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Research on the safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables

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ABSTRACT

In this paper, we investigate the problems for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables. We utilize the interval grey linguistic weighted geometric (IGLWG) operator to aggregate the interval grey linguistic variables corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s). Finally, an illustrative example for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology is given.

KEYWORDS

Safety evaluation; Interval grey linguistic variables; Interval grey linguistic variables weighted geometric (IGLWG) operator; Virtual instrument testing technology.

INTRODUCTION

Virtual Instrument (VI) is a new concept which has been advanced by American National Instrument (NI) corporation firstly in the middle of eighth decade. The system of virtual instrument is a great breakthrough to traditional instrument, and which is the production of combination of computer and instrument system technology. In the system of VI, the computer's outer devices is usually used to provide a platform to the input & output of signal, computer is used to solve the problem of the signal real-time disposal and analysis, which is the key point of the whole instrument[1-3]. The advancement of the concept of Virtual Instrument brings the test technology into a new developing time. VI and basic system character test technology is regarded as the task's directional idea. With the development of science and technology, the requirement on measurement technology is getting more and more important. The application of electronic measurement technology has extended to more fields than before[4-5]. Due to limited functions and big size, traditional electronic measuring equipments are no longer suitable to common purposes. The rapid development of integrated circuit and computer technology gives birth to a new kind of instrument, Virtual Instrument (VI)[6-7]. As a result, the testing cost increases by a wide margin. In recently years, a new measure technology that combines the technology of electron, technology of computer, technology of network, is developed and this new technology is named VI. Especially various measuring instruments based on computer, they are more widely used because of their excellence such as: lower cost, easily used, etc[8-9]. It is based on PC platform, which make it convenient to use the software and hardware resources of PC and get the ability of data processing flexible[10]. With VI, a measure system can be easily built for different requirements. Actually, virtual instrument is an automatic measuring and testing instrumentation system based on computer. As the integration of computer technology and modern instrument technology, virtual instrument makes the revolutionary breakthrough in the measuring theory and technique of the conventional instrument. Virtual digital oscilloscope system includes signal acquisition, signal processing and output display. The signal acquisition is completed by hardware, the other are realized by software[11]. Virtual digital oscilloscope we designed consist data acquisition, wave display, frequency spectrum and wave storage modules. It has some merits which common oscilloscope doesn't have, such as saving wave as permanence data, sing data at any moment, real-time display and print wave, cost low, extending functions based on requirement of application. LabVIEW is the innovate software of National Instruments Corps. of America. It is also the most widely used, the most quickly developing and the strongest function graph software. It has short development period and fast run-rate. So LabVIEW is the best way of design virtual digital oscilloscope[12-13].

The problems for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables are the multiple attribute decision making problems[14-18]. The aim of this paper is to investigate the problems for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables. In this paper, we investigate the problems for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables. We utilize the interval grey linguistic weighted geometric (IGLWG) operator[19] to aggregate the interval grey linguistic variables corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s). Finally, an illustrative example for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology is given.

RESEARCH ON THE SAFETY EVALUATION OF ELECTROMECHANICAL EQUIPMENTS METAL STRUCTURES BASED ON THE VIRTUAL INSTRUMENT TESTING TECHNOLOGY WITH INTERVAL GREY LINGUISTIC VARIABLES

Electromechanical equipments, a fundamental factor of industry, is very important to make the operation of factories normal. At every stage of maintenance, electromechanical equipments must be

tested from various aspects in order to get the physical parameters. There are lots of defects of the electromechanical equipments testing system based on the traditional development platform, such as a long development cycle, a low degree of automation, compatibility and scalability, and a high cost. So, it is very necessary to build the electromechanical equipments testing system which is convenient, effective, compatible and friendly. LabVIEW, a virtual instrument software, which is powerful, low-cost and flexible, is developed by National Instruments Co. Ltd. for complex automated test and control. LabVIEW has unique advantages in the field of electromechanical equipments testing. The following assumptions or notations are used to represent the MADM problems for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables. Supposed that $\tilde{A}_{\otimes a_i}\left(x_j\right)=\left(s_{\alpha_{ij}},[g_{ij}^L,g_{ij}^U]\right)$ be the attribute value in the attribute set x_j with respect to the alternative a_i which given by experts and $R=\left(\tilde{A}_{\otimes a_i}\left(x_j\right)\right)_{m\times n}$ be the decision making matrix., $i=1,2,\cdots,m$, $j=1,2,\cdots,n$.

In the following, we apply the IGLWG operator for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables.

Step 1. Utilize the decision information given in the interval grey linguistic decision matrix $\tilde{R}$, and the IGLWG operator

$$z_i=IGLWG\left(\tilde{A}_{\otimes a_i}\left(x_1\right),\tilde{A}_{\otimes a_i}\left(x_2\right),\cdots,\tilde{A}_{\otimes a_i}\left(x_n\right)\right)$$

$$=\prod_{j=1}^{n}\left(\tilde{A}_{\otimes}\left(x_j\right)\right)^{\omega_j}$$

$$=\left(s_{\prod_{j=1}^{n}(\alpha_j)^{\omega_j}},\left[\left(1-\prod_{j=1}^{n}\left(1-g_j^L\right)\right),\left(1-\prod_{j=1}^{n}\left(1-g_j^U\right)\right)\right]\right),i=1,2,\cdots,m$$

to derive the overall interval grey linguistic variables $\tilde{r}_i$ of the alternative A_i, where $\omega=\left(\omega_1,\omega_2,\cdots,\omega_n\right)$ is the weighting vector of the IGLWG operator, with $\omega_j\in[0,1]$, $\sum_{j=1}^{n}\omega_j=1$.

Step 2. We rank the above the interval grey linguistic variables by using the method presented in Section 2. The ranking of the alternatives can be gained and the best one can be find out.

Step 3. End.

NUMERICAL EXAMPLE

The core idea of Virtual Instrument (shortened from VI) technology was making use of the powerful computer resources to convert hardware technique to software technique in order to furthest reduce the cost of system and improve system functions and system flexibility. The VI technology is spurring the testing technique growth on with nonreversible force. Therefore the advanced open system architecture and VI technology are introduced into the design of the testing systems, It has theory and practice value that study the open integrated testing system with open architecture modularized instruments and plug and play characteristics. The existed papers analyses the latest studying of open architecture and Virtual Instruments in testing system in the world firstly, for problems that the update of testing systems and the expansion of functions were much limited by centralized architecture, the paper studies open system architecture and VI technology deeply, accomplishes the design of the open integrated testing system based on VXIbus Instruments. This section presents a numerical example for

safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology to illustrate the method proposed in this paper. Suppose a company plans to evaluate the safety of electromechanical equipments metal structures based on the virtual instrument testing technology. There is a panel with three possible electromechanical equipments $A_i\left(i=1,2,3,4,5\right)$ to evaluate. The team of experts must take a decision according to the following five attributes: ①G_1 is the metal bearing capacity; ②G_2 is the crack of the metal; ③G_3 is the dynamic stress test of metal; ④G_4 is the static stress test of the metal; ⑤G_5 is the toughness of the metal. The three electromechanical equipments $A_i\left(i=1,2,3\right)$ are to be evaluated using the interval grey linguistic variables by the decision maker under the above five attributes whose weighting vector $\omega=\left(0.20,0.15,0.20,0.30,0.15\right)^T$), as listed in the following matrix which is shown in TABLE 1.

TABLE 1: Decision matrix

Electromechanical equipments	A_1	A_2	A_3
G_1	$\left(s_4,\left[0.5,0.6\right]\right)$	$\left(s_5,\left[0.6,0.7\right]\right)$	$\left(s_5,\left[0.3,0.4\right]\right)$
G_2	$\left(s_3,\left[0.2,0.4\right]\right)$	$\left(s_3,\left[0.3,0.4\right]\right)$	$\left(s_3,\left[0.4,0.5\right]\right)$
G_3	$\left(s_3,\left[0.4,0.5\right]\right)$	$\left(s_4,\left[0.1,0.2\right]\right)$	$\left(s_2,\left[0.3,0.4\right]\right)$
G_4	$\left(s_2,\left[0.3,0.5\right]\right)$	$\left(s_2,\left[0.4,0.5\right]\right)$	$\left(s_5,\left[0.5,0.6\right]\right)$
G_5	$\left(s_2,\left[0.3,0.6\right]\right)$	$\left(s_4,\left[0.3,0.4\right]\right)$	$\left(s_4,\left[0.5,0.6\right]\right)$

Then, we utilize the approach developed to evaluate the safety of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables.

Step 1. Utilize the decision information given in the interval grey linguistic decision matrix $\tilde{R}$, and the IGLWG operator to derive the overall values $\tilde{r}_i$ of the electromechanical equipments A_i

$$z_1=\left(s_{2.8},\left[0.3,0.5\right]\right);z_2=\left(s_{3.8},\left[0.4,0.5\right]5\right);z_3=\left(s_{4.7},\left[0.2,0.3\right]\right)$$

Step 2. We rank all the electromechanical equipments in accordance with the interval grey linguistic variables

$$Q\left(z_1\right)=s_{2.67},Q\left(z_2\right)=s_{5.34},Q\left(z_3\right)=s_{4.48}$$

Step 3. The ranking of the electromechanical equipments can be gained: $A_2\succ A_3\succ A_1$, A_2 is the best electromechanical equipment.

CONCLUSION

Virtual Instrument (VI) is a new concept which has been advanced by American National Instrument (NI) corporation firstly in the middle of eighth decade. The system of virtual instrument is a great breakthrough to traditional instrument, and which is the production of combination of computer and instrument system technology. In the system of VI, the computer's outer devices is usually used to provide a platform to the input & output of signal, computer is used to solve the problem of the signal real-time disposal and analysis, which is the key point of the whole instrument. Combining the successful applications in AI, other authors studied and designed a system for evaluating the safety of

hydraulic metal structures, whose goal is to compute the reliability of electromechanical equipments metal structures. By analyzing the accidents, other authors proposed a multi-levels, multi-goals architecture for evaluating the safety of hydraulic metal structures. Applying the techniques of AI, we design and make up a framework for evaluating the safety of hydraulic metal structures. In terms of the production systems, other authors represented the domain knowledge by ranking rules, constraint rules and suggestion rules. Method base is another important component of our system. Further, they discussed the module of inference. Based on the theory of relational database and designed and presented the conceptual and logical views of the database of our system. In this paper, we investigate the problems for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology with interval grey linguistic variables. We utilize the interval grey linguistic weighted geometric (IGLWG) operator to aggregate the interval grey linguistic variables corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s). Finally, an illustrative example for safety evaluation of electromechanical equipments metal structures based on the virtual instrument testing technology is given.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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