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Comprehensive Evaluation of the Designing Scheme of Remote Students Practice Project by AHP Method

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Abstract

We fully study the various factor indexes involved, use the AHP to build an integrated-assessed mathematic model of hierarchy of good distinct and structure of high efficiency and calculate the weight assessment indicator of each hierarchy. This paper uses AHP to build the general objective function of the designing scheme of students practice property. By the statistical analysis of the tip of various property indexes of mass property data, we choose the corresponding subordinating degree functions in the fuzzy mathematic field to determine the appropriate subjection function, calculate the relevant degree of membership, and finally conduct the integrated assessment of mathematic model of the design of remote students practice system. The paper uses C# language in the developing environment of VS2010 to develop the fuzzy-comprehensive-assessment software system of the designing scheme of students, and, we also use the software to analysis the systematic reliability of this scheme by living example. Through this work, we could offer a scientific and rational theory of technology to students for the support of remote Students practice projects research department.

Keywords*: Fuzzy evaluation method, AHP, Students practice; Software system*

1. Introduction

Remote students practice project is a small recyclable reused carrier to students, which can have a long period of time to operations. From the point of development trend, in information warfare of the future, remote aircraft will play a very important role, mainly using for the environment detection, electronic jamming, intelligence, surveillance and reconnaissance, warfare, *etc*. [1].

In recent years, remote craft research is in the launch, and has made significant achievements in some respects. But we have always been the lack of guidance of the theoretical system in the design of remote aircraft, which is worth exploring. Complex Student practices have complex process and strong randomness. Therefore, this article uses fuzzy comprehensive evaluation based on AHP. For all kinds of factors that Students practice design refer to ,using the theory and methods of system science, this paper scientifically filters involved evaluation indicators, sets up a comparatively perfect Students design of practice indicators evaluation system, and carries respectively from three aspects that is the overall characteristics, Students and concealment practice on the fuzzy comprehensive evaluation on the basis of AHP method and fuzzy mathematic ,which can strive for constructing the students training more objectively and correctly.

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2. AHP and Fuzzy Comprehensive Evaluation

2.1. Principle of AHP

Analytic hierarchy process, called AHP for short, is a systematic and hierarchical analytical method of combination of determining the nature and quantify. Basic steps are as follows: First of all we classify the actual problem for involved the factors to set up the hierarchy structure model; then we construct pairwise comparison matrix to determine the relative importance; Finally we calculate weight vector and check consistency to get the weight of each level factors for the relevant levels [2].

2.2. Theory of Fuzzy System

The theory of fuzzy system is generally spread theory, which was created by control theory expert, Zdahe, who is from University of California, the United States in 1965. This theory can describe the concept of fuzzy phenomena without clear boundaries and extension. By using these uncertain phenomenon and the membership function, it establish one to one corresponding relation, which can be used to analyze many inexact fuzzy phenomena in nature with favorable mathematical tool.

2.3. Fuzzy Concept

In ordinary set theory, one object and its set of relation can be defined, either in the set, or not in the set, there is no other situation, that is to say, the ordinary set theory can only say "either / or" phenomenon. However, in real life, there are some common concepts, such as: the middle-aged people and young people, the meaning of these concepts is not exact and clear, we put this concept as fuzzy concept. Usually people in order to deal with the natural phenomenon, the concept that they formed in their brains are often fuzzy concept, moreover, the judgment and reasoning of the concept is also fuzzy.

2.4. Fuzzy Set

The fuzzy set is the method of representing fuzzy concept, it is an extension of ordinary set theory: among the ordinary set, the degree of membership for element u in set$A$ has only two values, namely 0 and 1. While fuzzy set can expand the degree of membership for element u in set$A$ from 0 or 1 to the expansion of [0, l].

3. The Determination Method of Subjective Weight Coefficient

Using AHP to determine the subjective weights of evaluation indexes, the main steps are as follows:

Constructing judgment matrix, scaling method for evaluation of each factor to carry on the assignment, the importance of the judgment j matrix of structure are as follows:

The sheer level and a consistency check of judgment matrix. as the largest of judgment matrix eigenvalue and eigenvector, and carries on the satisfaction degree of validation. The calculation steps are following:

Calculated judgment matrix product of all the elements:

$$m_i = \prod_{i=1}^{n} b_{ij} \quad i = 1,2,\cdots,n$$

The Nth root:

$$\varpi_i = \sqrt[n]{m_i} \quad (i = 1,2,\cdots,n)$$

On vector normalization processing

$$\varpi = \left(\varpi_1, \varpi_2, \cdots, \varpi_n \right)^T,$$

That is, to the desires of feature vector:

$$\omega_i = \frac{\varpi_i}{\sum_{j=1}^{n} \varpi_j} \quad i = 1,2, \cdots, n$$

Calculate the maximum characteristic root matrix:

$$\lambda_{\max} : \lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(A\omega)_i}{\omega_i}$$

Consistency check of judgment matrix, namely $CR = CI/RI$, Among them, $CI = \frac{\lambda_{\max} - n}{n - 1}$, When $CR < 0.10$, the judgment matrix is satisfied consistency, otherwise we need readjust the element values.

Hierarchy total ordering. That needs to compute synthetic weight of each factor on the system ‘s overall goal, to determine the relative importance that all the factors of A-layer have for the system overall goal-A layer. This process has been run from the top layer to the bottom layer.

The method of determining the coefficients of objective weight. Entropy weight is a kind of objective method of endow with weight, namely to determine the index weight according to relative degree of change about the index's influence on the overall system , greater degree of relative change means larger weights of indicators[3]. The main steps of using Entropy weight to give weight are as follows:

The original matrix. Index of comprehensive evaluation of a sample about m , a problem about n index, the formation of the original matrix are formatted as follows:

$$X = \left\{ x_{ij} \right\}_{m \times n} \left(0 \le i \le m, 0 \le j \le n \right)$$

Index normalized processing. Since the dimension and the order of the magnitude of each indicator has certain differences, we have to eliminate the influences of different dimensions on the evaluation result, so it is necessary to standardize various indicators.

$$x'_{ij} = \begin{cases} \dfrac{x_j - x_{\min}}{x_{\max} - x_{\min}} - A \\ \dfrac{x_{\max} - x_j}{x_{\max} - x_{\min}} - B \end{cases}$$

Index after normalization treatment, the matrix proportion is as follows:

$$Y = \left\{ \frac{x'_{ij}}{\sum_{i=1}^{m} x'_{ij}} \right\} \left(0 \le i \le m, 0 \le j \le n \right)$$

Calculation index information entropy and information utility value. The first item index j of information entropy value is:

$$e_j = -k \sum_{i=1}^{m} y_{ij} \ln y_{ij} \left(k = 1/\ln m \right)$$

Information utility value depends on the difference in value between 1and the index of information entropy e_j . Its computation formula is:

$$dj = 1 - e_i$$

Calculation entropy of index. The entropy value of the j item parameter values is defined as weight:

$$\omega_j = \frac{d_j}{\sum_{i=1}^{m} d_j}$$

First of all, Dividing factor set $U= \{u1, u2, ..., um\}ui, i=1, 2, ..., m$ into subset $Ui=\{Si1, Si2, S..., Sin\}i=1, 2, ..., S$ according to some properties so as to meet the conditions:

$$\sum_{i=1}^{s} U_i = Sin ; \bigcup_{i=1}^{s} Ui ; U i \cap Ui = \phi ,(i \neq j)$$

Then making a comprehensive evaluation on each factor set. If the evaluation result set $V=\{v1, v2, ..., vn\}vj, j=1, 2, ..., n, i=1, 2, ...,$ Then,the distribution of the weight of n is:

$$W=\{w_{i1}, w_{i2}, ..., w_{in}\}i, 1, 2, ..., n$$

Among them $\sum_{i=1}^{s} Win = 1 ,0 \leq Win \leq 1$. If Ri is the single factor evaluation matrix, then we will get a vector:

$$Bi=Wi\ Ri=(bi1, bi2, ...bim)\ i=1, 2, ..., s$$

Then taking each Ui as a factor, $\mu=\triangle\{U1, U2, ..., Un\}$, Thus, μ is a set of factor, the single factor evaluation matrix of μ is:

$$R_j = \begin{bmatrix} B_1 \\ B_2 \\ \cdots \\ B_3 \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & \cdots & B_{1m} \\ B_{21} & B_{22} & \cdots & B_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ B_{s1} & B_{s2} & \cdots & B_{sm} \end{bmatrix}$$

Each Ui is a part of U, which can reflect an attribute of U, it can be assigned according to the importance of the weight of $Wj=\{wj1, wj2,... Wjn\}j=1, 2, ...m$, therefore, we can get two grade evaluation vector:

$$Bj=Wj \circ R\,j=(Bj1,Bj2,...,Bjn)$$

If each factor set Ui contains more factors, then it can be further decomposed till it becomes three model, four model and so on.Establishing a hierarchy structure model, as shown in fig. 1.

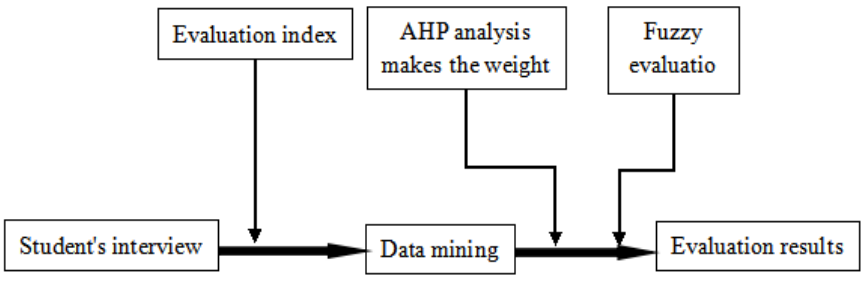

Figure 1. The Overall Structure of Evaluation on Student's Practice Situation and Practice based on AHP Fuzzy Theory

The Principle of Fuzzy Comprehensive Evaluation. Fuzzy comprehensive evaluation method is a comprehensive evaluation method based on fuzzy mathematics. According to membership theory of the fuzzy mathematics, the method translates the qualitative

evaluation into quantitative evaluation, which uses fuzzy mathematics to make an overall evaluation for things or object that subject to many factors. It results clearly and is very systematic, which can well solve the fuzzy problems, suitable for all kinds of uncertain problems to solve [4].

Establish the system of evaluation index. The key of affecting the establishment of the fuzzy index of designing students practice is how to accurately identify indicative conceptual model. The selection of indicators should be systematic, comparability, scientific, practicability and maneuverability, which ensure the accuracy and objectivity of evaluation results. The of design students practice practice is a complex and large system, which includes the complex and changing factors of hardware, software, and environment [5]. Based on this, through repeated consultants, drawing on the knowledge and experience of experts, we construct the appraised system of Students practice indicators shown in Figure 1 on the basis of the systematic analysis of Students practice design [6,7].(1first indicator, 16 second indicators ,4 three indicators).

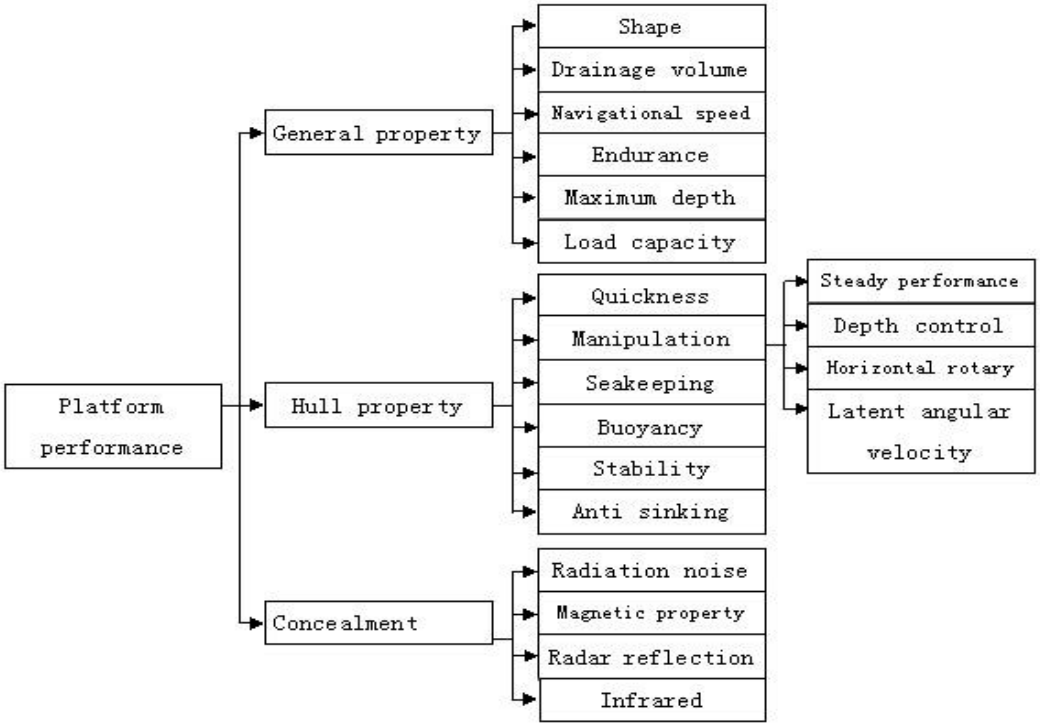

Figure 2. System of Students Practice Evaluation

Determining the weights of the evaluation. In the multi-index comprehensive evaluation, the determination of weight is one of the most basic and most important work[8]. Weight value directly affects the result of comprehensive evaluation, and the change of weight value may lead to change the order of the quality of evaluation object. Therefore, it is important to scientifically determine the position of the index weight in multi-index comprehensive evaluation system. Based on Students design practice evaluation system listed in Figure 2, we use the principle of AHP to determine all levels of index weight.

Weight calculation of each index Students practice evaluation system design system can generally be divided into the following three steps:

(1) Compare the same level of importance of each element to the previous level in a pairwise comparison criterion, and construct pairwise comparison judgment matrix *(P_i, Q_i, R_i)*. Use scale method to show in the process of judgment, which is specified in Table 1.

Table 1. The Scale Table

scale	significance
1	two factors have the same importance
3	a factor is more important to another slightly
5	a factor is more important to another clearly
7	a factor is more important to another strongly
9	a factor is more important to another extremely
2,4,6,8	mid-value of two adjacent judgment
reciprocal	Compare factor *i* to *j* to get the judge b_{ij}, inversely get $b_{ji=1/}b_{ij}$

(2) By the judgment matrix (P, Q_1, Q_2, Q_3, R), use the method of sum and Product to calculate the eigenvector of all levels of index judgment matrix (index weight).

The first layer index weight vector $B = (b_1, b_2, b_3)$;

The second index weight vector $C_1 = (c1_1, c1_2, c1_3, c1_4, c1_5, c1_6)$, $C_2 = (c2_1, c2_2, c2_3, c2_4, c2_5, c2_6)$, $C_3 = (c3_1, c3_2, c3_3, c3_4)$;

The third layer index weight $D = (d_1, d_2, d_3, d_4)$;

(3) Consistency checking .Consistency includes absolute consistency (or complete consistency) and order. So-called absolute consistency is that in judgment matrix *A*, if it satisfies:

$$a_{ij} = a_{ik} \bullet a_{jk} \tag{1}$$

then A is absolutely consistency matrix (or completely consistency matrix), while there is:

$$a_{ij} = W_i/W_j \tag{2}$$

$$AW = nW \tag{3}$$

Sort consistency means: If the factor A is more important than factor B, factor B more important than factor C, then A should be more important than C. And the C.I. table of consistency test indicators is expressed as follows:

$$C.I.=(\lambda_{max}-n)/(n-1). \tag{4}$$

Above it: n is the order of the judgment matrix *A*, and λmax is the largest eigenvalue of the judgment matrix *A*.

Calculate the consistency ratio *C.R.*:

$$C.R.=C.I./R.I. \tag{5}$$

Above it: *R.I.* is the average random consistency index, which is the correction factor of *C.I.* and *R.I.* values is shown in Table 2.

Table 2. Average Random Consistency Index *R.I.*

The order of matrix	*R.I.*	The order of matrix	*R.I.*
1	0	6	1.26
2	0	7	1.36
3	0.52	8	1.41
4	0.89	9	1.46
5	1.12	10	1.49

When CR<0.1, it is considered that the consistency of judgment matrix is acceptable.

4. The Assessment of Fuzzy Comprehensive Evaluation based on AHP

This paper adopts fuzzy distributing as the method of determining the membership function .Through counting and analyzing a lot of Students data for the last layer factors of each practice index, we select the corresponding membership function in fuzzy mathematics to fit, determine the corresponding membership functions, and calculate relative membership degree.

Evaluation process is divided into three steps.

The first step:

By the third grade of membership function, we get the membership vector $Z = (z_1 , z_2 , z_3 , z_4)$.Calculate a second-level single factor fuzzy evaluation to determine the membership value y8 of second stage factor for the third stage, and method is:

$$y_8 = D \bullet Z = (d_1, d_2, d_3, d_4) \bullet (z_1 , z_2 , z_3 , z_4) \tag{6}$$

The second step:

Through the membership function ,we calculate and get of the second stage membership vecto$Y_1 = (y_1 , y_2 , y_3 , y_4 , y_5 , y_6)$,$Y_2 = (y_7 , y_8 , y_9 , y_{10} , y_{11} , y_{12})$,$Y_3 = (y_{13} , y_{14} , y_{15} , y_{16})$.

We determine the membership value x_1 , x_2 , x_3 of first stage factor for the second stage by calculating, so that under the membership vector $X = (x_1 , x_2 , x_3)$, the method is:

$$x_1 = C_1 \bullet Y_1 = (c1_1, c1_2, c1_3, c1_4 , c1_5, c1_6) \bullet (y_1 , y_2 , y_3 , y_4 , y_5 , y_6) \tag{7}$$

$$x2 = C_2 Y_2 = (c2_1, c2_2, c2_3, c2_4, c2_5, c2_6) \bullet (y_7, y_8, y_9, y_{10}, y_{11}, y_{12}) \tag{8}$$

$$x3 = C_3 \bullet Y_3 = (c3_1, c3_2, c3_3 , c3_4) \bullet (y_{13} , y_{14} , y_{15} , y_{16}) \tag{9}$$

third step:

According to the specific score of evaluation level of each element , we get composite score of Students practice designing scheme , and the method is:

$$t = B \bullet X = (b_1 , b_2 , b_3) \bullet (x_1 , x_2 , x_3) \tag{10}$$

Through the above steps we can get comprehensive evaluation of remote aircraft students practice practice designing scheme. The value of t greater , shows that practice of the students practice designing scheme is better.

4.1. System Designing and Case Analyzing

First, we introduce Simply that VS2010 is a Microsoft software development students practice, and C # is a new object-oriented programming language pushed out by Microsoft's students practice .Since it is derived from the C and C++, so it has features of C + +, and is as simple as Visual Basic . C # uses VS2010 as its powerful students practice, making it get a wide range of applications in the Windows graphical interface.

4.2. Determining the Weights of Evaluation

According to the designing flow chart showed by figure 2, we can realize it using C # language on VS2010, and develop the corresponding fuzzy comprehensive evaluation system of students practice practice designing.

According to the requirements of the software interface arrangements, AHP and fuzzy evaluation method, we design interface shown in Figure 3.The interface mainly includes two aspects: Firstly, first grade, second grade, third grade weight setting and the design capacity offline value; second: assessment calculation to get the assessment results.

Specific steps are as follows:

Fill weight, design scope and design variables according to the requirements of import designing;

Clicking the button control to calculate, the software system will proceed to calculate according to the designing requirements to obtain Students practice designing evaluation results (upper left corner).

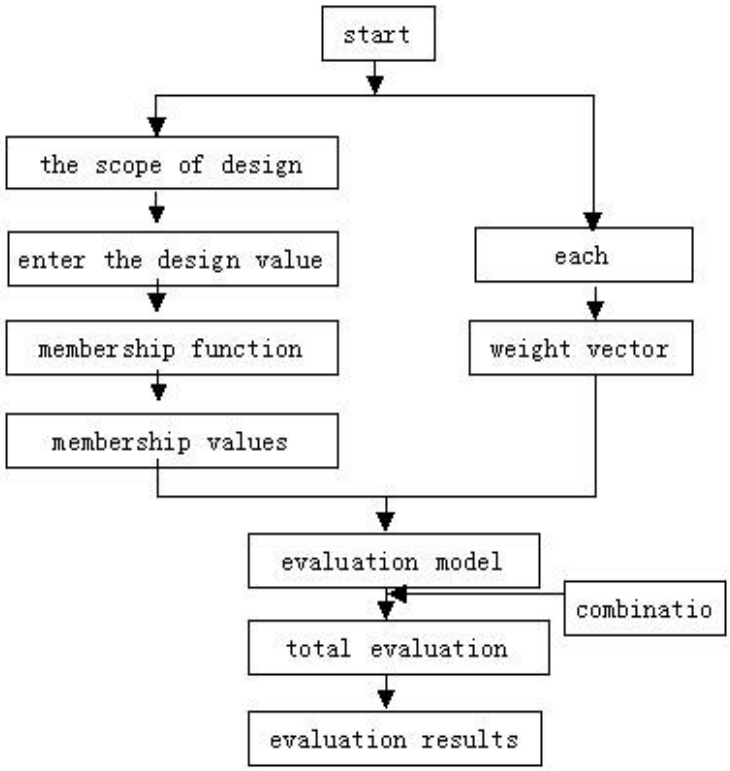

Figure 3. Designing Flow Chart

In recent years, the comprehensive fuzzy evaluation as a new method has got rapid development, its application scope is also expanding rapidly. The more complex things to make accurate and meaningful description, the more difficulty it will be increased, the description ability will be reduced at the same time. If it is beyond a certain threshold, the accurate feature and meaningful feature will repel each other. Generally speaking, the more complex the things are, the more fuzzy people's understanding will be, then it needs to use fuzzy mathematics at this time. The comprehensive fuzzy evaluation can give full consideration about the fuzziness of the complexity and the value system of the internal relationship, which can not only order the value of evaluation objects according to the comprehensive evaluation, but also can evaluate the object grade based on fuzzy evaluation set, in accordance with the principle of maximum degree of membership.

5. Conclusion

This paper comprehensively studies the integrated assessment of mathematic model of the design of Students practice system based on AHP, uses fuzzy evaluation method to construct students practice overall objective function ,and uses analytic hierarchy process to determine the weight of each subsystem . We choose the corresponding subordinating degree functions in the fuzzy mathematic field to determine the appropriate subjection function, calculate the relevant degree of membership, and finally use C# language to write the fuzzy-comprehensive-assessment software interface of the designing scheme of

students, which is a new method and technology system of comprehensive assessment of students system design.

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