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Evaluation Model of Telemedicine Service Quality Based on Machine Sensing Vision

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Abstract

INTRODUCTION: At present, the common telemedicine service quality evaluation methods can not obtain the key evaluation indicators, which leads to the low accuracy and low user satisfaction.
OBJECTIVES: This paper constructs a telemedicine service quality evaluation model based on machine vision technology.
METHODS: Machine vision technology is used to obtain telemedicine service information, preliminarily select service quality assessment indicators, complete the selection of indicators, build a telemedicine service quality assessment indicator system, adopt subjective and objective combination method to calculate the weight of service quality assessment indicators, and combine matter element analysis method to build a telemedicine service quality assessment model.
RESULTS: The experimental results show that the Cronhach a is higher than 0.7, the Barthel index is higher than 90, and the satisfaction of many users is more than 90%.
CONCLUSION: The proposed method solves the problems existing in the current method and lays a foundation for the development of telemedicine service technology.

Keywords: Machine sensing vision technology; Language information assessment, Evaluation index system, Subjective and objective combination weighting method, Telemedicine service quality assessment.

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1. Introduction

With the rapid development of computer science and technology and information communication technology, telemedicine has developed rapidly. Telemedicine overcomes the obstacles of traditional medicine in space and time, and realizes the sharing of medical information and resources across hospitals, regions and even borders; promotes doctor-patient communication and medical consultation among different disciplines, languages and specialties; extends the boundary of health activities such as medical treatment, scientific research and teaching, changes the mode and concept of medical service, promotes more people to obtain high-quality medical resources, and improves people's quality of life [1-2]. Large general hospitals can provide medical support for grass-roots hospitals through telemedicine services to improve the quality of grass-roots medical services. At the same time, they can also provide medical services for patients in remote areas to solve the problem that people cannot obtain high-quality medical services due to geographical barriers [3-4]. Evaluating the quality of telemedicine service can understand the weakness of telemedicine service and provide decision-making basis for the management of telemedicine service. At this stage, although telemedicine is conducive to improving service accessibility and utilization, helping to control medical expenses and reducing the burden on patients, the quality of telemedicine varies due to system construction, operational development and many other reasons, and most telemedicine projects are therefore limited to short-term pilots and fail to develop in a normal manner and are not sustainable enough.

From the perspective of value oriented medicine, Li et al. [5] selected evaluation indexes in four aspects: medical staff's service attitude, technical level, doctor-patient communication and service timeliness, and constructed an evaluation index system to evaluate telemedicine services. Shi et al. [6] used the stratified sampling method to investigate hospitals. From the perspective of medical service providers, they constructed a quality evaluation index system with 17 indexes based on the three-dimensional quality management theory model of Donabedian structure-process-result and expert opinions. The distance method of superior and inferior solution combined with rank sum ratio method was used to comprehensively evaluate the quality of telemedicine service. Deng et al. [7] extracted 41 evaluation indexes through pre investigation, collected sample data by questionnaire, and then analyzed the data by SPSS to verify and modify the evaluation model to realize the evaluation of medical service quality.

In recent years, the rise of online medicine has not only effectively solved the problem of asymmetric medical information, but also had an important impact on patients' decision to seek medical services. At present, there are errors in the indexes selected by the existing methods, which can not accurately obtain the key evaluation indexes. In order to solve the problems in the above methods, this paper proposes a method of constructing telemedicine service quality evaluation model based on machine vision technology.

2. Evaluation index of telemedicine service quality

2.1. Index selection

Dynamic vision sensor (DVS) is used to acquire telemedicine information, and the obtained medical information is preprocessed. The imaging speed of DVS is not limited by exposure time and frame rate, the response time of pixels is in microseconds or nanoseconds, and the output signal format is not a frame, but a stream of events excited by moving objects. Therefore, dynamic vision sensors have great advantages in detecting ultra-high speed moving objects. The characteristics of DVS events make it possible to filter the background data effectively and save the amount of data greatly. At the same time, it reduces the cost of transmission and processing.

The imaging process is shown in Figure 1.

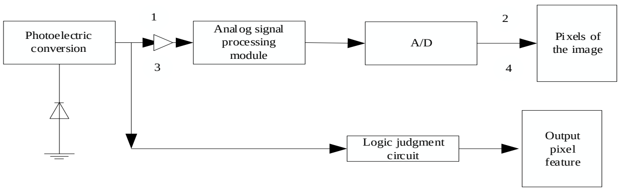


Figure 1. Imaging frame

Paths 1 and 2 in Fig. 1 are conventional APS imaging processes. Path 3 is a DVS imaging process implemented by a circuit that adds an AER logic judgment circuit behind each pixel unit. Based on the idea of DVS design, the modeling method of dynamic vision sensor based on frame image is shown in path 1 and 4, which can realize the dynamic vision sensor processing of frame image by adding AER logic judgment module at the end of APS circuit, and finally outputs the result of logic judgment.

Based on DVS imaging, When the background modeling based on Gaussian mixture model[8-9] is initialized, the number of Gaussian functions L and Gauss coefficient $\beta(0.001 \le \beta \le 0.1)$ are set, it can initialize L Gaussian functions with mean value v_k and variance σ_k^2 for each pixel, and the corresponding weight is θ_k.

For the next frame y, the gray value or brightness vector is c_t, a pixel in the frame is recorded as z, and the matching Gaussian function is found. Let the learning rate of this point be ς, and the formula is as follows:

$$\varsigma = \beta L(c_l \mid v_l, \sigma_l) \tag{1}$$

The Gaussian function mean and variance at this point are updated as follows:

$$\begin{cases} v_{lt} = \varsigma c_t + v_{l(t-1)}(1-\varsigma) \\ \sigma_{lt}^2 = \varsigma (c_t - v_{lt})(c_t - v_{lt})^T + \sigma_{lt}^2 (1-\varsigma) \end{cases} \tag{2}$$

If the appropriate Gaussian function c_t is not matched, set the mean v_{lt}, variance σ_{lt}^2 and weight θ_{lt} as follows:

$$\begin{cases} v_{lt} = c_t \\ \sigma_{lt}^2 = 2 \max\limits_k \sigma_{l(t-1)}^2 \\ \theta_{lt} = 0.5 \min\limits_k \theta_{l(t-1)} \end{cases} \tag{3}$$

After the best matching Gaussian function of the point is obtained, the background or foreground is determined according to the function. Finally, image filtering algorithm can be used to remove some small impurities.

The basis of mathematical morphology is the algebra of nonlinear operators for object shape, which is superior to the linear algebraic system based on convolution in restoring details and smoothing edges [10-11]. The purpose of morphological operation is to enhance the object structure and segment the object from the background. The binary image is regarded as a two-dimensional point set, and the structural element N is used to scan the whole point set. The results obtained by the relationship between the point set and the structural element N are stored in the corresponding position of the output point set, and the output point set finally obtained by the open operation is the result. Morphological operations include four operations: expansion, corrosion, and closure. The expansion operation of morphological operation adopts vector addition. Let the input binary image be S and the structural element be N. The expansion operation of N to S is defined as follows:

$$S \oplus N = \{a \in \phi^2, a = s + n, s \in S \; and \; n \in N\} \tag{4}$$

Where a is the pixel point of the output image; s is the pixel point in the image S; n is a pixel in the structural element N. The expansion operation can effectively fill the holes and cracks in the target object. The corrosion operation of morphological operation adopts vector subtraction, and the structural element N is used to corrosion the image S, which is defined as follows:

$$S \Theta N = \{a \in \phi^2, a + n \in S, \forall n \in N\} \tag{5}$$

Corrosion operation can effectively remove the noise in the image and obtain the bone structure of the target object.

The opening and closing operations of morphology are based on expansion and corrosion. The definitions of opening and closing operations are as follows:

$$\begin{cases} S \circ N = N \oplus (S \Theta N) \\ S \cdot N = N \Theta (S \oplus N) \end{cases} \tag{6}$$

The open operation expands the lines and lines inside the target object, but the shape of the object remains unchanged. This operation is mostly used to strengthen the internal detail information of the object and highlight the texture information of the object. The closed operation fills the holes and cracks in the target object, and smoothes the edge of the object. This operation is mostly used to restore the shape of the object and highlight the characteristics of the outer edge of the object.

The machine sensing vision technology is used to obtain the relevant information of telemedicine service through the above process, and the telemedicine service quality evaluation model is constructed.

Telemedicine has the generality of mobile service quality, medical service quality and its own characteristics [12-13]. Therefore, according to the analysis of reference in relevant fields, based on the analysis of telemedicine characteristics and quality definition, and according to the principle of index selection, the evaluation dimensions of telemedicine service quality are summarized into network quality, system quality, structure quality, interaction quality and results quality to analyze the influencing factors of telemedicine service quality, and select the initial evaluation index, as shown in Figure 2.

2.2. Index screening

Language information assessment

When evaluating the measurement items of service quality, the evaluator sometimes cannot express the information with accurate values, so it will use language information instead of values. Currently, it is usually necessary to select an appropriate language evaluation scale to describe this uncertainty. Assuming that the language evaluation information set $D = \{d_t\}$, $t \in \{0,1,2,\cdots,T\}$, d_t represents the t-th evaluation information, it must have the following characteristics:

(1) Order: $D_i \geq D_j$, $i \geq j$;

(2) There is a negative operation: $Neg(D_i) = D_j$, making $j = T - i$;

(3) There is a maximization operation: if $D_i \geq D_j$, then $Max(D_i, D_j) = D_i$;

(4) There is a minimization operation: if $D_i \leq D_j$, then $Min(D_i, D_j) = D_i$;

The number of d in the set determines the granularity of D. If the granularity is 7, the language term of evaluation information can be expressed as:

$$D = \{d_0, d_1, d_2, d_3, d_4, d_5, d_6\} \tag{7}$$

Generally, the evaluator will give the evaluation information according to the given language information set. Therefore, in order to avoid data loss, an extended language information evaluation set will be defined on the basis of the original language evaluation information set, which is set to $\bar{D} = \{d_t \mid 0 \leq t \leq T'\}$, if $d_t \in D$, then the evaluation language information is in the original evaluation language information set, otherwise, $d_t \in \bar{D}$, and the language evaluation information is expanding the language evaluation information set.

If $o = [d_i, d_j]$, $d_i, d_j \in D$ and $0 \leq i \leq j \leq T$, o is the language evaluation information in the language evaluation information set D, D_i and D_j are the upper and lower limits of o. When $i = j$, the fuzzy language evaluation information is degraded to the determined language evaluation information. For any two fuzzy

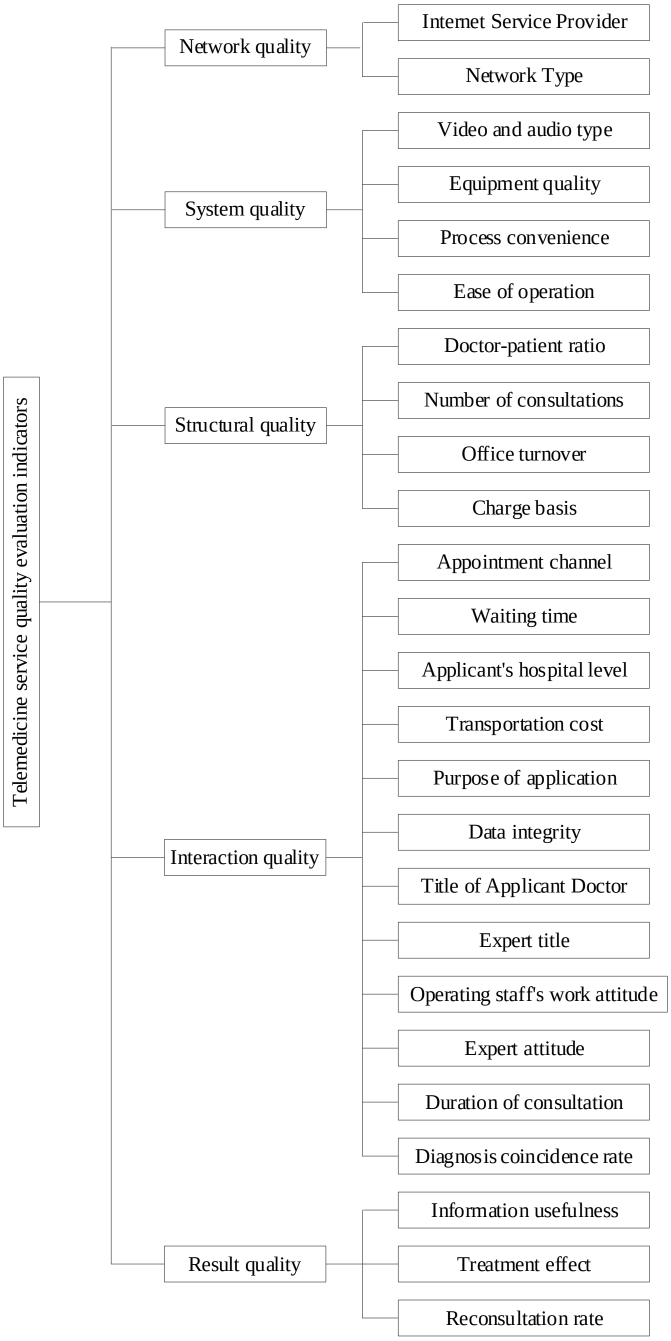


Figure 2. Initial evaluation index of telemedicine service quality

language evaluation information $o=[d_i,d_j]$, $b=[d_m,d_n]$, $d_i,d_j,d_m,d_n \in D$, the operation follows the following principles:

$$\begin{cases} o\oplus b=[d_i,d_j]\oplus[d_m,d_n]=[d_i\oplus d_m,d_j\oplus d_n]=[d_{i+m},d_{j+n}] \\ o\oplus b=b\oplus o=[d_{i+m},d_{j+n}] \\ o\oplus b=[d_i,d_j]\otimes[d_m,d_n]=[d_i\otimes d_m,d_j\otimes d_n]=[d_{im},d_{jn}] \\ \beta o=[\beta d_i,\beta d_j]=[d_{\beta i},d_{\beta j}] \\ \chi(o\oplus b)=\chi o\oplus \chi b \end{cases} \tag{8}$$

In order to facilitate the processing of fuzzy language information, it is necessary to convert fuzzy language information with different scales into corresponding fuzzy numbers. Triangular fuzzy numbers are mainly described by a value, while trapezoidal fuzzy numbers are represented by an interval. In addition, trapezoidal fuzzy numbers defined in interval [0,1] are sufficient to capture the uncertainty and fuzziness of language information. Therefore, the proposed method uses trapezoidal fuzzy numbers to complete the conversion of language information and numerical information. To deal with multi granularity uncertain language information, a method of converting multi granularity language information or uncertain language information into trapezoidal fuzzy numbers is given below.

Let T be a set of real numbers. If $S=(s,n,v,f)$ and $-\infty < s \le n \le v \le f < +\infty$, S is said to be a trapezoidal fuzzy function. Where s and f are the lower and upper bounds of the trapezoidal fuzzy function respectively, and the closed interval $[n,f]$ is the median value of S. If $s>0$, S is called the positive trapezoidal fuzzy function. If $n=v$, the trapezoidal fuzzy function degenerates into a standard triangular fuzzy number. If $s=n$, $v=f$, the trapezoidal fuzzy function degenerates into a general fuzzy interval number. Membership function of trapezoidal fuzzy function is $\varpi_S : T \to [0,1]$, satisfying:

$$\varpi_S = \begin{cases} (x-s)/(n-s) & s \le x < n \\ 1 & n \le x \le v \\ (x-f)/(v-f) & v < x \le n \\ 0 & other \end{cases} \tag{9}$$

Where, ϖ_S represents the qualification that element x belongs to fuzzy subset S. The closer its value is to 1, the greater the qualification that x belongs to S is, the closer its value is to 0, and the lower the qualification that x belongs to S is. If $\varpi_S(x)=0$ or $\varpi_S(x)=1$, the fuzzy set degenerates into a classical set. Let the positive trapezoidal fuzzy numbers be $S_1=(s_1,n_1,v_1,f_1)$ and $S_2=(s_2,n_2,v_2,f_2)$. For any two positive trapezoidal fuzzy numbers, they follow the following algorithm:

$$\begin{cases} S_1 \pm S_2 = (s_1,n_1,v_1,f_1) \pm (s_2,n_2,v_2,f_2) = (s_1 \pm s_2, n_1 \pm n_2, v_1 \pm v_2, f_1 \pm f_2) \\ S_1 \times S_2 = (s_1,n_1,v_1,f_1) \times (s_2,n_2,v_2,f_2) = (s_1 s_2, n_1 n_2, v_1 v_2, f_1 f_2) \\ S_1 / S_2 = (s_1,n_1,v_1,f_1) / (s_2,n_2,v_2,f_2) = (s_1/s_2, n_1/n_2, v_1/v_2, f_1/f_2) \end{cases} \tag{10}$$

For any language evaluation information set, it can be approximately expressed as trapezoidal fuzzy number by the following formula:

$$S_1 = (s_1,s_1,s_1,s_1) = \{\max[(2i-1)/(2T_i+1),0], 2i/(2T_i+1), (2i+1)/(2T_i+1), \max[(2i+2)/(2T_i+1),1]\} \tag{11}$$

The distance measurement of two trapezoidal fuzzy numbers can be expressed by Minkovsky distance:

$$F(S_1,S_2) = \left(\frac{|s_1-s_2|^\beta}{6} + 2|n_1-n_2|^\beta + 2|v_1-v_2|^\beta + |f_1-f_2|^\beta \right)^{1/\beta} \tag{12}$$

Where β is the distance parameter, $1 \le \beta \le +\infty$. When $\beta=1$, $F(S_1,S_2)$ is the weighted Hamming distance, and when $\beta=2$, $F(S_1,S_2)$ is the weighted Euclidean distance.

Identification of key indexes

In order to make the constructed evaluation indexes more accurate, the proposed method uses the method of expert evaluation [14] to judge the importance of the initial indexes and screen out the key indexes. Considering the fuzzy state of the evaluator, the proposed method introduces fuzzy language evaluation phrases to represent the evaluation results of experts more intuitively. The language evaluation term is defined as 7 granularities, i.e. $D=[d_0,d_1,d_2,d_3,d_4,d_5,d_6]$. From d_0 to d_6, it means very unimportant - very important respectively. The questionnaire is distributed to experts in the form of e-mail and direct distribution. The experts are doctors in grass-roots hospitals, experts in central hospitals, staff of telemedicine centers and researchers engaged in telemedicine research, the importance questionnaire of telemedicine service quality evaluation indexes is distributed to them, and the experts evaluated the importance of the indexes in the table according to their own experience.

Evaluation information processing

According to the above process, the collected expert language information evaluation is processed, converted into corresponding trapezoidal fuzzy numbers, and the mean value $\overline{x}_{ij}$ of the importance evaluation value of each index is calculated. Since the selected experts have practical experience in telemedicine and are familiar with telemedicine, they can give objective suggestions in the evaluation. Therefore, when calculating the importance score, the weight between experts is regarded as equal, and the calculation formula is as follows:

$$\overline{x}_{ij} = \frac{\sum_{k=1}^{m} x_{ijk}}{m} \tag{13}$$

Where, x_{ijk} represents the importance score of the k-th expert on the j-th index under the i-th dimension; $\overline{x}_{ij}$ represents the average score of the importance score of the j-th indicator under the i-th dimension.

Calculate similarity

7. The trapezoidal fuzzy number corresponding to the particle size evaluation phrase is $Q_{\vartheta}=(q_{\vartheta}^{1},q_{\vartheta}^{2},q_{\vartheta}^{3},q_{\vartheta}^{4})$, $\vartheta=0,1,2,3,4,5,6$. According to the similarity calculation formula, the similarity between the evaluation index is calculated as follows:

$$U(g^{*},Q_{\vartheta})=1-\frac{\sum_{i=1}^{4}|g^{*}-M_{\vartheta}^{i}|}{4} \tag{14}$$

To sum up, it can build the telemedicine service quality evaluation index system, as shown in Figure 3.

3. Telemedicine service quality evaluation model

3.1. Weight calculation

There are many methods to determine the index weight, which can be summarized into three categories: subjective weighting method [15], objective weighting method and subjective and objective combination weighting method. The subjective weighting method is to determine the weight according to the decision maker's intention, and its advantage is that the weight can be determined according to a lot of information without legal emblem. The shortcoming of subjective weighting method is that it lacks objective basis. Objective weighting method has objective advantages, but it can not reflect the degree of importance of different indicators, and will have a certain weight and contrary to the actual indicators. In view of the merits and demerits of the subjective and objective weighting methods, we try to control the randomness in a certain range to realize the centrality in the subjective and objective weighting. Objective aspects. Index weighting is fair, which realizes the unity of subjectivity and objectivity, and the evaluation result is true, scientific and credible.

The subjective and objective combination weighting method combines the expert opinions of the subjective weighting method and the objective data of the objective weighting method. The proposed method uses the subjective and objective combination weighting method to weight the indexes of the telemedicine service quality evaluation model. The subjective weighting method adopts pairwise comparison weighting method, the objective weighting method adopts entropy method, and then the two weights are combined according to the preference coefficient to form the final weight.

Subjective weight

The pairwise comparison weighting method adopts the binary comparison method [16], compares the index importance scores, and calculates the index weight according to the comparison results. The specific process is as follows:

The set of indexes is set as $X=\{x_1,x_2,x_3,\cdots,x_n\}$, and X contains n indexes.

The indicator weight set is $E=\{e_1,e_2,e_3,\cdots,e_n\}$, and E contains n weights.

z_{ij} represents the comparison result of the importance score of index x_i and index x_j. When the importance score of x_i is greater than that of x_j, z_{ij} is assigned a value of 1, 0.5 if it is equal, and 0 if it is less than that. To avoid the case that the sum of the index columns with the least importance is 0, a virtual index is introduced. Any index is more important than the virtual index, and the value is 1 after comparison. The proposed method uses the index self-comparison, which is assigned as 1 without introducing virtual index, and there is no difference in the calculation results.

Among the weight values of j experts and i experts, according to the evaluation of index importance by the k expert, the calculated weight of x_i is recorded as E_{ki}, and the comparison value is recorded as Z_{ij}^{k}. the calculation formula is as follows:

$$E_{ki}=\frac{\sum_{j=1}^{n}Z_{ij}^{k}}{\sum_{i=1}^{n}\sum_{j=1}^{n}Z_{ij}^{k}} \tag{15}$$

Where, $\sum_{j=1}^{n}Z_{ij}^{k}$ is the sum of the comparative values of index x_i, and $\sum_{i=1}^{n}\sum_{j=1}^{n}Z_{ij}^{k}$ is the sum of the comparative values of all indexes, which is calculated in combination with the evaluation of the importance of the index e_i by all experts:

$$e_i=\frac{\sum_{j=1}^{n}e_{ki}}{m} \tag{16}$$

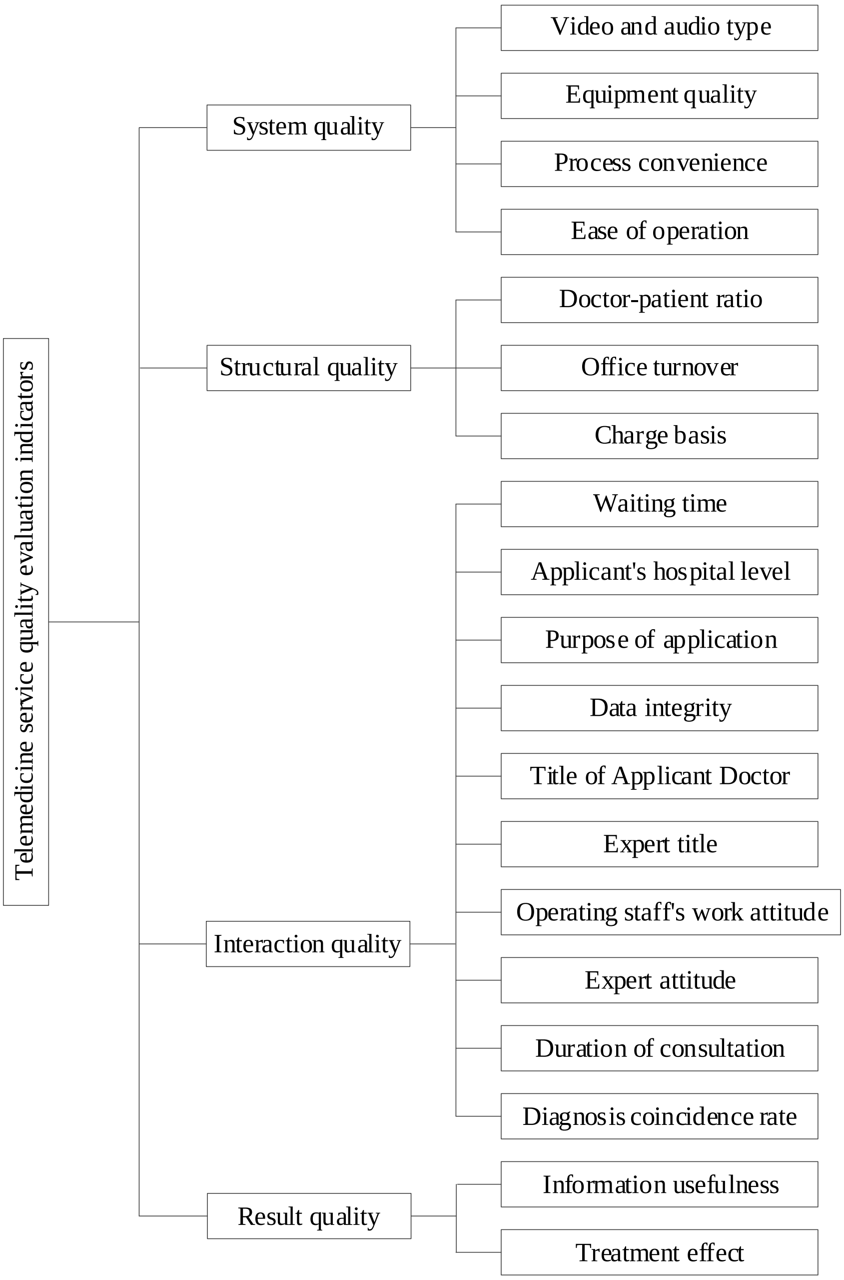


Figure 3. Telemedicine service quality evaluation index system

Objective weight

The proposed method uses entropy method [17-18] to calculate the survey data and objectively weight the indexes. Entropy represents the disorder degree of the system, which can measure the effective information of objective data and determine the weight of indexes. Determining the weight of the index is to reflect the discrimination degree of the evaluation object index from the perspective of index entropy. The smaller the entropy of the index is, the more orderly the data reflecting the index in the evaluation sample is, the greater the difference between the data values of the sample index is, the stronger the ability to distinguish the evaluation object is, and the greater the weight is[19]. Firstly, the entropy value of each index is calculated by entropy function, and then the entropy value is normalized to calculate the index weight.

1) There are m survey samples and n evaluation indexes, and x_{ij} represents the j -th evaluation index value of the i -th sample.

2) Normalization of index score. In some studies, the dimensions of indexes are different. To compare the

indexes under the same standard, the indexes need to be normalized. The absolute value of the indicator is converted to the relative value of the indicator. The normalization of indexes is processed as follows according to the characteristics of indexes:

Positive indexes:

$$x_{ij}^{'} = \{x_{ij} - \min[x_j, \cdots, x_{mj}]\} / \{\max[x_j, \cdots, x_{mj}] - \min[x_j, \cdots, x_{mj}]\} \tag{17}$$

Reverse indicator:

$$x_{ij}^{'} = \{\max[x_j, \cdots, x_{mj}] - x_{ij}\} / \{\max[x_j, \cdots, x_{mj}] - \min[x_j, \cdots, x_{mj}]\} \tag{18}$$

The normalized $x_{ij}^{'}$ is still recorded as x_{ij}.

3) Calculate the proportion of the i-th sample value in the index value under the j-th index:

$$a_{ij} = x_{ij} / \sum_{i=1}^{m} x_{ij} \tag{19}$$

4) Calculate the entropy of the j-th index:

$$r_j = -k \sum_{i=1}^{m} a_{ij} \ln(a_{ij}) \tag{20}$$

Where, $k = 1/\ln(m) > 0$, satisfying $r_j \geq 0$.

5) Calculate the information entropy difference:

$$fj = 1 - r_j \tag{21}$$

6) Calculate the weight of each index:

$$e_i = f_j / \sum_{j=1}^{n} f_j \tag{22}$$

Combined weight

Combined weight is the combination of subjective weight and objective weight in a certain way. The commonly used way is to combine subjective weight and objective weight through preference coefficient. The combination methods include addition combination method, multiplication normalization method, sum of squares of deviation method, game theory method and objective optimization method. The addition or multiplication normalization combination method adds the subjective and objective weights according to the same preference coefficient to obtain the combination weight or multiplies and normalizes to obtain the combination weight. This method is more convenient in calculation and more accurate than using subjective weight or objective weight alone. Therefore, the proposed method selects the way of additive combination to combine subjective weight and objective weight. The combined formula is as follows:

$$e_i = \frac{e_i^1 + e_i^2}{2} \tag{23}$$

Where, e_i^1 is the subjective weight and e_i^2 is the objective weight.

3.2. Model construction

Build a telemedicine service quality evaluation model based on the matter-element analysis model:

The basic domain model of the matter-element analysis model [20] is represented in the following form:

$$T(A,V,B) = \begin{bmatrix} & v_1 & b_1 \\ A & v_2 & b_2 \\ & \vdots & \vdots \\ & v_{18} & b_{18} \end{bmatrix} \tag{24}$$

Where: A is the characteristic value of the studied object; v_n is the characteristic of things; b_n is the corresponding eigenvalue.

The classical domain represents the basic interval of attribute change. The classical domain model is mainly used to determine the quality of medical service, and its expression is as follows:

$$T_{ej}(A_{ej}, V, B_{ej}) = \begin{bmatrix} & v_1 & b_{e1j} \\ A_{ej} & v_2 & b_{e2j} \\ & \vdots & \vdots \\ & v_{18} & b_{e18j} \end{bmatrix} = \begin{bmatrix} & v_1 & <s_{e1j}, n_{e1j}> \\ A_{ej} & v_2 & <s_{e2j}, n_{e2j}> \\ & \vdots & \vdots \\ & v_{18} & <s_{e18j}, n_{e18j}> \end{bmatrix} \tag{25}$$

Where, T_{ej} is the j-th matter-element; A_{ej} is j-th level service quality; b_{eij} represents the basic range of T_{ej} with respect to characteristic v_i, that is, the classical field, which is recorded as $b_{eij} =< s_{eij}, n_{eij} >$; $j = 1$ indicates excellent service quality; $j = 2$ indicates good service quality; $j = 3$ indicates good service quality; $j = 4$ indicates that the service quality is acceptable; $j = 5$ indicates average service quality.

The section field represents the range of all possible values under each level of service quality, and its expression is as follows:

$$T_p(A,V,B_p)=\begin{bmatrix} & v_1 & b_{p1} \\ A & v_2 & b_{p2} \\ & \vdots & \vdots \\ & v_{18} & b_{p18} \end{bmatrix}=\begin{bmatrix} & v_1 & <s_{p1},n_{p1}> \\ A & v_2 & <s_{p2},n_{p2}> \\ & \vdots & \vdots \\ & v_{18} & <s_{p18},n_{p18}> \end{bmatrix} \tag{26}$$

Where, A is all levels of service quality; b_{pi} is the value range of characteristic v_i, i.e. node field, marked as $b_{pi} =< s_{pi}, n_{pi} >$.

In the index system, the results of data measurement and analysis can be represented by matter-element, i.e., "matter-element to be evaluated", and the expression is as follows:

$$T_0(A_0,V,B)=\begin{bmatrix} & v_1 & b_1 \\ A_0 & v_2 & b_2 \\ & \vdots & \vdots \\ & v_{18} & b_{18} \end{bmatrix} \tag{27}$$

Extension sets are described by correlation functions. The value range of correlation function is the whole real number axis.

The application of correlation function in extension set can transform qualitative problems into quantitative problems. The calculation formula of correlation function value is as follows:

$$L_j(b_i)=\begin{cases} -\dfrac{\varsigma(b_i,b_{eij})}{|b_{eij}|} & b_i \in b_{eij} \\ \dfrac{\varsigma(b_i,b_{eij})}{\varsigma(b_i,b_{pi})-\varsigma(b_i,b_{eij})} & b_i \notin b_{eij} \end{cases} \tag{28}$$

Where

$$\begin{cases} \varsigma(b_i,b_{eij})=|b_i-\dfrac{(s_{eij}+n_{eij})}{2}|-\dfrac{(n_{eij}-s_{eij})}{2} \\ \varsigma(b_i,b_{pi})=|b_i-\dfrac{(s_{eij}+n_{pi})}{2}|-\dfrac{(n_{pi}-s_{eij})}{2} \end{cases} \tag{29}$$

The membership degree of medical service quality is calculated as follows:

$$L_j(A_0)=\sum_{i=1}^{18} e_{ij} L_j(b_i) \tag{30}$$

4. Experiment and discussion

In order to verify the overall effectiveness of the proposed model construction method, the following comparative experiments are designed to complete the performance test.

Comparative analysis of validity of different methods

Validity analysis: validity refers to the consistency and stability of test results. The reliability of evaluation indexes is mainly tested by Cronbach a coefficient. It is generally considered that Cronbach a value ≥ 0.7 belongs to high reliability, 0.35 ≤ Cronbach a value < 0.7 belongs to fair, and Cronbach a value ≤ 0.35 belongs to low reliability. The test methods are the research model, the core evaluation method of inpatient medical service quality based on value medicine proposed in reference [5], the comprehensive evaluation method of rehabilitation medical service quality of tertiary general hospitals proposed in reference [6], and the evaluation method of online medical community information service quality based on user perception proposed in reference [7]. The validity of different methods is tested by Cronbach a value. The test results are shown in Table 1.

By analyzing the data in Table 1, it can be seen that the Cronhach a value corresponding to the indexes selected by the evaluation model of telemedicine service quality based on machine sensing vision technology is higher than 0.7, indicating that the indexes selected by this method have high reliability, because the telemedicine service quality evaluation model based on machine sensing vision technology screens the evaluation indexes on the basis of language information evaluation, so as to select the key indexes and improve the Cronhach a value of the indexes.

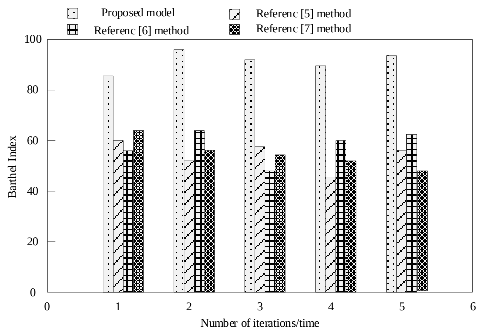
Barthel

The Barthel Index is a measure of the accuracy of the results of the assessment of the method. The Barthel Index is determined by the accuracy of the assessment of the quality of a range of medical services, with a total score of 0-100. A score of 0-20 indicates that the assessment result is seriously inaccurate, a score of 20-45 indicates that the assessment result is inaccurate, a score of 50-70 indicates that the assessment result is slightly inaccurate, and a score of 75-100 indicates that the assessment result is accurate.

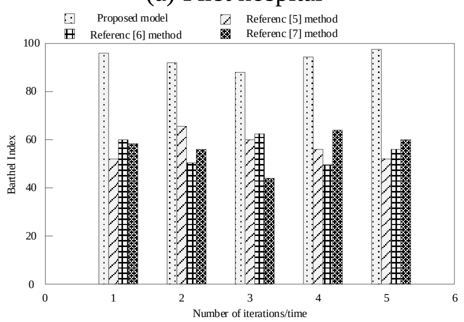
The two telemedicine services are evaluated by using the evaluation model of telemedicine service quality based on machine sensing vision technology, the methods of reference [5], reference [6] and reference [7]. The higher the Barthel index is, the more accurate the evaluation results of the method are. The test results are shown in Figure 4.

Table 1. Results of validity analysis

Primary index	Secondary index	Cronbach a value			
		Proposed model	Reference [5] method	Reference [6] method	Reference [7] method
System quality	Network type	0.81	0.69	0.71	0.75
	Video and audio type	0.82	0.58	0.72	0.71
	Equipment quality	0.79	0.62	0.74	0.63
	Convenient operation	0.88	0.63	0.69	0.66
Structural quality	Doctor patient ratio	0.75	0.63	0.67	0.70
	Consulting room turnover times	0.83	0.64	0.71	0.65
	Charging basis	0.87	0.57	0.66	0.70
Interaction quality	waiting time	0.83	0.67	0.70	0.63
	Applicant's hospital level	0.77	0.66	0.60	0.69
	Application purpose	0.79	0.69	0.65	0.68
	Data integrity	0.72	0.70	0.74	0.62
	Title of applicant's doctor	0.80	0.71	0.72	0.72
	Expert title	0.86	0.67	0.70	0.68
	Working attitude of operators	0.73	0.72	0.60	0.68
	Expert attitude	0.85	0.77	0.62	0.75
	Consultation duration	0.84	0.66	0.63	0.73
	Diagnostic coincidence rate	0.77	0.63	0.68	0.69
Treatment effect	Information usefulness	0.76	0.62	0.52	0.67
	treatment effect	0.79	0.72	0.67	0.70



(a) First hospital



(b) Second hospital

Figure 4. Barthel index test results

By analyzing Figure 3, it can be seen that during the testing process of the two hospitals, the Barthel index of the proposed method is higher than that of the methods in reference [5], reference [6] and reference [7], indicating that the accuracy of the evaluation results obtained by the proposed method in evaluating the quality of telemedicine service is high.

User satisfaction

The proposed method and the methods of reference [5], reference [6] and reference [7] are used to evaluate the quality of telemedicine service, and the satisfaction of different users with the evaluation results is compared. The test results are shown in Figure 5.

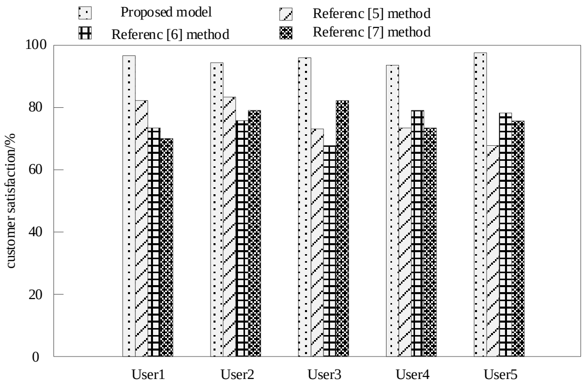


Figure 5. Results of user satisfaction test

The analysis of Figure 5 shows that the satisfaction of the five users with the proposed method is more than 90%, and the satisfaction of the users with the methods of reference [5], reference [6] and reference [7] is less than 90%, indicating that the proposed method has a good evaluation effect.

5. Conclusion

Due to the imbalance of overall development, the distribution of medical and health resources in China has been uneven for a long time, especially in the vast rural areas and remote border areas. Even the basic medical needs of some people are difficult to meet, and the problem of "Difficult and expensive medical treatment" is more prominent in these areas. As an effective technical means to adjust the layout of medical resources, the effective technical means of narrowing the regional medical service gap and integrating medical resources can effectively improve the remote grass-roots health and medical service capacity and promote the fair use of health and medical resources by urban and rural residents. At present, the evaluation method of telemedicine service quality has the problems of low evaluation accuracy and low user satisfaction. An evaluation model of telemedicine service quality based on machine sensing vision technology is proposed. This method uses the selected key evaluation indexes to build an evaluation model of telemedicine service quality based on the matter-element analysis model to complete the evaluation of medical service quality. It solves the problems existing in the current method and lays a foundation for the development of telemedicine service technology.

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