The Human Interface Interaction Design Based on Blood Oxygen Meter

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Abstract. Health has always been the focus of human's attention, however there is not enough research about home medical device interfaces. This paper aims to discover the key principles and perceptual demands that should be taken into consideration when designing a oximeter interface. The concept of 'human-centered' is not only for the product design, but also for the interface design. Compared with normal people, patients need more emotional supports from the products they used. In the second part, Kansei engineering is used to discover these emotional needs. Using these Kansei words can guide the next iterative interface of oximeter. In the third part, aesthetic evaluation is proposed in order to choose the best interface among the three optimized interfaces which put forward in part two. Balance, sequence and cohesion are the three calculation indexes. The result of this paper has a great influence on a human oriented interface design.

Keywords: Oximeter interface · Kansei engineering · Aesthetic evaluation · Human factors · Medical appliance

1 Introduction

In the twenty-first century, the pace of human's life is speeding up, as well as the pressure of human's work is getting higher, causing a lot of problems in people's health condition. The traditional medical treatment is facing a revolution because of the convenience and efficiency of home medical devices. With the development of Internet of things (IoT) technology, home medical assistants have become more and more powerful and popular among common families. It is believed that with wearable medical devices, diseases can be detected and found quickly in daily life. This device enable the patients to notice when they are in critical condition [1]. From hundreds of home medical devices, the pulse oximeter has been demonstrated to be the best medical instrument which used to monitor human' arterial oxygen saturation and pulse rate [2]. A pulse oximeter is a non-invasive home medical appliance, the work principle of it is using red and infrared light. These two kinds of lights can penetrate the tissue of human. Through measuring the transmitted light penetration from source to receiver, which are placed on the opposite sides of the oximeter, the numerical values of arterial oxygen saturation and pulse rate are shown on the embedded electronic screen [3]. They are the two key physiological indicators that can evaluate the real-time health condition assessment of human.

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Fig. 1. The common type of an oximeter which people can find in market.

Figure 1 depicts the finger oximeter design for home healthcare consisting of lots of sensors and an embedded screen. The data on the screen is not easy to distinguish from different health indicators and the arrangement of elements and layout ignore patient's emotion and user experience. Home medical devices have broad market prospects, however the related research for human-centered interface of oximeters is not enough. Based on previous interface, Kansei engineering and aesthetics evaluation are chosen to measure the ergonomics of the three new pulse oximeter interfaces which put forward in this paper. This analysis result provides a valuable reference to enhance the usability and the flexibility of the next iteration of the pulse oximeter prototype.

2 Kansei Engineering

2.1 Theory and Method

Human factors focus on human and the interaction between human and products [4]. A good design is a combination of human, product, environment, economic and technology [5]. Interface is a bridge of information communication between human and product, therefore human factors should be considered in order to enhance the effectiveness of product and achieve certain desirable human values. For hundreds of years, lots of scientists have been trying to answer what element has an effect on human's emotion. Kansei engineering is one of these representative theories. It was first put forward by Yamamoto, the former president of Mazda motor corporation [6]. This theory transforms ambiguous emotional demands to a certain design point which can be adopted into a product design, and has the guiding significance of exploring the relevance between human's emotion and product design characters [7]. Kansei engineering has been applied in many research areas, such as automatic digital mood boards, city public environment facilities and automotive interior design [8–10]. As a home medical product, perceptual demands should be taken into consideration when designing the interface of an oximeter to relieve the anxiety of a patient. Through the Kansei words analysis, certain emotional requirements can be extracted to help researchers optimize the oximeter interface. Figure 2 shows the Kansei engineering procedure analysis in this part.

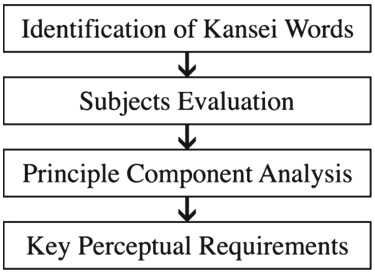

Fig. 2. Research procedure and frame of Kansei engineering

Ten Kansei words were selected based on the design trends of interfaces and medical devices. Twenty subjects who have used an oximeter at home before were invited to participate in this research. Using Semantic Differential scale, they need to fill in the blanks of a Kansei words list and mark the objects in a range from 1–10 point to measure their perceptual evaluation of the medical product interface. During the scoring process, discussion is not allowed. Principal component analysis was performed among these data to find the key Kansei words in determining an oximeter interface design. The analysis was calculated by SPSS, a statistical software product that can assist researches to do some mathematical analysis based on the data obtained from the experiment.

2.2 Result and Discussion

After finishing the principle component analysis, the result is shown as Table 1. 'Positive', 'Scientific' and 'Warm' obtained the highest scored in factor1, which means they have the greatest impact on an oximeter interface design meet a patient's special emotional requirement.

Table 1. Principal component analysis

Kansei words	Component	
	Factor1	Factor2
Positive	.769	.332
Scientific	.733	.112
Warm	.690	−.207
Simple	−.021	.822
Cute	−.187	.742
Smooth	.215	.593
Colorful	−.163	−.353
Modern	−.471	.294
Unique	.297	−.254
Dynamic	.231	−.037

Patients are more sensitive to products than common people and need obtain emotional strength from the products that they use. Based on this result, three optimized oximeter interfaces are proposed as Fig. 3, using Kansei words positive, scientific and warm. The screen size is 28 mm (width) and 40 mm (height).

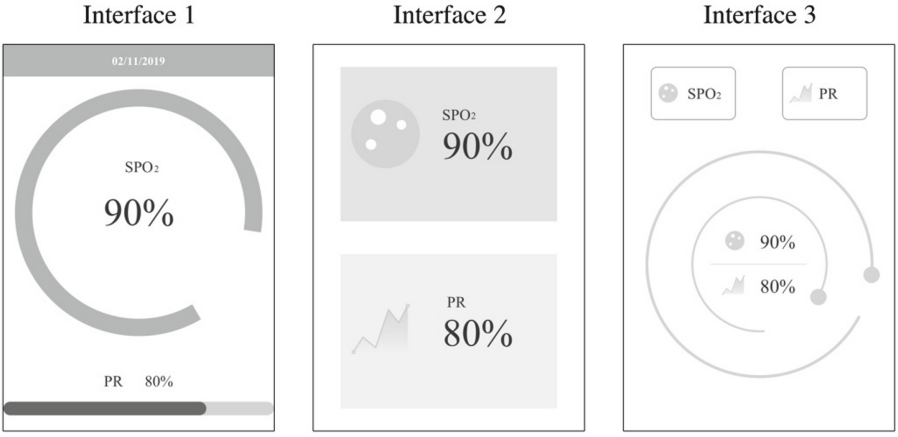

Fig. 3. Optimized oximeter interfaces based on Kansei words

3 Aesthetic Evaluation

In addition to emotional demands, another important aspect of oximeter interface design is aesthetic. High correlations were found between interface aesthetics and usability, and interface aesthetics has an effect on comprehensibility as well [11, 12]. Therefore, it supposed that elements layout has some relationships with people's emotion and the main purpose in this part is to discover the ambiguous standards. Since in the age of print, human have the spirit of pursuing beauty. However, it is not easy to distinguish beauty from ugly. The aesthetic standards confused researchers for a long time. Balance, symmetry and sequence are the common design techniques that used by many graphic designers. They are related to interface design as well. Ngo, Teo and Byrne proposed twelve equations of the quantitative analysis in interface aesthetics [13]. In this part, three equations will be selected to assess the oximeter interface for choosing the best one. To simplify the calculation, all the elements are regarded as squares. The equations focus on the perception of structure created by spacing, not on single words.

3.1 Balance

Balance refers to the object are in an interface. Human have the perception that larger objects are heavier than small objects, which is called optical weight. The screen is divided into four parts, upper-left, upper-right, lower-left and lower right.

$$BM = 1 - \frac{|BM_V| + |BM_H|}{2}. \quad (1)$$

The calculation result of the three optimized oximeter interface is shown as Table 2.

Table 2. Computation result of balance

Interface1	Interface2	Interface3
0.84	1.00	0.99

3.2 Sequence

Sequence refers to a measurement of how information in an interface is ordered according to a reading pattern that is common in human reading habit: from upper-left to lower-right. In addition, larger elements attract human's attention and break this eye movement.

$$SQM = 1 - \frac{\sum_{j=UL,UR,LL,LR} |q_j - v_j|}{8}. \quad (2)$$

Each quadrant is given a weighting ranging from one to four. The calculation result of the three optimized oximeter interface is shown as Table 3.

Table 3. Computation result of sequence

Interface1	Interface2	Interface3
1.00	1.00	1.00

3.3 Cohesion

Similar aspect ratios contributes to cohesion. Aspect ratios means the quotient of width and height. This element also has an effect on eye movement.

$$CM = \frac{|CM_{fl}| + |CM_{lo}|}{2}. \quad (3)$$

The calculation result of the three optimized oximeter interface is shown as Table 4.

Table 4. Computation result of cohesion

Interface1	Interface2	Interface3
0.65	0.75	0.75

3.4 Result

Finally, the average of each optimized interface is calculated to find the best one with the highest aesthetic evaluation value. The result is shown in Table 5.

Table 5. Sum of aesthetic indexes

Interface1	Interface2	Interface3
2.49	2.75	2.74

The second screen gets the highest computed value and conforms to the aesthetic demand of human.

4 Conclusion

This research adopted Kansei engineering and aesthetic evaluation to analyze the most important element in an oximeter interface design based on the user's psychological commands and the desire in beauty. Through principle component analysis, positive, scientific and warm are the three key emotions that influence the design of home medical devices. Using three aesthetic calculation formula, the value of balance, sequence an cohesion of the three optimized oximeter interfaces. Finally, it can achieve the combination and balance of emotion and aesthetics. Further research will attempt to discover whether this conclusion can generalize from the oximeter to common home health devices. The aesthetic effects about colors and shapes of the elements on an interface are also need to be evaluated in additional research.

References

1. Agustine, L., Muljono, I., Angka, P.: Heart rate monitoring device for arrhythmia using pulse oximeter sensor based on android. In: 2018 International Conference on Computer Engineering, Network and Intelligent Multimedia, Surabaya, pp. 106–111. IEEE Press (2018)
2. Lin, B.S., Huang, C.Y., Chen, C.Y.: Design of a finger base-type pulse oximeter. Rev. Sci. Instrum. **87**, 103–108 (2016)
3. Lu, Z., Chen, X., Dong, Z.: A prototype of reflection pulse oximeter designed for mobile healthcare. J. Biomed. Health Inf. **205**, 1309–1320 (2015)
4. Salvendy, G.: Handbook of Human Factors and Ergonomics. West Lafayette (1997)

5. Kang, H., Li, J.: Application and research on ergonomics and Kansei engineering in human-computer interface design. Appl. Mech. Mater. **563**, 245–247 (2014)
6. Yamamoto, K.: Kansei Engineering-the Art of Automotive Development at Mazda. Ann Arbor (1986)
7. Sun, Y.: The study of man-machine interface design based on Kansei engineering and with the center on users. In: 18th International Conference on Industrial Engineering and Engineering Management, Chang Chun, pp. 671–673. IEEE Press (2011)
8. Zabotto, C.N., Amaral, D.C., Benze, B.G.: Automatic digital mood boards to connect users and designers with Kansei engineering. Int. J. Ind. Ergon. **74**, 152–156 (2019)
9. Wei, X.: Research of Human culture design of city public environment facilities based on Kansei engineering – with Chengdu as example. In: IOP Conference Series Earth and Environmental Science, Beijing, pp. 46–49. IOP Press (2016)
10. Zhu, L.H., Zhao, H., Yin, X.C.: Computer aided automotive interior design for Kansei engineering. Appl. Mech. Mater. **130**, 504–507 (2011)
11. Tractinsky, N.: Aesthetics and apparent usability: empirically assessing cultural and methodological issues. In: CHI '97 Conference Proceedings, New York, pp. 103–108. Machinery Press (1997)
12. Tullis, T.S.: An evaluation of alphanumeric, graphic, and color information displays. Hum. Factors **23**, 541–550 (1981)
13. Ngo, D.C.L., Teo, L.S., Byrne, J.G.: Modelling interface aesthetics. Inf. Sci. **152**, 25–46 (2003)