Control Method of Human-Computer Interaction Interface Based on Multi-level Analysis

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Abstract. In order to understand the effectiveness of man-machine interface control method, a man-machine interface control method based on multi-level analysis is proposed. Firstly, using the advantages of AHP, the factors related to users in the evaluation of man-machine interface are comprehensively analyzed, and the usefulness, efficiency and comfort are summarized. Secondly, the evaluation system of man-machine interface as an evaluation index is established and the corresponding model is established to evaluate it reasonably, so as to achieve the purpose of reasonable evaluation of man-machine interface. Finally, the effectiveness of the model is proved by an example calculation.

Keywords: multi-level · Man-machine exchange · Control method

1 Introduction

For the human-machine interface, the functions and features must be determined by the user, and the design of the human-machine interface usually only focuses on its functions and features. With the rapid development of technology, the human-machine interface has become an important part of the software development process and has attracted more and more people. The use of measurement results to evaluate and improve human-machine interfaces has become an important issue.. Those. The Analytic Hierarchy Process (AHP) is often used to analyze complex processes with multiple objectives and models. In general, the concept of human-machine interface can be divided into two types: broad human-machine interface and narrow human-machine interface. In a broad sense, a human-machine interface is an information exchange between humans and machines. People receive information from machines through their senses such as seeing and hearing, and after analyzing the received information and making decisions, the human brain feels like it knows the truth of information exchange between humans and machines. Fine human-machine interface usually refers to the human-machine interface in the computer system, that is, the human-machine interface, the user interface as a means of transmitting and exchanging information between people and computers, and the environment [1, 2]. For computer users. Computer Its schematic diagram is shown in Fig. 1.

N. Akhtar et al. (Eds.): PMIS 2023, AHIS 8, pp. 906–912, 2023.
https://doi.org/10.2991/978-94-6463-200-2_94

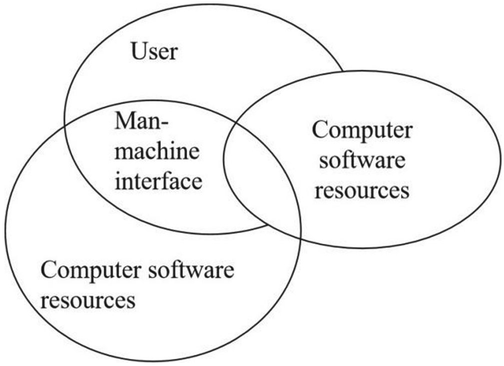

Fig. 1. Schematic diagram of man-machine interface

2 Evaluation of Man-Machine Interface Based on Analytic Hierarchy Process

Evaluating the effect of human-computer interaction is a key problem of human-computer system. In the past, the evaluation of human-computer interface often focused on the evaluation of human-computer interface function itself, ignoring the importance of users in practical application. In this paper, considering human factors, based on the hierarchical model of man-machine interface established in the above article, the quantitative and qualitative analysis methods are used to evaluate the man-machine interface objectively.

2.1 Analytic Hierarchy Process

The Analytia Hierarchy Process (AHP) is a decision-making model proposed by American logistics expert Professor Saati in the 1980s and is often used to analyze complex processes with multiple brands, plans, and multiple models. Its main features are: the combination of good and effective decision-making, the decision stage and evaluation based on the principle of thought and emotion. Since its introduction in China in 1982, this model has been widely used in many social and economic fields, such as energy analysis, urban planning, financial management, scientific research, etc., and features a combination of these. Advantages of different decision efficiency, multifaceted treatment, flexibility and precision [3, 4].

The idea of the Analytic Hierarchy Process (AHP) is to solve problems that need to be solved at different levels. When applying this concept to the evaluation of human-machine interfaces, one must first identify the factors that affect the evaluation and classify these situations according to certain standards. The basic level can be written as follows.

1. Establish a hierarchical structure model

On the basis of in-depth analysis of strategic problems, the problem is decomposed into various components and decomposed at different levels from top to bottom according to the influence and interdependence of the factors considered as a hierarchical model. Those. In a process model, everything at the same level is subordinated to or related to higher-level events, and at the same time is affected by lower-level supervisors or lower-level events. Lower level. We call the top layer the target layer, which is usually just one, while the bottom layer is called the layer or layers. There can be one or more levels of plans or layers, often referred to as systems or systems. In general, if there are many models (say more than 9), it should be continued as a sublayer.

2. Construct a contrast matrix.

According to the human judgment of objective reality, the importance of each factor is specified in the formula, and then the importance of the weight of each factor in each layer is determined by of the mathematical model. Starting from the second layer of the hierarchical model, for the events in a layer that are affected or influenced by all of the above layers, the connected model is created by comparing the corresponding model compare and go down to the lower procedures 1–9.

3. Calculate the weight vector and do consistency check.

For each comparison variable, the root and maximum of the corresponding feature vector are calculated, and the similarity measure, variance measure, and contrast are used to measure the similarity. If the test passes, the face vector becomes its weight vector; if it cannot be done, the building must be repaired.

4. Calculate the combination weight vector and do the combination consistency test.

By calculating the relative importance of each layer, the relative importance of the lowest layer with the highest layer (general purpose) is obtained, which is used to measure and select ideas. Likewise, this process should be checked for consistency. If the test is passed, a decision can be made based on the result represented by the composite weight vector. Otherwise, the model should be reconsidered or the comparison matrix with the same size should be repeated.

2.2 User-Based Human-Computer Interface Evaluation

If we want to get an ideal evaluation method for man-machine interface, we need to constantly adjust the parameters of the evaluation algorithm to achieve the optimal evaluation effect, which requires the purposeful realization of the design effect for man-machine interface, which belongs to the multi-factor comprehensive evaluation feedback problem. There are many strategies to solve the problem of multi-factor comprehensive evaluation, and there are also many mature algorithms in China, such as: taking the evaluation factor of single factor as a certain component of space and constructing a spatial function to realize comprehensive evaluation. However, due to the independence of each factor and the lack of necessary connection, the evaluation results often only reflect the effect of a certain aspect of the man-machine interface. In order to get the multi-factor evaluation results, it is necessary to choose the appropriate algorithm and make a comprehensive evaluation and analysis of the man-machine interface.

The research of man-machine interface evaluation system is one of the hot issues in the field of man-machine interface evaluation. The evaluation of man-machine interface is ultimately tested by users, so the combination of subjective and objective factors based on users' psychological factors and physiological characteristics is unified. Researchers analyze the relationship between interface usability and user understanding, and establish a corresponding mathematical model to realize the corresponding user-based evaluation mechanism, which is easier to realize than using the standard subjective evaluation model before, and the evaluation effect can also be used as a feedback link to get a better optimization algorithm, and the operation is simple and fast.

1. hierarchical structure.

There are many factors that affect the man-machine interface. Different interfaces should be analyzed in detail in practical application, and appropriate criteria should be selected according to the actual situation. However, no matter what kind of human-computer interface is used, it is necessary to consider the system's ability and characteristics, efficiency and user comfort from the user's point of view at the beginning of design. In this paper, usefulness, efficiency and comfort will be used as the indicators to evaluate the selection of system factors, and these three indicators will be analyzed in a hierarchical and detailed way [5].

(1) Usefulness B_1; It focuses on the system's learning ability, response ability, user's help-seeking mechanism and error-checking ability, and mainly considers the realization of the basic functions and characteristics of the system. This is the most basic requirement for a man-machine interface.
(2) Efficiency B_2: On the premise of ensuring usefulness, we need to further consider the efficiency of interface function realization and operation completion. Reducing the user's memory burden as much as possible and controlling the interface effectively, such as system response ability, learning ability, user control right and consistency of interface operation, are all factors that need to be considered to improve the efficiency of man-machine interface.
(3) Comfort B_3: Pay attention to the user's sensory factors when using, mainly considering the user's operating comfort, such as the overall layout and collocation of the interface, the amount of information on the screen and the display mode, whether the terminology and operation are consistent, and whether the user's preferences are considered.

2. Single weight solution at the same level.

The single weight at the same level indicates the relative importance of the factors at this level to a single factor at the upper level, which is the basis for calculating the weight of the factors at a single level relative to the total target combination. According to a certain criterion, the factors of this level are compared in pairs, and then the weight of this level of factors to this criterion is obtained by calculating the maximum characteristic root of the judgment matrix and its corresponding orthogonal characteristic vector [6].

3. level total sorting.

Using the weight of each factor in the same level to a factor in the upper level, the weight is synthesized layer by layer from top to bottom, and finally the weight of each factor in the lowest level to the target is achieved.

It is assumed that the relative weight of the n_{k-1} factor on the k-1 layer relative to the total target has been obtained as shown in Formula (1):

$$w^{k-1} = (w_1^{k-1}, w_2^{k-1}, \cdots, w_{nk-1}^{k=1})^t \tag{1}$$

3 Example Analysis

The analytic hierarchy process (AHP) method proposed in this paper is used as the evaluation standard for scheme selection of an interface, where T_1 ~ T_7 are the corresponding evaluation factors. Through the user demand survey and expert group discussion, the relative weights of evaluation factors B_1, B_2 and B_3 relative to S are obtained in combination with the actual situation. Through the analysis of this man-machine interface design scheme, the judgment matrix corresponding to B_1, B_2 and B_3 is obtained, and the weight values, λ, CL, CR, comprehensive weight values and combination consistency ratio are shown in Table 1:

According to the expert group's analysis on the design emphasis of these schemes, combined with the user's demand analysis, these design schemes are provided to the user for testing at the same time, and the judgment matrix of the three schemes for T_1 ~ T_7 is obtained through pairwise comparison as shown in Table 2:

According to the results in Table 2 above, it is not difficult to see that the design scheme F1 mainly focuses on the consideration of system usefulness, and is superior to the other two schemes in terms of system response ability, checking/correcting ability and online help function; The design scheme F2 mainly focuses on the consideration of user comfort, which is superior to the other two schemes in terms of overall screen layout and user control rights; The design scheme F3 pays more attention to efficient design, which is superior to the other two schemes in terms of system learning ability and consistency of interface

Table 1. Calculation results of man-machine interface evaluation system S

Scheme t	The weight of T to B			
	B1	B2	B3	Comprehensive weight value (T versus B)
T_1	0.0998	0.2969	0.2369	0.0168
T_2	0.3726	0.2896	0.1259	0.1469
T_3	0.1859	0.4569	0.4589	0.1325
T_4	0.3569	0.7892	0.2698	0.4596
T_5	0.2369	0.4263	0.7856	0.4896
T_6	0.2398	0.1259	0.5983	0.8963
T_7	0.1297	0.6392	0.4593	0.1589
λ	4.0105	4.0406	4.0896	0.1789
CL	0.0036	0.0125	0.0293	0.3694
CR	0.038	0.0125	0.0325	0.2593

Table 2. Hierarchical Total Sorting

	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Comprehensive value
	0.0162	0.1437	0.0301	0.3237	0.0975	0.0597	0.3288	
F_1	0.6585	0.5905	0.5498	0.0926	0.1261	0.2159	0.1638	0.2212
F_2	0.1851	0.2765	0.2098	0.2923	0.4162	0.681 9	0.5395	0.4024
F_3	0.1 563	0.1282	0.2403	0.6154	0.4578	0.1026	0.2968	0.3756

operation. However, judging from the overall ranking results, the priority order of these three schemes is F_2, F_3 and F_1. As the design scheme selection of man-machine interface, scheme F2 should be given priority as its design criterion [7, 8].

The evaluation factors that affect a man-machine interface are often not single, and the same factor will affect different evaluation indicators at the same time. The difference is that the relative importance of different indicators is different. Moreover, because the evaluation factors corresponding to the establishment of AHP model are different, the evaluation conclusions will also be different. Therefore, it is very important to rationally select user evaluation indicators and evaluation factors for evaluation systems with different purposes [9, 10].

4 Conclusion

This paper constructs a user-based human-computer interface evaluation model from the perspective of human factors, and deeply studies the principle of realizing the model. According to the idea of this paper, it is hoped that a concrete and realizable human-computer interface evaluation system can be established, and it is hoped that the system can be easily transplanted to other application fields. Based on the established hierarchical user model, the subjective factors in the evaluation process are analyzed by AHP, and the man-machine interface is evaluated on this basis. Through case study, it can be seen that the evaluation method proposed in this paper becomes more objective and makes the analysis process more reasonable by weighting the subjective components in the evaluation for many times.

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