An evaluation method for human-computer interaction interface of sports electronic products based on Naive Bayes algorithm

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Abstract: There are some problems in the evaluation method of human-computer interaction interface of sports electronic products, such as long evaluation time and relatively accurate evaluation of interactive interface. An evaluation method of human-computer interaction interface of sports electronic products based on Naive Bayes algorithm is proposed. Determined by Fisher method choice, sports man-machine interface evaluation index of electronic products and through the MRMR method the product interface evaluation indices' redundant data is eliminated. Through comprehensive evaluation matrix calculate weight of the man-machine interface evaluation index membership degree, with the help of Naive Bayes algorithm to calculate weight evaluation index of discrete. The comprehensive evaluation model of human-computer interaction interface is constructed to complete the evaluation of human-computer interaction interface of sports electronic products. Experimental results show that the shortest evaluation time of the proposed method is about 31 s, and the evaluation accuracy is always higher than 90%.

Keywords: simple Bayesian algorithm; Fisher selection; redundant data; comprehensive evaluation model.

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1 Introduction

With the rapid development of artificial intelligence technology, human-computer interface has become the medium of communication between human and machine. Human obtains the corresponding information through the operation of the interactive interface, and the machine obtains and processes the information under the operation of human (Yang et al., 2021). With the increasing demand of people, the function of human-computer interaction interface in electronic products is constantly improved. Among them, the human-computer interaction interface of sports electronic products has also become the key research object in the field of sports (Yeom et al., 2019). The human-computer interaction interface of sports electronic products can help athletes improve the training effect and help them continuously improve the shortcomings in training (Zhai et al., 2020). But with the continuous development of human-computer interface function, the experience of human-computer interface of sports electronic products cannot be satisfied. The evaluation of human-computer interaction interface of sports electronic products has become the premise of its continuous improvement (Cao and He, 2019). Therefore, researchers in this field have done a lot of research.

Zhang et al. (2019) proposed a human-computer interaction interface evaluation method based on visual perception characteristics. This method designs the classification model of visual perception characteristics through the different location distribution of human eye cells, evaluates the flatness of human-computer interaction interface by priority method, realises the weight division of visual elements, and realises the quantitative analysis of human-computer interaction interface by using screw hole detector. This method has high efficiency in evaluating human-computer interaction interface of sports electronic products; however, the energy consumption is high. In Wang (2020), a multimedia human-computer interaction interface evaluation method based on visual saliency is proposed. In this method, the filter is used to filter the multimedia human-computer interaction interface, the Guassian function is used to optimise the derivatives of the human-computer interaction interface, the hue of the interaction interface is adjusted by the visual saliency, the luminance value is compressed according to the texture complexity function, and the weighting coefficient of the multimedia human-computer interaction interface is determined to realise the quality evaluation of the human-computer interaction interface. This method can improve the efficiency of quality evaluation, but the balance of human-computer interaction interface is poor. In Zhu et al. (2020), an evaluation method for human-computer interaction interface of submersible based on behavioural and eye movement data is proposed. According to E-Prime software, the data of human behaviour interaction is collected, the distribution of visual stimulation is analysed by machine vision and the evaluation of human-computer interaction interface is realised by statistics. This method can obtain better evaluation effect of human-computer interaction interface, but the evaluation energy consumption is too large.

Aiming at the problems of excessive energy consumption and poor balance of human-computer interface in product evaluation, this paper proposes a human-computer interface evaluation method of sports electronic products based on Naive Bayes algorithm. The specific route of this paper is as follows:

- *Step 1*: Through Fisher selection method, the evaluation index of human-computer interaction interface of sports electronic products is determined, including succinct degree, balance degree, colour quantisation degree and continuity degree data;
- *Step 2*: Using the information gain method to determine the contribution degree of the interactive interface evaluation index, calculate the weight of each index and eliminate the redundant data in the product interface evaluation index data by MRMR method to complete the determination of the human-computer interface evaluation index of sports electronic products;

- *Step 3*: Through the comprehensive evaluation matrix to calculate the succinct degree, balance degree, colour quantisation degree and the weight membership degree of continuous degree data, and with the help of Naive Bayes algorithm to calculate the discrete weight of evaluation index, the comprehensive evaluation model of human-computer interaction interface is constructed to complete the evaluation of human-computer interaction interface of sports electronic products.
- *Step 4*: Verify the evaluation quality of human-computer interaction interface through experiments, and get the experimental results.

2 Determine the evaluation index of human-computer interaction interface of sports electronic products

In order to improve the effectiveness and accuracy of human-computer interface evaluation of sports electronic products (Shang and Fan, 2020), this paper uses Fisher selection method to extract the evaluation index of human-computer interface of sports electronic products. In this paper, the evaluation index of human-computer interaction interface of sports electronic products mainly includes the simplicity, balance, colour quantification and continuity of human-computer interaction interface. Because the data of the human-computer interaction interface evaluation index of sports electronic products are more abstract, such as the simplicity of human-computer interaction interface, the balance of interface, the quantification of interface colour and the continuity of interface, this paper uses Fisher selection method to determine the index effectively.

By measuring the distance of different nodes in the evaluation data of human-computer interaction interface of sports electronic products, the within class dispersion is classified by filtering. When the evaluation data of human-computer interaction interface is extracted, the Fisher selection rule of human-computer interaction interface is set as follows:

$$J(x) = \frac{X^T S_b X}{X^T S_w X}, x \neq 0 \tag{1}$$

In the formula (1), S_b is represented as the sample interclass value of sports electronics, S_w is represented as a sample value of sports electronics, S_t is represented as the overall spread matrix of the product interface. This time exists:

$$S_t = S_b + S_w \tag{2}$$

In the formula, t represents the *n*-dimensional real vector of the human-computer interaction interface of sports electronics.

When the human-computer interactive interface and the internal divergence are integrated, the best projection value interval (Luo, 2019) of the human-computer interaction interface of sports electronics is obtained. The extremal ratio of the feature selection rule target function $J(x)$ is unique to the interaction interface. Similarly, the vector t also achieves the maximum interface dispersion of sports electronics.

Based on this, this paper uses the MRMR method to eliminate the redundant information data in the overall distribution matrix of the product interface. Filter minimum redundancy information selected by MRMR, obtain subset Zhou et al. (2020) of product interface evaluation data using minimum redundancy and select the probability density function $P(x, y)$. In the space of index data of sports electronics, the mutual information interface is as follows:

$$I(x,y)=\iint P(x,y)\log\frac{P(x,y)}{P(x)P(y)}dxdy \quad (3)$$

In the formula (3), random variable x, y represents the product characteristic points of human-computer interaction interface evaluation.

The maximum correlation function of c (Wu et al., 2019) is:

$$D(S,c)=\max\left(\frac{1}{|S|}\sum_{x_i\in S}^{m}I(x_i,c)\right) \quad (4)$$

In formula (4), the minimum redundant function of S, electronics is:

$$R(S)=\min\left(\frac{1}{|S|}\sum_{x_i\in S}^{m}I(x_i,x_j)\right) \quad (5)$$

In the formula (5), i, j, respectively represent human-computer interaction interface evaluation data, $I(x_i, x_j)$ indicates the evaluation index information of human-computer interaction interface of sports electronic products. D for the effectiveness of evaluation data, R represents the redundant data of the human-computer interaction interface evaluation data and the reduced index data after removing the maximum redundant information is:

$$\max\psi(D,R),\psi=D-R$$

At this time, including simplicity, balance, colour quantification degree and continuum index data (Liu et al., 2020a), to obtain high-interface evaluation accuracy (Wang et al., 2020).

3 Implementation of human-machine interaction interface evaluation of sports electronic products based on Naive Bayes algorithm

3.1 Human-machine interaction interface index weight calculation of sports electronic products

Before evaluating the human-computer interaction interface of the sports electronics products, the weight of the human-computer interactive interface evaluation index should be analysed and processed. In this paper the information gain method (Liu et al., 2020b), which classifies the index and determines its importance. Based on the weight of information metric, the influence of the weight change on the evaluation of sports electronic products is analysed. To evaluate the importance of a certain characteristic index to the overall human-computer interaction interface. Making X, Y a random variable, the information entropy of X and Y information entropy about X are defined as:

$$H(X)=-\sum_{i}^{n}P(x_i)\log_2(P(x_i)) \quad (6)$$

$$H(X \mid Y) = -\sum_{j}^{m} P(y_i) \sum_{i}^{n} P((x_i \mid y_i)) \log_2 (P(x_i, y_i)) \tag{7}$$

Information gain is represented as a difference in the information entropy, defined as

$$IG(X,Y) = H(X) = H(X \mid Y) \tag{8}$$

After determining the information entropy of the human-computer interface characteristic index of sports electronics, the simplicity, interface balance, colour quantification and continuity of the interface are calculated.

Learn and train the different index data of the above evaluation, and the simplicity weight of the human-computer interaction interface of the sports electronics products obtained after the training can be calculated by the formula (9), namely:

$$Sim = \frac{3}{r_i + r_j + r} \in [0,1] \tag{9}$$

In the formula, r_i representing the number of vertical alignment points of the human-computer interactive interface of sports electronics products, r_j represents the number of level alignment points of sports electronics, r represents the number of human-computer interaction interface elements of sports electronics products.

The human-computer interaction interface balance weight of sports electronics is calculated by formula (13), namely:

In the formula, F_i represents the vertical balance of the interactive interface of sports electronics, F_j represents the horizontal balance of the human-computer interaction interface of sports electronics products.

The weight of colour quantification of human-computer interaction interface is:

$$L = \frac{|U_i| + |U_j|}{2} \tag{10}$$

In the formula, U_i represents the HMI element dimension relationship of sports electronics, U_j represents the spatial correlation degree of the interactive interface of sports electronics.

The continuity weight of the human-computer interaction interface for sports electronics is:

$$V = \frac{\sum |U_i| + |U_j|}{2} \tag{11}$$

In the weight calculation of the human-computer interaction interface, the contribution degree of the evaluation index weight is determined through the information entropy and the simplicity, interface balance, interface colour quantification degree and continuum index weight of the interface are calculated, respectively.

3.2 Construction of human-machine interaction interface evaluation model for sports electronic products

Naive Bayes algorithm is a kind of artificial intelligence algorithm, which is widely used in the fields of electronics, network, image and so on. Therefore, this paper uses Naive Bayes algorithm to achieve the final evaluation. Naive Bayes algorithm is a calculation method that randomly determines two research objects in the research objects and carries out conditional probability under the occurrence probability of any event. Its calculation formula is as follows:

$$E\left(a|b\right)=\frac{E(a,b)}{E(a)} \tag{12}$$

In the formula, $E(a|b)$ represents a conditional probability calculation method, $E(a,b)$ represents a prior test probability, $E(a)$ represents the posterior probability.

In this paper, the evaluation method of human-computer interaction interface of sports electronic products, the evaluation index of human-computer interaction interface is divided into several parts and the index weight of each part is obtained, respectively. According to the conciseness degree, balance degree, colour quantification degree and continuity index weight of the human-computer interaction interface determined above, each evaluation index is calculated through the comprehensive evaluation matrix to determine the membership degree of each index in the human-computer interaction interface evaluation of sports electronic products.

1) *The concise membership of the MI interface is:*

$$P\left(W_d\right)_1=\frac{V\left(x_1\right)\int\left(l_1\right)}{x_1}a \tag{13}$$

In the formula, $P\left(W_d\right)_1$ represents the result of MI simplicity membership, $V\left(x_1\right)$ represents the vity factor in the interactive interface, a represents the fitness of the simplicity index.

2) *The membership of the HMI balance is:*

$$P\left(W_d\right)_2=\frac{V\left(x_2\right)\int\left(l_2\right)}{x_2}s \tag{14}$$

In the formula, $P\left(W_d\right)_2$ represents the result of balance membership, $V\left(x_2\right)$ represents the balance factor in the interactive interface, s represents the fitness of the balance index.

3) *The human-computer interaction interface is:*

$$P\left(W_d\right)_3=\frac{V\left(x_3\right)\int\left(l_3\right)}{x_3}d \tag{15}$$

In the formula, $P\left(W_d\right)_3$ represents the human-computer interaction interface, $V\left(x_3\right)$ represents the colour quantification degree factor in the interaction interface, d represents the adaptation of colour quantification indicators.

4) *The interface continuity membership of the HMI interface is:*

$$P\left(W_d\right)_4=\frac{V\left(x_4\right)\int\left(l_4\right)}{x_4}f \tag{16}$$

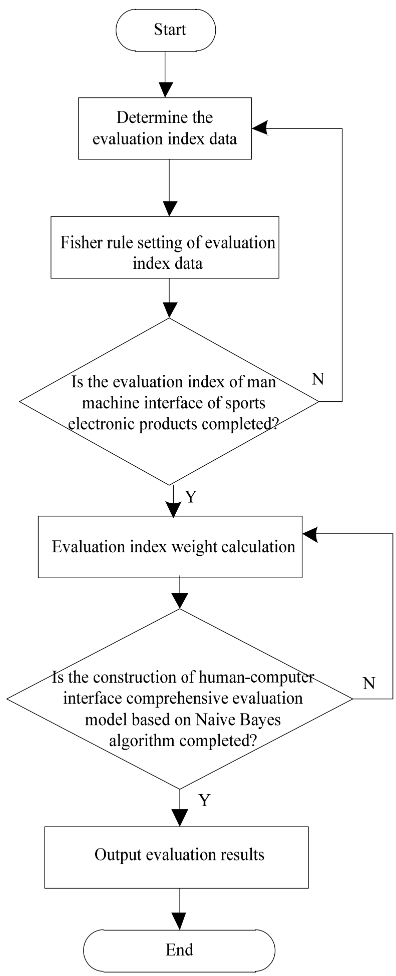
In the formula, $P(W_d)_4$ represents the result of the interface continuity membership of the HMI interface, $V(x_4)$ represents the interface continuum degree factor in the interaction interface, f represents the adaptation of the interface continuum index.

Then, according to the membership of the evaluation index, the likelihood probability of the evaluation index is calculated through the Naive Bayesian algorithm, construct the human-computer interface evaluation model of electronics and complete the evaluation of sports electronics (Ma et al., 2020), namely:

$$Z = \frac{1}{n}\sum_{i=1}^{x}\left(P(W_d)\sum_{i=1}^{n}F_i\right) \tag{17}$$

In the formula, Z represents the comprehensive evaluation results of the HMI, The n represents the number of indicators identified in the evaluation, F_i represents the discrete weights of the participating evaluation indicators. The evaluation process of human-computer interaction interface based on naive Bayesian algorithm is shown in Figure 1.

Figure 1 Evaluation process of human-computer interaction interface of sports electronic products based on Naive Bayes algorithm



In the evaluation of human-computer interaction interface, this paper calculates the discrete weight of evaluation index, constructing an evaluation model to realise the evaluation of sports electronics.

4 Experimental analysis

4.1 The experiment scheme

To verify the effectiveness of the proposed method on human-computer interaction interface of sports electronics, simulation analysis is conducted. In the experiment, a basketball software developed in 2019 with a software support system of Windows 10 system with running memory of 16 GB, core CPU of 3.6 GHz. Relevant parameters in the test are shown in Table 1.

Table 1 Test parameters

Parameter	*Data*
Basketball software version	V.6.6.156
Human-computer interface size /in	9.7
Interface corresponding speed / s	0.2
Interface data sampling interval / s	5
Iterations / times	100

According to the selected experimental parameters, the sample basketball software is taken as the effectiveness analysis object of human-computer interaction interface evaluation. According to the operation process and human-computer interaction process of the software as the observation object, the data are analysed in detail.

4.2 Experimental indicators

On the basis of the above experimental environment and parameter design, in order to highlight the advantages of the method in this paper, experiments are carried out by comparing the method in this paper, the method in Zhang et al. (2019), the method in Wang (2020) and the method in Zhu et al. (2020). The results were as follows:

1) *Evaluation time for HMI interface of sports electronics products*: The lower the energy consumption of sports electronics, the lower the efficiency in the quality evaluation.

2) *Comprehensive evaluation accuracy of human-computer interaction interface for sports electronics products*: Interface balance is an important index to evaluate the interface quality of sports electronics. The higher the balance of the interface indicates that the interface quality of sports electronics is the better. On the contrary, the lower the balance of the interface indicates that the worse the quality of the human-computer interaction interface of sports electronics products. The calculation formula is:

$$P_i = \frac{k_i}{u} \times 100\% \tag{19}$$

In the formula, P_i represents the human-computer interaction interface balance of sports electronics, k_i represents the actual balance of the interactive interface of sports electronics, *u*represents unbalances within the limits.

4.3 Results analysis

4.3.1 Evaluation time analysis of human computer interaction interface

In order to verify the evaluation effect of human-computer interaction interface of sports electronic products, the methods of Zhang et al. (2019); Wang (2020); Zhu et al. (2020) and the experiment of energy consumption evaluation of human-computer interaction interface of this paper are adopted. The results of energy consumption evaluation of human-computer interaction interface are shown in Table 4.

Table 4 Time for MI assessment (s)

Number of human interfaces	*HMI Assessment Time / s*			
	Document Zhang et al. (2019) method	*Document Wang (2020) method*	*Document Zhu et al. (2020) method*	*Method of this paper*
10	36	42	32	12
20	46	52	43	16
30	49	64	48	21
40	54	68	55	24
50	62	71	62	27
60	78	76	82	31
70	82	93	91	35

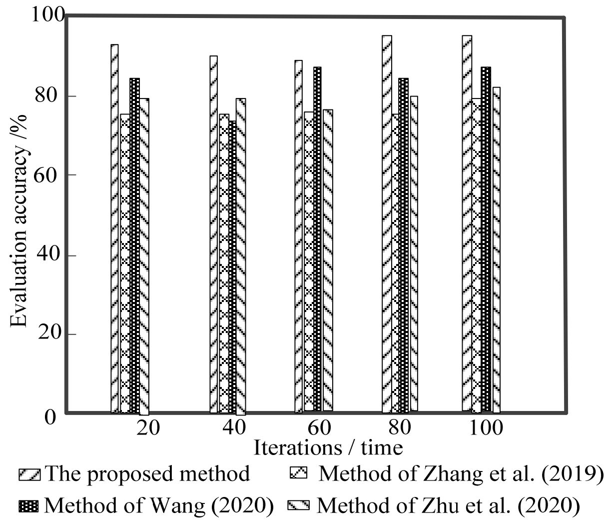
Analysis of Table 4 shows that there are differences in the energy consumption of human-computer interaction interface evaluation under different methods. When the number of human-computer interaction interfaces of sports electronic products is 30, the evaluation time of Zhang et al. (2019) method is 49 s, Wang (2020) method is 64 s, Zhu et al. (2020) method is 48 s and the evaluation time of this method is only 21 s. When the number of human-computer interaction interfaces is 60, the evaluation time of Zhang et al. (2019) method is 78 s, Wang (2020) method is 76 s, Zhu et al. (2020) method is 82 s and the evaluation time of this method is only 31 s. This shows that the evaluation energy consumption of this method is low, and the evaluation efficiency of human-computer interface quality of sports electronic products is high.

4.3.2 Accuracy analysis of human computer interface evaluation

Based on the basis of the above experiments, the method of Zhang et al. (2019); Wang (2020); Zhu et al. (2020) method and this paper method further verify the evaluation accuracy of human-computer interaction interface of sports and electronic products and the results are shown in Figure 1.

As can be seen from the analysis of the experimental results in Figure 2, there are certain differences in the accuracy of the evaluation of the four methods under the same experimental environment. Among them, the experimental results obtained by the proposed method are higher than those obtained by the other three methods, and are always higher than 90%. Although the accuracy of the other three methods is also within a reasonable range, they are always lower than the method in this paper. This is because the method in this paper takes advantage of the Naive Bayes algorithm and reduces the dimension of the texture features of the human-computer interaction interface of sports electronic products through MRMR technology, so that the evaluation results of the human-computer interaction interface are more accurate.

Figure 2 Analysis of accuracy of MI interface



5 Conclusions

This paper proposes an evaluation method of human-computer interaction interface of sports electronic products based on Naive Bayes algorithm. The evaluation indexes of human-computer interaction interface of sports electronic products were determined by Fisher selection method, including conciseness, balance, colour quantisation and continuity data. Information gain method was used to determine the contribution degree of interactive interface evaluation index, the weight of each index was calculated and the redundant data were removed from the product interface evaluation index data by MRMR method, so as to complete the evaluation index determination of sports electronic products human-computer interaction interface. Man-machine interface evaluation index by comprehensive evaluation matrix calculation terseness, balance, colour quantisation degree and degree of continuous weights of membership degree of data, with the help of Naive Bayes algorithm is the discrete weight of evaluation indexes, constructing a comprehensive evaluation model of human-computer interaction interface, complete man-machine interface evaluation sports electronic products. The method in this paper has the following advantages:

1) The shortest evaluation time of this method is only 31s, which shows that the evaluation efficiency of this method is high.
2) The accuracy of this method is always higher than 90%, which shows that the accuracy of this method is high.

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