Design of Human Health Indicator Based on Internet of Things Technology

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Abstract: Health knowledge transmission and behavior intervention centered on disease treatment are the development direction in the field of health. The difficulty of individual health evaluation through the acquisition of health indicators lies in how to overcome the diversity of test population and the uncertainty in the evaluation process. According to the diversity of population samples, the anthropomorphic thinking mode decomposes the human health assessment system into two levels: decision-making and assessment. Each level deals with different tasks in three stages: intelligent calculation, qualitative analysis and quantitative implementation. In the specific assessment method, human health assessment is studied as a multi-attribute assessment problem, and cloud model is used to realize the determination in the process of health assessment According to the medical prior knowledge, the standard evaluation cloud model based on the health indicators and the actual cloud model based on individual measurement are established. Through the definition and calculation of similarity, more scientific and objective evaluation results are obtained. The feasibility of this method is illustrated by the analysis of individual cases in the sample population, which expands a new way for the scientific evaluation of human health.

Analysis of Evaluation Indexes of Human Health

Through the description of the second chapter, we can use the dynamic change rate of body composition, body fat distribution and related indicators to evaluate the health status of human body. In this study, the parameters of population sample are decomposed into the exact combination of male (old, middle-aged, young) and female (old, middle-aged, young) population types, which have a significant impact on human health evaluation criteria; the evaluation indicators of human health are decomposed into different component factors according to the basic principle of AHP, forming a multi-level analysis structure model: the degree of human obesity(It is qualitatively characterized by the three element standards of body BMI, body fat content, fat distribution - defined as the ratio of fat / subcutaneous fat tissue in the abdomen of the human body), nutritional status (described by inorganic salt content, protein content), and change rate of human body status (described by the change rate of fat content, inorganic salt, and the sum of change rate of protein content), as shown in Figure 1.

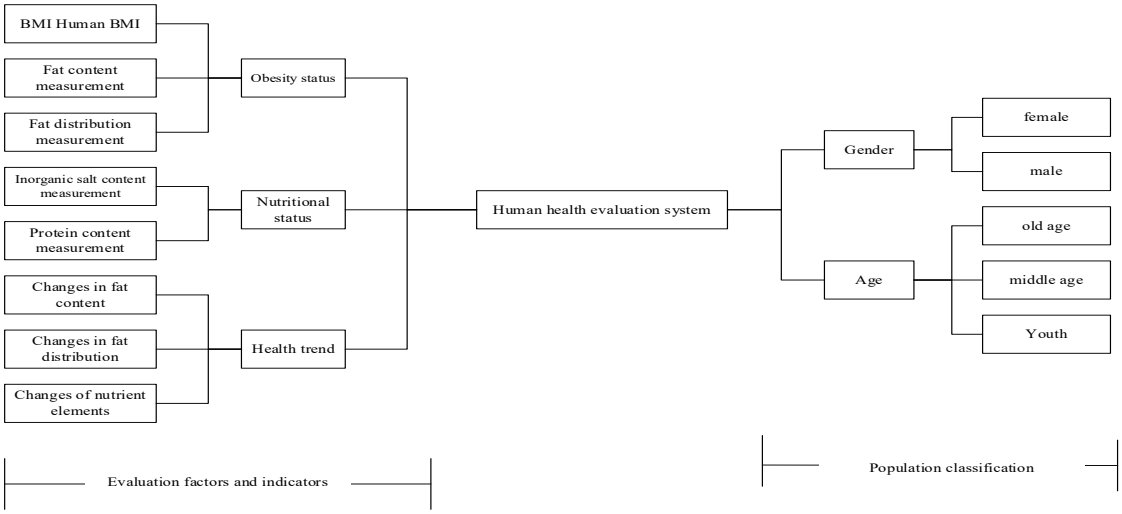

Figure 1. Structure graph of human health evaluation hierarchy analysis

It can be seen that there are many problems in the evaluation of human health status, such as the heterogeneity of the target population and the many health-related characteristics. At the same time, the evaluation needs to establish a anthropomorphic reasoning process, and the evaluation results should have human semantic information. The application of medical research results to machine health assessment can be regarded as a multi-attribute assessment problem involving multiple dimensions, different models, complex index systems and criteria.

Research on Multi-attribute Health Assessment Strategy Based on Cloud Model

Cloud Model Generator for Human Health Assessment. Cloud model theory is based on Statistical Mathematics and fuzzy mathematics. It describes the uncertainty transformation between a certain qualitative concept and quantitative numerical representation with linguistic value. With the development of research, cloud model has been applied in the fields of prediction, control, recognition and knowledge representation. The core content of cloud model can be regarded as the processing of uncertainty. It has not been reported that cloud model is used to evaluate human health. Based on the study of human health indicators and health evaluation methods, this paper uses cloud model theory and intelligent control idea to establish an intelligent evaluation system of human health.

In the process of human health evaluation, it is necessary to achieve the range and distribution of quantitative data from the qualitative language value information of health expression, and at the same time, it is also necessary to obtain the qualitative health state language value from the quantitative health index data. Through the forward cloud generator and the reverse cloud generator, we can realize the qualitative and quantitative mutual transformation in the process of health evaluation. At the same time, for the generation of cloud model of some health indicators, we need to define the uncertain information reverse cloud generator. The specific implementation process is as follows.

(1) The forward cloud generator algorithm used to convert qualitative language values of a health index state to quantitative data is as follows:

Input: Three digital eigenvaluesE_x, E_n, $H_e$and the number of cloud drop droplets N (the number of measurement indexes) representing the qualitative concept A of a health index state.

Output: N cloud droplets representing quantitative values of an index, and the certainty that each cloud droplet belongs to the qualitative concept A of a health state.

Step 1 To generate a normal random number E_n' with $E_n$as expected value and $H_e$as mean square error;

Step 2 To generate a normal random number x with $E_n$as expected value and abs(E_n')as mean square error;

Step 3 Set x as the specific quantitative value of the qualitative concept A, called cloud droplet;

Step 4 Calculate the y=exp[-$(x-E_x)^2/2(E_n')^2$];

Step 5 Set y as the certainty that x belongs to the qualitative concept A;

Step 6 {x,y} fully reflects all contents of qualitative and quantitative conversion;

Step 7 Repeat the above steps to produce N cloud droplets.

(2) In the process of health evaluation, the inverse cloud generator algorithm used to convert the quantitative value of a health index to the qualitative language value of its health state is as follows:

Input: The quantitative position of N cloud droplets representing a health index value in the space of the number field, and the certainty of each cloud droplet representing the concept of health.

Output: Expected value, entropy and superentropy of the qualitative concept of health state of the index, and the given number of cloud droplets of all health index values;

Step 1 Obtain $E_{\hat{x}}$ by fitting the known cloud droplet with the cloud expectation curve equation $y=e^{-\frac{(x-E_x)^2}{2E_n^2}}$

Step 2 Remove the points with y>0.999, leaving m cloud droplets

Step 3 Obtain E_n' from $E_n'=\frac{|x-E_x|}{\sqrt{-2\ln y}}$

Step 4 Obtain $E\hat{n}$ according to $E\hat{n}=\sum_{i=1}^{m} E_n/m$

Step 5 Obtain $H\hat{e}$ according to $H\hat{e}=\sqrt{\sum_{i=1}^{m}(E_{n,}'-E_{\hat{n}})}/\sqrt{m-1}$

(3) It is difficult to get the certainty of some health indexes in the process of human health evaluation. How to build a reverse cloud generator without the certainty information so as to establish a one-dimensional cloud model corresponding to each health index attribute is a difficulty of research. In this paper, an inverse cloud generator without certain information is defined by calculating the mean, first-order center moment and variance of the sample points, as follows:

Input: A health index value of the obtained sample X_i, where i=1,2,…,n.

Output: Numerical characteristics of qualitative concept of the health state (E_x,E_n,H_e).

Specific steps:

Step 1 Calculate the mean value, first-order sample absolute center moment $\frac{1}{n}\sum_{i=1}^{n}|x_i-\bar{X}|$and the sample variance $S^2=\frac{1}{n-1}\sum_{i=1}^{n}(x_i-\bar{X})^2$;

Step2 $E_x=\bar{X}$;

Step3 $E_n=\sqrt{\frac{\pi}{2}}X\frac{1}{n}\sum_{i=1}^{n}|x_i-E_x|$;

Step4$H_e=\sqrt{S^2-E_n{}^2}$

Design of Layered and Segmented Intelligent Evaluation System

The human health evaluation system is a multi-tasking and complex system that involves multi-attribute evaluation process. It is difficult to apply the evaluation strategy in Figure 5-3 to all sample populations, and the input evaluation cannot be completed at one time in its implementation process. In this paper, by combining a layered hierarchical model and an expert system, a layered and segmented intelligent evaluation system is proposed specific to the requirements of human health monitoring. The structure is shown in Figure 2[112-113].

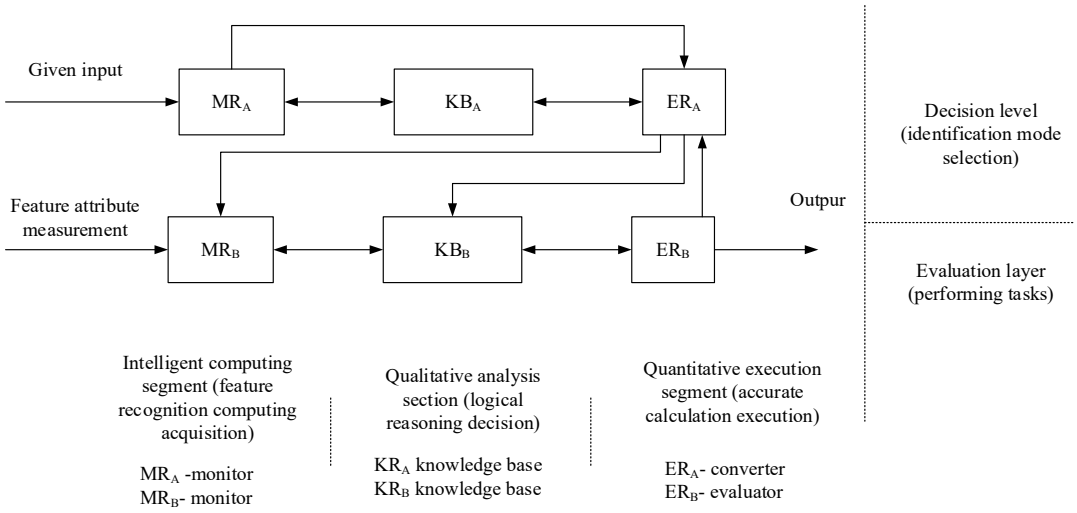

Figure 2. Two-Layer Three-Segment Intelligent Evaluation System

Establishment of Intelligent Evaluation System Model of Layered and Segmented Structure.

(1) Functional Mechanism

In the evaluation system based on the Internet of Things technology model, the evaluation process of the object is divided into two levels, namely, the decision-making layer and the evaluation layer. The decision-making layer solves the selection of strategies and parameter adjustment function for the multi-mode qualitative measurement and evaluation in the evaluation layer. The evaluation layer completes the specific measurement and evaluation function of the system.

1) The decision-making layer is oriented towards the evaluation strategy. The decision-making layer consists of MR_AKB_A and ER_A. The qualitative feature primitives of multi-evaluation modes of the object to be evaluated are obtained through the monitor MR_A. The knowledge base KB_A infers and decides the appropriate evaluation strategy for the evaluation layer based on prior knowledge, including the exact classification of the population, the selection of health evaluation expert database.

2) The evaluation layer is oriented to the evaluation objects. The evaluation layer consists of MR_B, KB_B and ER_B. According to the measurement and evaluation strategy, the type and parameter of multi-evaluation model selected by the decision-making layer, the monitor improves the characteristics of multi-evaluation model required for measurement and evaluation with corresponding methods, including the body fat content, visceral fat area, body composition analysis, height, blood pressure, etc. The real-time evaluation of the object to be measured is performed according to the prior knowledge of the knowledge base KB_B.

(2) Operating Mechanism

1) Hierarchical decision-making and execution: By imitating the macro-structural functions and micro-executive functions of human thinking, the evaluation tasks are divided into two layers of decision-making and evaluation, a parallel coupling structure. The decision-making layer is used to complete the conversion of qualitative and quantitative evaluation and strategy selection, and the evaluation layer completes the execution of evaluation.

2) Segmented qualitative and quantitative: In the real-time multi-mode observation and evaluation, the selection of the mode and the implementation of the corresponding mode are different stages of the problem, the qualitative segmentation of the reasoning decision function and the quantitative segmentation of the method and means function are organically combined.

3) Mapping mechanism: The characteristic data-driven reasoning mode of the decision process is (IF…THEN…). The first level is the heuristic intuitive reasoning that imitates people, If (inputting the characteristic mode of the information then (output evaluation mode); the second level is the data-driven logical reasoning that imitates people, If (output evaluation mode and memory information) Then (output the information of evaluation results).

This model combines the layered hierarchical and expert system models to establish an uncertainty conversion model between qualitative concepts and quantitative domain. It integrates the ambiguity and randomness of subjective cognition, and takes into account the semantic clarity of satisfaction qualitative representation and the precision of quantitative representation, which can better achieve an objective evaluation of the level of human health state.

Design of Human Health Cloud Model Evaluation System Based on Internet of Things Technology. The human body electrical impedance measurement technology is used to measure the body composition and abdominal fat. The above model is established for the human health evaluation process by classifying the population to be evaluated and combining existing medical results.

(1) Decision-making layer: It performs task allocation, completes decision-making information acquisition and evaluation mode conversion based on the population information input and the results returned by the evaluation layer. The three specific functions are defined as follows:

1) Monitor (MR_A): It selects the evaluation mode based on the characteristic information of the population input in the system and sends the mode into the evaluation device. The operation of the crow characteristic space S of the evaluation object is defined as:

$$S=P\otimes B \tag{1}$$

In the general form, S in the equation is an n-dimensional vector, B is an m-dimensional vector, P= $[p_{ij}]_{n\times m}$order relation matrix, p_{ij} can take (negative, zero and positive), and the symbol $\otimes$ represents a matrix multiplication relationship of "AND", i.e.

$$m_i=[(p_{i1}\cdot b_1)\cap(p_{i2}\cdot b_2)\cap L\cap(p_{im}\cdot b_m)]\text{i=1,2,…,n} \tag{2}$$

10100

10010

10001

For the health evaluation system, take P as 01100, and B as $[B_1^T, B_2^T]$

0 1 0 1 0

0 1 0 0 1

According to the Eq.1 and Eq.2, the population characteristic of the test subject is one of (young men, young women, middle-aged men, middle-aged women, old men and old women), which is mapped to knowledge base of the decision-making layer for selecting an evaluation model.

2) Knowledge base (kbua): using the positive cloud generator to construct the evaluation expert knowledge base through the existing medical results, that is to form the evaluation standard cloud model.

The establishment of the standard cloud model of health evaluation is based on the existing medical achievements, and establishes the reverse cloud evaluation model for the three attributes of obesity, nutrition and health trend. The attribute set and evaluation set of the health evaluation standard model of each attribute are as follows.

a. Evaluation cloud model of obesity status standard: according to the current medical research results, the degree of obesity is expressed by three parameters: BMI index, fat content and fat distribution.

b. Evaluation cloud model of nutritional status standard: according to prior knowledge and current development of bioelectrical impedance technology, inorganic salt content

And protein content as attributes of human nutritional status.

c. Change trend of human health: take one week as the time particle, compare the health indicators of human body, and pass the time product

Tired, granulate the indicators, and predict the trend of human health status through learning.

3) Converter (er a): complete the conversion between the decision-making layer and the evaluation layer, output the decision-making information of the decision-making layer to the evaluation layer, for the selection of the health evaluation expert database, and receive the input information of the monitor Mr A and the evaluation information fed back by the evaluation layer

To the knowledge base of decision-making level.

(2) Evaluation layer

Carry out specific measurement and evaluation, get specific evaluation attribute value through the measurement and analysis of monitor Mr □ B, and send it to knowledge base KB □ B,

And feedback to the decision-making level, output the evaluation results, and carry out physical health evaluation. Three specific functions are defined as follows:

1) Monitor (MB? B): according to the decision-making information of the decision-making level, obtain the relevant health index information through the bioelectrical impedance measuring instrument, including the body composition, visceral fat, index change rate, etc., and send the results to the knowledge base for evaluation.

2) KB (knowledge base): establish a multi-attribute decision-making model of the actual cloud model, use less qualitative information to quantify the evaluation process, and provide a simple method for multi-objective and multi criteria human health evaluation. See the example section in the next section for the establishment process of the specific cloud model.

3) Er? B: complete the conversion between the decision-making layer and the evaluation layer, feedback the information to the decision-making layer in the evaluation process, and output the evaluation results at the end of the evaluation. During the evaluation process, the evaluator Er output evaluation system feeds back the current system status to Er a of the decision-making layer according to the output information of knowledge base KB; when the evaluation system is in the end state, the final evaluation result is output according to knowledge base KB.

Conclusion

Human health assessment is one of the main contents of this research. Aiming at the problems such as many influencing factors, heterogeneous population samples, and huge evaluation data in the process of human health assessment, the human health assessment system is divided into two levels: decision-making, assessment, which processes different tasks in three stages: intelligent calculation, qualitative analysis and quantitative execution. The main goal of the study is not to put on the mathematical model of object pattern recognition, but to establish the knowledge model of the combination of qualitative and quantitative characteristics of the tested object pattern model, which solves the problem of complex task and difficult modeling in human health assessment. In the specific evaluation process, the multi-attribute group decision cloud model analysis method based on natural language is given. Firstly, the standard cloud model based on the health evaluation index attribute and natural language comment is established. According to the measured actual tester index, the personal attribute actual and model are established. Through the definition of similarity, the tester's health comment is obtained. To a certain extent, the evaluation method objectively expresses the fuzziness and randomness of decision information in health evaluation, and shows that natural language always expresses this and that in qualitative way. Through case analysis, the feasibility of this method is illustrated, and a new method for solving this kind of problems is proposed.

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