Web-Oriented Software Reliability Measurement Model and Application

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***Abstract*—This article discusses a Web-oriented software reliability measurement evaluation system, including the major rating categories, software reliability attribute hierarchical structure model and evaluation method based on fuzzy comprehensive. This article proposes a Web-oriented software reliability model attribute hierarchy models based on existing software quality model and software credibility attribute model. In addition, in order to adapt to the credibility of the assessment software, this paper presents a dynamic Web-oriented software reliability evaluation system, establishing the credibility of an open target database based on the concept of the software reliability. Finally, this article evaluates Web software by applying this Web-oriented software reliability evaluation system. The results show that the model has strong validity, feasibility and adaptability.**

***Index Terms*—Software reliability, software trustiness, reliability attribute model, fuzzy comprehensive evaluation, AHP**

I. Introduction

The reliability of the software problem is authentic calculation of research in the field of one branch. In the modern society, almost all industries are inseparable from the complex software system and the software credibility problem has been the important focus in recent years.

About the software reliability, the Trusted Computing Group thinks: reliability is always in the way accordance with a goal of the expectations. ISO/IEC 15408 standard thinks: a trusted component, operation or the behavior of the process are predictable at any operating conditions, and well to resistance the application software, viruses and certain physical interference of the damage caused [3]. Microsoft's Bill Gates thinks trusted computing is a safe and reliable calculation in anytime, and including the degree human trust the computer, just like freedom and security to use electric power system and telephone [4]. WangHuaiMin defines the reliability as: if a software system behavior is always in line with expectations, and still can provide continuous service software when it is interference, that it can be called reliability software [7]. In this paper, I use the reliability definition of WangHuaiMin as a research model on the basis of software reliability measure, if the software system behavior always consistent with the expected, we call it the for software reliability.

Because the traditional software for web software has the very big difference in software development, software test, running environment and user experience, the existing software is not able to make effective evaluation for the web software. Based on this objective, this paper depending on some present software reliability measure model, gives a reliability measure model facing to the web, and takes some experiment .

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II. The Architectural Study of Web- Oriented Software Reliability Index Procedure for Paper Submission

A. The Hierarchy of Web-Oriented Software Reliability

It takes a method that divide 0-1 into five levels to express the quantization of the reliability relationship, the hierarchy as shown in Table I:

TABLE I: The Hierarchy of Reliability of Application Software

Level value	Level name	Describe	Level value	Level name	describe
0.00 ~ 0.25	Unable trust	It cannot be trusted	0.50 ~ 0.75	Middle trust	The degree of trust is ok
0.25 ~ 0.50	Low trust	The degree of trust is low	0.75~ 1.00	High trust	The degree of trust is high

B. The Attribute Structure of Web-Oriented Software Reliability

This paper is based on the definition of reliable software, the trusted computing organization, the national software product quality evaluation measure, software reliability classification standard [6], according to the software reliability attributes and quality standard, and considering the characteristics of the software for the web, such as the running environment, compatibility, easy to use, the user experience and so on in web software, summarizes the attribute structure of web-oriented software reliability.

The represent of level 1 and level 2 in reliability attribute structure as follows:

1) Usability: when the user in specific environment use the web software to complete the specific tasks, the effectiveness of the interaction process, customer satisfaction, software compatibility and so on.
2) Reliability: under the specified conditions, in the required time, the probability that the web software does not cause the system failure. Including level 2 attribute about reliability, the failure rate, tolerance.
3) Security: once system failure, it can make the result of environment damage (or loss) held in an able accept within the range of the probability. Including level 2 attribute about data confidentiality, the data security, conform to the standards.
4) Real-time: the capacity that software complete reaction or submit output within the time limit specified. Including level 2 attribute about web server software

response ability and time characteristics.

5) Maintainability: the system has the repair and upgrade ability itself. Including level 2 attribute about web easy test, web service and support, be able to be changed.

Survive: software can restore all the service in time under attack or failure in time. Including level 2 attribute about resistance against the aggression, recognition, self-improvement, easy to resume, load ability.

III. The Dynamic Web-Oriented Software Reliability Evaluation System

Because the software reliability is known of people in the different time and different perspectives, represent the different research purposes and research field. So it requires measure model can adapt to the needs of different software reliability, generality and evolution. Thus, this article summarizes a kind of software index system of the reliability of the dynamic structure model credible evaluation index system software. This paper define the model shown in Fig. 1, through the graphical user interface, user demand choice in light of their own or enter the required reliability index, refine step by step until gain direct of weighted index, manage to get a reliability evaluation of the software for measure tree.

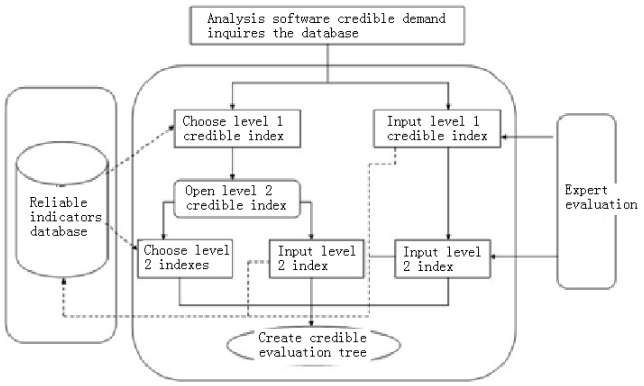

Fig. 1. The dynamic web- oriented software reliability evaluation system.

A. Comprehensive Evaluation Model Based on the Theory of Fuzzy

The evaluation of the software reliability itself has certain fuzziness, can't absolutely with "reliability" or "not reliability". It contains several properties and several evaluation index, respectively each index is showed as several measure atom. Based on this reason, a fuzzy comprehensive evaluation method for many factors is the characteristics of the overall evaluation system of a kind of effective method.

B. The Fuzzy Comprehensive Evaluation Method

The first level indexes collection facing the web software reliability evaluation are: $\mathrm{U} = \{U_1, U_2, U_3, U_4, U_5, U_6\}$; The first index *Ui*(*i*=1,2,3,4,5,6), and it has second indexes with number Ki, there are: $\mathrm{U_i} = \{u_{i1}, u_{i2}, ..., u_{uj}\}$ (*i*=1, 2, 3, 4, 5, 6; *j*=1, 2,… , *Ki*), *uij* is mean the j index.

IV. Level 2 Fuzzy Comprehensive Evaluation

According to the data and information collected or expert experience set of each factor uij for four comments levels of membership (*rij*1, *rij*2, *rij*3, *rij*4), the evaluation results of the factor Ki can show as *Ki*×4 order fuzzy matrix *Ri*.

1) for each of the factors uij *Ui* generation into the membership functions of the factors for four obtained membership degree credible level (*rij*1, *rij*2, *rij*3, *rij*4)
2) The results of the evaluation of a factor *Ki* available *Ki* * 4 order fuzzy matrix *Ri*:

$$\mathrm{Ri} = \begin{bmatrix} r_{i11} & r_{i12} & r_{i13} & r_{i14} \\ r_{i21} & r_{i22} & r_{i23} & r_{i24} \\ \cdots & \cdots & \cdots & \cdots \\ r_{ik_i1} & r_{ik_i2} & r_{ik_i3} & r_{ik_i4} \end{bmatrix} \tag{4.1}$$

$$\mathrm{B}i = w_i \circ R_i = (w_{i1}, w_{i2,}..., w_{i3}) \circ \begin{bmatrix} r_{i11} & r_{i12} & r_{i13} & r_{i14} \\ r_{i21} & r_{i22} & r_{i23} & r_{i24} \\ \cdots & \cdots & \cdots & \cdots \\ r_{ik_i1} & r_{ik_i2} & r_{ik_i3} & r_{ik_i4} \end{bmatrix} = (b_{i1,} b_{i2}, ..., b_{ik_i}) \tag{4.2}$$

Ri for one class index of the *Ui* fuzzy comprehensive evaluation of single factor evaluation matrix, which rijm said *uij* as credible level m (*m* = 1, 2, 3, 4) membership degree.

3) Using the AHP method for each uij *Ui* (*j* = 1, 2, 3, Ki) set the weight of *wi* = {*wi*1, *wi*2,... *Wiki*}
4) The Ui for the primary index fuzzy comprehensive evaluation matrix Bi.

Among them, the ∘ is Synthetic operation, Can use the fuzzy operator, not depending on actual situation and operation effect decision.

V. Level 1 Fuzzy Comprehensive Evaluation

Comprehensive evaluation of single factor evaluation matrix by one class index of fuzzy *R* judgment matrix (*Bi*, 2,3,4,5 *I* = 1, 6) constitute, repeat secondary fuzzy comprehensive evaluation 1)-4) process, have one class index fuzzy judgment matrix *Bi* = (*I* = 1, 2, 3, 4, 5, 6).

$$\mathrm{R} = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \\ B_6 \end{bmatrix} = \begin{bmatrix} A_1 \circ R_1 \\ A_2 \circ R_2 \\ A_3 \circ R_3 \\ A_4 \circ R_4 \\ A_5 \circ R_5 \\ A_6 \circ R_6 \end{bmatrix} = (b_{ik})_{6*4} \tag{5.1}$$

$$\mathrm{B} = W \circ R = (w_1, w_2, w_3, w_4, w_5, w_6) \circ \begin{bmatrix} A_1 \circ R_1 \\ A_2 \circ R_2 \\ A_3 \circ R_3 \\ A_4 \circ R_4 \\ A_5 \circ R_5 \\ A_6 \circ R_6 \end{bmatrix} = (b_1, b_2, b_3, b_4) \tag{5.2}$$

Using the AHP method again for the weights of evaluation factors level set *W* = {*w*1, *w*2 *w*3 *w*4-60 grabs *w*5,,,, *w*6} So secondary fuzzy comprehensive evaluation sets B:

Finally, according to the maximum membership degree or weighted average method to obtain the final evaluation results, the maximum membership degree is to point to, in the

final membership in the matrix, comprehensive index rating of which the membership degree is higher, so we will want to evaluate the goal as the evaluation level.

VI. Web-Oriented Software Reliability Measurement Model Application

This section mainly through an actual Web software project-farming reliability power-relevant credible attribute extraction and measure, use of this software credibility measure model, and thus get the software project for the credibility of the assessment, and validate the model of practical, adaptability and robustness.

A. North West Farming Reliability Power Credible Evaluation Attribute Hierarchical Structure

Based on the Web for the software credible attribute structure in this paper, evaluation person think following a few key level 1 and level 2 credible attributes can be used as the credibility of its dynamic evaluation index. Through evaluating the user defined, a credible evaluation tree is shown in Fig. 2.

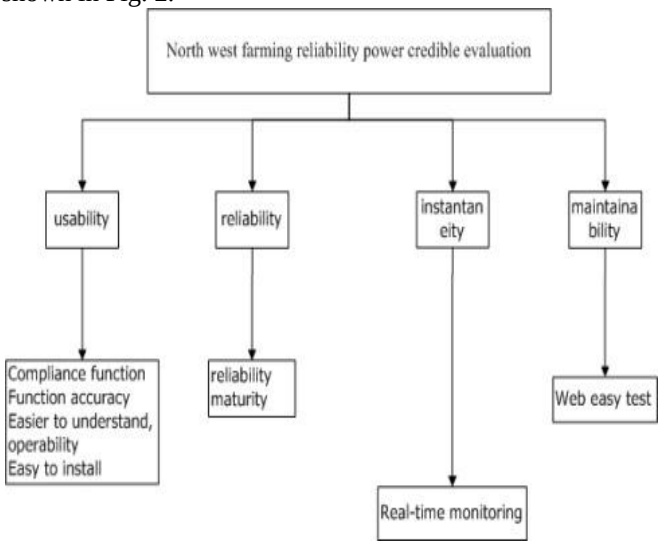

Fig. 2. Farming reliability power evaluation index tree structure

B. The AHP Method of Weight Matrix

Four credible attributes are used in the first index: usability, reliability, real-time, maintainability as an example. This paper use the Expert Choice which an open source tools to carry on the analysis, analysis procedure is as follows:

1) Evaluation person base on the software application scope, purpose, credible and fill in the actual situation of the primary attribute weights to compare the questionnaire.
2) Input the content of the questionnaire into the Expert Choice
3) Operation get level 1 credible index weight vector W = {0.573, 0.244, 0.94, 0.89}

Repeat the above steps 1) to 3), can continue to get each secondary indexes of credible the weights of attributes vector.

Usability level 2 index weight vector $w1$ = {0.339, 0.281, 0.164, 0.80}

Reliability level 2 index weight vector $w2$ = {0.547, 0.263, 0.190}.

C. Reliability Attribute Data Processing

In order to take usability testing for farming reliability power, has selected target users to a total of 10 of the software usability testing. We will divide test content into 22 tasks, to test the function point, by testers for testing. Through the test can get this 22 task completion, understood, and by the operating conditions. The following chart is the result of reliability attributes of farming reliability power, like the Fig. 3 shown:

Level 2 function index	Data	Explain
Compliance function	X=1.0*(1-4/22) = 0.818	There are four function points different with the requirement description in 22 function points
Function accuracy	X=1-3/22 =0.864	There are four function points with not correct explain in 22 function points
Easier to understand	$X=\sum_{i}^{10} p_i /220 *0.8$ = 0.669	Comprehensive 10 be tested persons understand the tasks
Handleability	$X=\sum_{i}^{10} O_i /220$ =0.818	Comprehensive 10 be tested persons understand the tasks
Installability	X=11/16=0.688	Workers attempt to install during the test, including successful 16 times for the installation of 11 times
Reliability	R(t)=13/20=0.650	System interval 13 times to work normally at specified time
Maturity	X=0.85	Through the open source software Emma test coverage
Real-time monitoring	X=890/1203 =0.740	In the testing process it has a total of 1203 times, including making a request to the server 890 times get success immediate response
Testability	X=62/162=0.383	In all, 162 test cases, there are 62 through the built-in test of the realization of the function

Fig. 3. the result of reliability attributes of farming reliability power

D. North West Farming Reliability Power Credibility Assessment

To level 2 index usability, for example, assessment procedure is as follows:

1) Constructing evaluation fuzzy matrix in this article, the trapezoid and half to determine the trapezoid subordinate function distribution. According to the software for Web rank credible, it can be concluded that the center of each class divide value. As shown in table 4.3.

   Put the usability four level 2 index measurement data generation into the membership functions, constructing the usability evaluation fuzzy matrix:

$$R_1 = \begin{bmatrix} 0 & 0 & 0.456 & 1 \\ 0 & 0 & 0.088 & 1 \\ 0 & 0 & 1 & 0.648 \\ 0 & 0 & 0.456 & 1 \\ 0 & 0 & 1 & 0.496 \end{bmatrix} \quad (6.1)$$

$$R'_1 = \begin{bmatrix} 0 & 0 & 0.313 & 0.687 \\ 0 & 0 & 0.081 & 0.919 \\ 0 & 0 & 0.607 & 0.393 \\ 0 & 0 & 0.313 & 0.687 \\ 0 & 0 & 0.668 & 0.332 \end{bmatrix} \quad (6.2)$$

2) The normalized get fuzzy matrix R '1:
3) Fuzzy matrix R '1 and usability w1 = {0.137, the weight of 0.164, 0.281, 0.339, 0.080} synthesis:

$$B_1 = w_1 \circ R'_1 = [0.137,0.164,0.281,0.339,0.080] \circ \begin{bmatrix} 0 & 0 & 0.313 & 0.687 \\ 0 & 0 & 0.081 & 0.919 \\ 0 & 0 & 0.607 & 0.393 \\ 0 & 0 & 0.313 & 0.687 \\ 0 & 0 & 0.668 & 0.332 \end{bmatrix}$$

$$= [0,0,0.313,0.339] \quad (6.3)$$

According to the maximum membership degree of usability metrics that is 0.339.

Repeat the above steps 1) to 3), can get reliability synthetic matrix for *B*2 = [0, 0, 0.556, 0.444], measurement data for 0.556, real-time measurement data for 0.740, maintainability metrics for 0.383.

Repeat step 1) to 3), with usability metrics data, reliability measure data, real time measurement data, and maintainability measurement data structure level fuzzy matrix, and with index level index weight vector synthesis, and ultimately the reliability evaluation vector for its power *I* = [0.740, 0.356, 0.566,]. According to the theory of fuzzy maximum subjection principle, we get the credibility of its dynamic evaluation index of 0.740. According to this paper defined for the Web software credible hierarchies, its power for the software reliability evaluation of for credible.

VII. Conclusion and Prospect

This paper introduces the present situation of research of reliability measure model, then summarizes a web software reliability measure model, including Web software for the credibility of the hierarchy, facing the Web software credible attribute hierarchical structure and based on the theory of fuzzy comprehensive evaluation method. In addition, in order to make the model more adaptable and robust, this paper summarizes the development of a dynamic credible index of the library. Finally, this article verifies the correctness of the model, the adaptability and operability.

The web attribute hierarchical structure software credible is not enough completely and it is needed to continue to revise. In a related Web software for the extraction and credible attribute data get enough is accurate, its measurement method, measurement accuracy would be further developed. For dynamic development credible index library was still on theory stage, the next step is to achieve its algorithm, rich the user interface, convenient the related software for measurements of credibility.

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