

Since the Chinese input method was born in the 1980s, people are free to use Chinese language symbols. With the development of economy and technology, Chinese input method has also continuously derived new products. At present, the Chinese use Pinyin input method most when inputting Chinese characters. On the other hand, with the deepening of informatization, the traces of networking in people's study, life and work are getting deeper and deeper, and the online language is updated faster and faster. The Chinese characters commonly used by Chinese people are also quietly changing. Therefore, this study collected the commonly used Chinese characters from 2017 to 2019 and the Chinese characters used on the Internet, and analyzed the alphabet usage of each

Chinese character under the Pinyin input method.

3.2. Survey Results

Collect and sort 4,761 common characters and network words from 2017 to 2019, and count the frequency of letters used in Pinyin input method. The summary is shown in Table 4.

Table 4. Usage of Pinyin letters of commonly used Chinese characters

Letter	Frequency	Frequency of occurrence	Letters ranking
i	2035	0.13576623	1
n	2019	0.13469878	2
a	1741	0.11615184	3
u	1323	0.08826473	4
h	964	0.06431383	5
o	928	0.06191207	6
g	916	0.06111148	7
e	675	0.04503302	8
z	482	0.03215692	9
y	478	0.03189005	10
s	408	0.02721996	11
j	343	0.02288345	12
l	338	0.02254987	13
x	304	0.02028154	14
c	246	0.01641204	15
m	226	0.01507772	16
q	222	0.01481086	17
p	221	0.01474415	18
t	215	0.01434385	19
d	188	0.01254253	20
b	171	0.01140837	21
w	165	0.01100807	22
k	161	0.01074121	23
f	119	0.00793916	24
r	84	0.00560411	25
v	17	0.00113417	26

4. Optimization of Keyboard Layout Based on Finger Work Ability and Letter Frequency

4.1. Evaluation of QWERTY Keyboard

According to bibliography, the alphabet keys on the QWERTY keyboard are controlled by 8 fingers (except the left and right thumbs), and the alphabet keys controlled by each finger are shown in Table 5 below. The data in the previous table 4 shows the ranking of the frequency of the letters when the Pinyin input method is used under the current commonly used Chinese characters. According to the principle of matching the finger work ability with the frequency of letter use, the keys after matching can be obtained. It can be seen from Table 5: The mismatch of the original QWERTY keyboard is 23/26=88.46%.

Table 5. Qwerty keyboard matching evaluation table from the perspective of Pinyin input method

Finger ability sorting	Name of the fingers	Original letter control	Improved letter control keys	Number of mismatched keys
1	Right index finger	YHNUJM	INAUHO	3
2	Right middle finger	IK	GE	2

3	Left index finger	RFVTGB	ZYSJLX	6
4	Right ring finger	OL	CM	2
5	Left middle finger	EDC	QPT	3
6	Left ring finger	WSX	DBW	3
7	Right litter finger	P	K	1
8	Left little finger	QAZ	FRV	3

4.2. Improved Keyboard Layout

First, divide the area according to the position of the finger and the ability of the operation. The strong finger is responsible for the large area and control more alphabet on the keyboard; then, considering the principle of matching the frequency of letter use with the ability of the finger, the letter with high frequency is assigned to the strong operation ability Fingers. Combined with the basic layout scheme of the traditional keyboard, comprehensively considering Table 3 and Table 4, the letter keys and the number of controls controlled by each finger are adjusted, and an improved scheme is obtained. as picture 1.

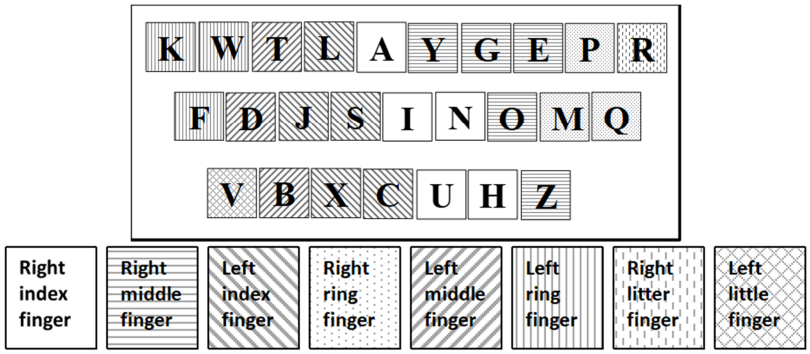

Figure 1. Keyboard layout improvement plan

5. Discussion

The frequency of letters and the ability to work with fingers are two key factors when designing a keyboard layout. The Qwerty keyboard currently used is designed according to the alphabet usage habits of English-speaking countries. It is not suitable for Chinese people who mainly use Chinese Pinyin input method. Although many scholars have conducted research on keyboard layout optimization, most of them have improved the keyboard based on the principles of ergonomics, paying attention to the convenience and rationality of the operation, avoiding user muscle tension and static fatigue, etc., there is very little research on combining the frequency of letter use and finger work ability. In addition, with the development of time, the frequency of use of different Chinese characters will also change.

This study is based on a comprehensive consideration of the frequency of use of Chinese Pinyin input method letters and finger work ability in recent years. The results show that there are indeed significant differences in the ability of different fingers to work. According to the principle that the finger work ability matches the frequency of letter usage, the keyboard letter control keys are redesigned, as shown in Figure 1 above. The improved letter key layout is quite different from the traditional Qwerty keyboard letter key layout (see Table 5 above): the control keys of each finger are adjusted, the overall adjustment degree reaches 88.46%, and the left hand index finger adjustment is the largest (All six letter keys have been replaced).

The Qwerty keyboard has been used for more than 100 years and has been used in China for a long time. The user's adaptability is worth paying attention to. For the skilled users who are already used to using the Qwerty keyboard, the efficiency of the Chinese Pinyin input using the Qwerty keyboard is likely to be higher than the improvement scheme of this study due to the learning effect. For novices (such as teenagers) who have not used the Qwerty keyboard, if they use this research

improvement plan during the enlightenment learning of Chinese Pinyin input, the efficiency of Chinese Pinyin input after becoming a skilled user will be much higher than that of the Qwerty keyboard.

6. Conclusion

(1) In the new era of informatization networks, statistically surveyed commonly used Chinese characters; combined with the Pinyin input method, sorted the frequency of letters; and analyzed the differences in human finger work ability using the experimental method and ranked.

(2) According to the idea of matching the finger work ability and the frequency of letter use, it is found that the traditional Qwerty keyboard has a very high mismatch, and the letter key layout suitable for the Chinese Pinyin input method has been redesigned.

(3) Participants in the study were all right-handed, and the results of the study did not meet the needs of a small number of left-handed operators; the study only considered the layout of alphabetic keys, and did not comprehensively consider other keys, which was further improved in subsequent studies.

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