Automatic diagnostic system for the equipment on the basis of the theory of fuzzy sets

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Summary

The application of fuzzy set theory to create an automatic diagnostic system of technical equipment is considered

1 Problem Statement

Now in the modern equipment various systems of diagnostics are used. Application of technical diagnostic systems raises reliability and readiness of the equipment.

Principles of classical diagnostic systems are based on comparison of reference characteristics and real characteristics of the equipment received as a result of measurement of parameters. Analytical methods of diagnostic systems construction appear ineffective as, first, because of low accuracy of sensors of the operative information there is a big error of the measurement, received from objects of control, secondly, there is an ambiguity (uncertainty) between results of control and the faulty element which has caused malfunction as the modern equipment represents difficult system.

As a result acceptance by the operator of the objective decision on a condition of object of diagnostics appears inconvenient.

For a solution of a problem it is offered to use the theory of fuzzy sets. The theory of fuzzy sets is effective under following conditions

- high dimension of possible causes of defect that does inefficient search of all variants,
- incompleteness and likelihood character of relationships of cause and effect.

The basic advantages of application of indistinct logic consist in the following:

- substantial increase of speed of managerial processes;
- possibility of creation of control systems for the objects which algorithms of functioning are difficultly formalized by methods of traditional mathematics;
- decrease in probabilities of erroneous decisions at functioning of operating algorithms.

2 Fuzzy expert system

Expert System - a software product that allows to simulate the creative work of the expert specialist in making decisions, using on earlier experience.

Fuzzy expert systems are based on the theory of fuzzy sets, they work under the following conditions

- uncomplete, unclear, the probabilistic nature of initial data on the domain,

large dimension of the space of possible solutions, making it impossible to find a solution by trying all the options.

For the diagnosis of process equipment proposed fuzzy expert system to allow a diagn6ostiku in the "advisor".

For development of fuzzy expert system it is necessary to construct the indistinct attitude which substantially describes a situation of troubleshooting of the equipment. For this purpose the set of the reasons for defect X = (x_1, x_2, x_3 ... x_k) and set of displays of defect Y = (y_1, y_2, y_3, ... y_m) is entered. Between each element of sets X and Y there is a causal relationship.

Further function of an accessory $\omega(x_i, y_j)$ the indistinct attitude which quantitatively estimates a degree of confidence that this or that reason for defect can lead to this or that consequence pays off.

3 Example of diagnostics on the basis of fuzzy sets

Let's consider a virtual example of diagnostics of the radio sending device.

Set X = (x_1 – Breakage of one of blocks of the power supply, x_2 – Gain decrease of the amplifier, x_3 – Connection loss between blocks of the transmitter, x_4 – Condenser breakdown).

Set Y = (y_1 – The radio transmitter isn't started, y_2 – The radio transmitter works unstably, y_3 – The radio transmitter doesn't develop a total power).

The fuzzy relation of diagnostics looks like

Sets	y_1	y_2	y_3
x_1	0.1	0.2	0.5
x_2	0.1	0.1	0.8
x_3	0.7	1.	0.7
x_4	0.8	0.9	1

Table 1 1: Fuzzy relations

Using max-min a composition of binary relations [2], it is possible to receive that most a malfunction plausible reason is connection loss between blocks (probability 0.8).

The literature

[1] Stoeva S.P. A weight-learning algorithm for fuzzy production systems with weighting coefficients. - Fuzzy Sets and Systems, 48,1, 1992, 87 - 98.

[2] Михайленко В.С., Оженко Е.М. Экспертная система диагностики судового оборудования. Автоматизация судовых технических средств. Научно-технический сборник, вып.14, Одесса, 2008, 64-68.