THE DECISION OF THE PROBLEM OF INTELLECTUAL DIAGNOSING OF ASYNCHRONOUS ENGINES IN CONDITIONS OF UNCERTAINTY

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ABSTRACT

The application of methodology of expert systems to construction of system of intelligent diagnosing of faults of asynchronous engines has allowed to increase adequacy of the model of diagnostics of asynchronous engines at the expense of use of expert knowledge.

Ability of intelligent system to simulate a course of reasonings of the expert and to explain its actions, removes a psychological barrier of misunderstanding in a process of interaction betwein an end-user and the system.

Keywords: asynchronous engines, attributes of malfunctions, intelligent diagnosing system, base of knowledge, rule-production.

I. INTRODUCTION

As is known, there is a set of mathematical models diagnosing of malfunctions of asynchronous engines (AE) [1-3]. However their uses in real conditions frequently it happens it is complicated. In particular it concerns carrying out of checkup and repair the AE during which there is a problem of a realizability of models and necessities of their operative updating in view of the information of a feedback on an actual condition the AE. Thus it is necessary to collide with uncertainty of the purposes arising at aspiration to carry out simultaneously unattainable tasks land to necessity of increase of number of controllable parameters and the requirement of efficiency of diagnosing.

Besides as a result of influence of revolting factors, and also incompleteness and discrepancy of the initial information there are indistinctly certain basic information parameters (noise level, a level vibration, temperature of bearings, temperature of the case). In this connection employees of the technical control and line fault services in practice are inclined to use the own knowledge - rules of the decision based on their experience and intuition. Such heuristic rules though do not guarantee a mathematical optimality, but appear adequate to real conditions of manufacture and realize in practice.

In this direction the new approach to the decision of problems of diagnosing of malfunctions a AE, basing on the concept of indistinct sets of L.Zade [4] is offered, allowing to take into account such difficultly formalizable factors, as experience and intuition of the highly skilled specialist - expert.

II. ARCHITECTURE OF INTELLECTUAL DIAGNOSTIC SYSTEM THE AE

The intellectual diagnostic system the AE is realized on the basis of system of artificial intellect ESPLAN using the device of the theory of indistinct sets, allowing to receive the operative conclusions about technical diagnosis malfunctions the AE by refusal of traditional requirements to accuracy of the description of its functioning [5].

The architecture инетеллектуальной diagnostic system the AE is submitted on fig. 1, where BI and the PID-block of input and processing of the initial data; BD-base of data; BK-base of knowledge; BI and IK - block of input and interpretation of knowledge; SB-settlement block; ETC and BLC-estimation of a technical condition and the block of a logic conclusion; BE and DR-block of an explanation and delivery of the recommendation [6].

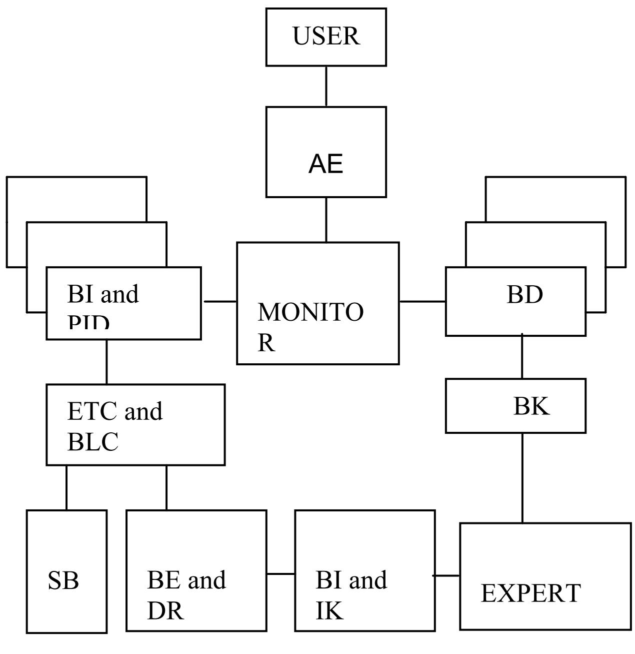

Fig.1.

III. THE FORM OF REPRESENTATION OF KNOWLEDGE IN SYSTEM

For input of knowledge in base of knowledge (BK) of intellectual diagnostic system language of representation of the knowledge, the AE taking into account specific feature are used. By development BK of intellectual diagnostic system it has been taken into account that:
The AE is described by set of malfunctions and attributes of malfunctions (AM); AM the AE-named елементы, essential to the AE (noise level, a level of vibration, temperature of bearings, temperature of the case, non-uniform distribution of temperature, a pulsation of amplitude of currents of phase sizes and so on);
AM can accept the values reflecting fixed conditions the AE, for example, object NOISE LEVEL -value 50 dB, object LEVEL OF VIBRATION - value 2.2 mm /s with. Values can also put on frills as linguistic terms: it is FEW, NORM, SUPREME, MORE_SUPREME, ALLOWABLE and that sort of thing; Values of linguistic variables can be computer-oriented, for example

DV = ((CVV - NVV)/ NVV) *100

where, the DV-deviation of voltage, CVV- current value of voltage, NVV-nominal value of voltage; and also production rule:

IF noise level = few
AND level of vibration = allowable
AND temperature of bearings = few
AND temperature of the case = few
THEN THE ENGINE WORKS NORMALLY

The formal model of knowledge in system is represented as follows. Let $W = \{\omega_1, \omega_2\}$ set of attributes of malfunctions in the AE. Each of attributes of malfunctions is characterized by a train

$$(\omega, n, d, 1)$$

where, ω name AM; n-full name AM; n-нормалный a range of change of values AM ; l-unit of measurements AM, corresponding functions of an accessory-μ (u). Function of an accessory looks like a trapeze and is defined four by parameters,

$$(\alpha, ml, mr, \beta)$$

where, α-the left deviation; the ml-left peak; mr-right peak; β-the right deviation. Analytically μ(u)-write down as follows:

$$\mu(u) = \begin{cases} 1 - \dfrac{ml - u}{\alpha}, & \text{if } ml-\alpha \le u \le ml \\ 1, & \text{if } ml \le u \le mr \\ 1 - \dfrac{u - mr}{\beta}, & \text{if } mr \le u \le mr+\beta \\ 0, & \text{in other cases} \end{cases}$$

graphic μ(u) fig. 2 is represented as a trapeze.

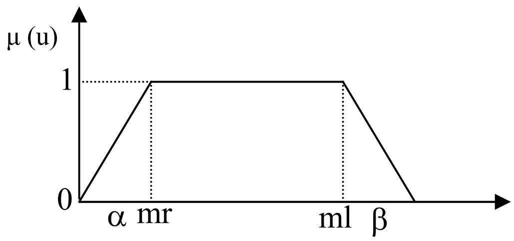

Fig.2. LR-format of function of a belonging

IV. A LOGIC CONCLUSION

During a logic conclusion two components cooperate: Base of knowledge and the Database. The base of knowledge contains rule - production, having left and right parts for example,

IF… AND $W_k=A_{jk}$ AND… THEN… OR $Y_i=B_{ji}$ OR……………………………….

The data base contains objects (linguistic variables) W_k with the values (ν_k; cf_k), where, ν_k-values of linguistic variables, $cf \in]0, 100]$ – coefficient reliability of value V_k.
The analysis of applicability of rules consists in an estimation of a degree of the validity of a parcel(sending) on the basis of the current values (V_k; cf_k) the target objects W_k taken from a database, and values A_{jk} which has been written down in a rule (as far as the first are equal / are unequal the second). If the rule is applicable, actions from the right part are carried out, resulting in most cases to entering in a database of new pairs "object-value" and process repeats until will fulfil all applicable rules.
For calculation of a degree of the validity of rules - production during a logic conclusion are used operation of indistinct similarity $a_1 \Theta a_2$, where a_1 and a_2 – linguistic values; Θ operation « it is close to » as it for the chosen format of function of an accessory we have:

$$Poss(a_1 | a_2) =$$

$$= \max \cdot \min\left(\mu_{a_1}(u), \mu_{a_2}(u)\right) \in [0,1] =$$

$$= \begin{cases} 1 - \dfrac{ml_1 - mr_2}{\alpha_1 + \beta_2}, & \text{if } 0 < ml_1 - mr_2 < \alpha_1 + \beta_2 \\ 1, & \text{if } \max(ml_1, ml_2) \le \min(mr_1, mr_2) \\ 1 - \dfrac{ml_2 - mr_1}{\alpha_2 + \beta_1}, & \text{if } 0 < ml_2 - mr_1 < \alpha_2 + \beta_1 \\ 0, & \text{in other cases} \end{cases}$$

V. THE DECISION OF A PROBLEM INTELLECTUAL DIAGNOSIS MALFUNCTIONS THE AE IN CONDITIONS OF UNCERTAINTY WITH USE ESPLAN

As algorithm of the decision of a problem set heuristics which highly skilled experts use acts. The heuristics, formulated by experts, enter the name in language of representation of knowledge ESPLAN and will be worn out in base of knowledge of system.
We shall result for clearness a fragment diagnosing of malfunction the AE at heating:

OB (NL, " noise level ", 20,93, "dB");
OB(LV, " level of vibration ", 0.05,3, "mm/s");
OB(TB, " temperature of bearings ", 20, 100, "degree");
OB(TC, " temperature of the case ", 20, 100, "degree");
… … … … … … … … … … … … … … … … … … ;
OB(DV, " deviation of voltage ",-5, 10, "%");
OB(DC, " deviation of current ",-3, 3, "%");
… … … … … … … … … … … … … … … … … …;
OB(DRLD, "is the duty running long-drawn? (yes / not) ", " ");
OB(BVS, "are blades of ventilator sideling? (yes / not) ", " ");
… ….;
LINGV (TC, " few "," 20, 20, 50, 10);
LINGV (TC, "supreme", 10, 70, 90, 10);
LINGV(TC, "more supreme ", 10, 110, 120, 20);
.. … … … … … … … … … … … … … ….;

IF begin **THEN** … … … … … … … … … …...;
INQUIRY (NL) **AND** **INQUIRY** (LV) **AND** **INQUIRY** (TB) **AND INQUIRY** (TC)
BECAUSE " For diagnosing malfunctions it is necessary to know a technical condition the AE";
NL=34; LB=1.456; TB=56; TC=68.

IF NL = "few" **AND** LV = "allowable" **AND** TB = "few" **AND** TC = "supreme" **THEN** voltage on clips less nominal – confidence 40 %
OR the engine overloaded -confidence 30 %
OR nominal power setting not observe- confidence 15 %
OR the direction rotation is chosen wrong - confidence 10 %
OR ventilating ways of the engine have got littered; active steel and windings have become covered теплоизолирующим by a layer fine dust - confidence 5 %
BECAUSE "The temperature of the engine limiting and is not present other attributes of abnormal work";
IF TC="supreme" **AND** DV= " less norm"
THEN voltage on clips is less than norm
RECOMMENDATION
To increase a voltage up to nominal or to reduce loading up to nominal force of a current
BECAUSE " The deviation of a voltage is less than norm "
IF TC = "supreme" **AND** DV = "norm" **AND** DC = "more_norm"
THEN the engine is overloaded
RECOMMENDATION
to lower loading of the engine
BECAUSE "Force of a current more nominal and voltage on clips in norm.";
IF … … ………………………………..;

VI. CONCLUSION

The intellectual diagnostic system the AE created on the basis of integrated environment ESPLAN, allows to estimate dynamics of change of a technical condition a AE described by internal uncertainty operation, and it is necessary to carry out diagnostics of malfunctions practically in real time.

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