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KNOWLEDGE BASE OF FUZZY DIAGNOSIS EXPERT SYSTEM OF COMPUTER DEVICES

In this paper, we have analysed kinds of the information which to contain in the knowledge base of fuzzy diagnosis expert system of competer devices. The production-frame model of knowledge representation is offered, its provides an opportunity to consider the fuzzy diagnostic information.

fuzzy diagnosis expert system, fuzzy information, signs diagnosis, knowledge bases, membership function, fram, production rule

Introduction

Today components of artificial intelligence, just expert systems of diagnosis (ESD), are widely used in technical diagnosis. The reason of its is the opportunity to solve not formalized and difficult formalized tasks with assistance of ESD.

The opportunity of reservation and further operation of the skilled experts unique experience is one of major factors using expert systems [1].

The performance of expert systems is defined by quantity and quality experts knowledge and a strategy of their use. Experts knowledge are individual, depend on the experts qualification and often given in the fuzzy form.

In computer devices, which we shall consider as of diagnosis objects, also it is necessary to consider fuzzy knowledge at construction ESD.

The problem of processing of the fuzzy diagnostic information is solved due to creation of fuzzy diagnosis expert systems (FDES).

In knowledge bases (KB) of such systems is not only the quantitative information which characterizes a condition of diagnosis objects (DO), and the qualitative information which represents expert estimations that attributes of a condition of DO. The account to the qualitative information during diagnosing enables to raise its efficiency.

The majority of toolkits of construction ESD existing on today or expert environments is used with different approaches for operating with an illegibility of knowledge and data, but they solve problems of representation of the fuzzy information only for highly specialized problem area [1 – 3] The some ESD, such as Cadiag-2, Fault, FLOPS, FRIL, SYSTEMZ-II, FLIPS and others support elements of fuzzy reasonings, but they are created specially for languages of a high level and for bounded data domain (DD) [4, 5].

Formulation of a problem. The basic problem at use of expert systems for diagnosis computer devices (CD) is filling KB of such systems in sufficient volume of the formalized knowledge in conditions of an illegibility of data on object and diagnosis process. It is caused by absence formalisms of representation of the fuzzy diagnostic information in knowledgebases and incomplete algorithms of its further processing.

The expert data about typical faults and signs of CD are very important during diagnosis. Often experts represent this information in an fuzzy kind. The account of such information enables to receive the most exact picture of condition CD, to accelerate and more precisely to carry out its diagnosing.

The purpose of research is development of principles of a knowledge base construction which contained fuzzy information about CD.

Number of problems are necessary to solve for creation of KB, namely:

1) to define structure of knowledge;
2) to develop principles of the organization of knowledge;
3) to develop model of knowledge representation.

Decision of a problem. Knowledge base of fuzzy diagnosis expert system of CD

We investigate kinds of the information, with which the system works, for the decision of the problem of knowledge reservation and processing of in KB.

Definition of the knowledge structure. We shall formulate the list of problems which are solved system, methods of their decision and ways of representation of results for definition of the knowledge structure in the KB FDES.

FDES carries out search of present attributes and the possible reasons of malfunctions, and also gives recommendations on their elimination.

We shall include the information which describes components and elements of DO, values and parameters of hardware components and another in structure of knowledge. The information of possible types of faults, characteristic signs of their display, the reasons of occurrence and the recommendation about their elimination is brought in structure KB for decision the problem of diagnosis CD. Sources of the information are:

– the documentation on hardware components of DO and reference books;

– the expert information received during interrogation of experts.

Presence of different kinds of the information is inherent in fuzzy expert systems of diagnosis CD:

1) points measurements and values of parameters;

2) admissible intervals of their change;

3) statistical laws of distribution for separate sizes;

4) criteria and the restrictions received from experts in the lingvistic form and so forth.

There are such kinds of a fuzziness, as the fuzzy data and fuzzy knowledge are present during diagnosis CD.

We shall carry to fuzzy knowledge :

1) fuzzy set parameters, for example, a pressure of a feed of a system payment ±5 V, ±12 V, the resistor 30 - 50 Ohm , speed of work of the disk drive 70-100 msec, change of frequency of a head of reading-record of a magnetic disk in a range 62,5 - 250 kc;

2) fuzzy technological data - errors of devices of measurement;

3) use of average values in case of absence of values of parameters, the reason can be absence or restriction of access to control points.

To a fuzziness of the knowledge received from experts, result discrepancy of expert estimations, underdetermined concepts and terms.

Example of fuzzy knowledge are estimations of experts: “temperature nearby 70°C ”, “a range of change of parameter from 2 up to 5”, “cold”, ”hot” and so on. Fuzzy knowledge are presented by means of fuzzy sets in FDES. Each fuzzy set is estimated on the certain serial scale and has membership function of an accessory which accepts values on an interval $[0,1]$. Membership function of an accessory defines value judgment of a degree of confidence of the expert in an accessory of concrete value to the certain fuzzy set. The precise information has membership function of an accessory which is equaled to unit.

The principles organization of knowledge base of FDES. Number of principles were used for construction knowledge base [6]:

1) principle lingvistic input and output variables.
2) principle for formation of dependence “input-output” in the form of fuzzy production rules;
3) principle of hierarchy KB.

The data domain has been certain, the class of objects, value of their characteristics and attitudes

between objects and characteristics is set for construction of the knowledgebase. The description of a data domain (DD) is presented in the form of hierarchical structure. Each object of hierarchical structure DD described by the frame. On top level of hierarchy frames which contain the information about type of diagnosis object are placed. As values of slots is the information about firm-manufacturer CD, year of release, operational and repair characteristics and another.

As an example of the description DO we shall consider motheboards. The frame "type of motheboard" is base for frames which contain the information about components of the motheboard $K1...Km$. All frames are connected with base communications of inheritance. It speaks that types of components depend on type of the motheboard. Each component of the motheboard in turn can consist of components $KJ_i...KJ_t$, where J - corresponds to number of a component from the previous hierarchical level, $i=\overline{1,t}$. Following hierarchical level is the level of elements $EJ_1...EJ_q$ (fig. 1).

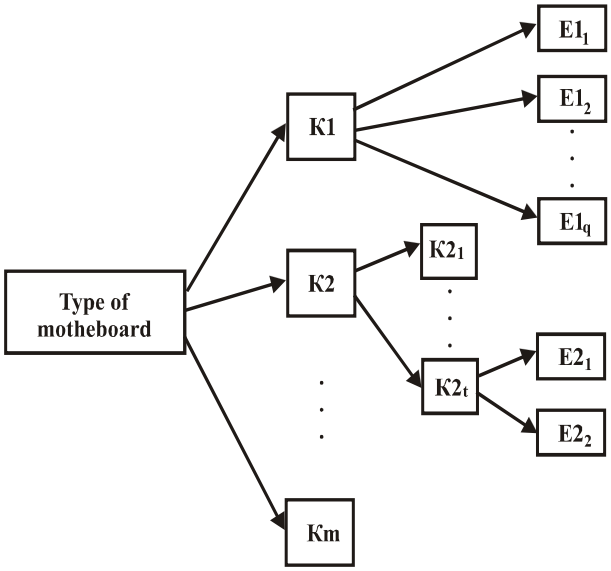

Fig. 1. Hierarchical structure of the description DO

Process of search faults in the FDES CD is carried out up to a level of elements. The information about experts represented in the form of frames (fig. 2).

The integrated characteristic of quality of the decision of a problem (Qv) is the important parameter of the qualification of the expert and influences a level of competence of expert.

Qv is calculated under the formula :

$$Qv = \sum_{i=1}^{d} vz_i / d ,$$

where vz – quantity of successfully solved problems,

d – total of solved problems.

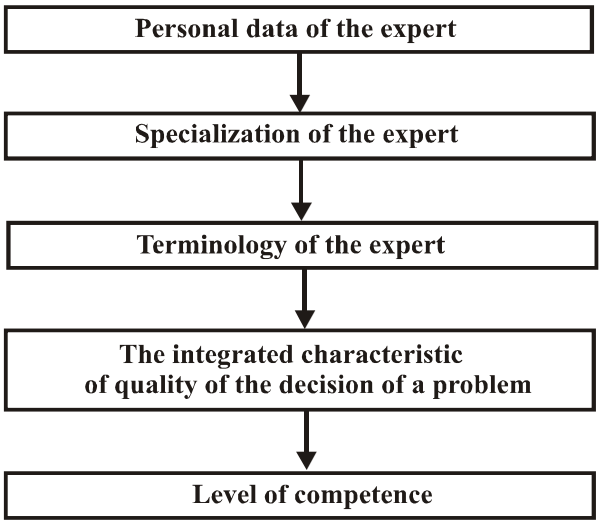

Fig. 2. Hierarchical structure of the data about experts

Before the beginning of the decision of a problem $Qv = 0$. After the termination of work of the expert with system under successfully solved problem $vz = 1$, else - $vz = 0$.

On the basis of value Qv each expert the estimation from an interval $s \in [0,1]$ is exposed, which will display a level of their competence, where $s = 1$ for the most gualified experts, for the less gualified experts should be satisfied condition $0{,}6 \le s < 1$. The information given by experts, which level of competence less 0,6, is not considered.

The model of knowledge representation in FDES knowledge base. Hybrid model of knowledge representation, exactly frames and production rules, is most perspective. Hybrid model have a number an advantage: the possibility to use of maximum volume

experts knowledge about DD, to simplificate of exception poccess and to keep a subsumption hierarchical [7].

Model knowledge base we represente in the following form:

$$BZ = \left\langle P_i(X_k, Y_n, A_k, R_n), \Phi_j(E_i, V_i(P_i', W_i)) \right\rangle, \quad (1)$$

where BZ - knowledge base filling experts knowledge, which formalized with the assistance of production rules, in the following form:

$$P_i = IF\ x_1\ is\ A_1\ AND \ldots x_j\ is\ A_j\ AND \ldots \\ \ldots x_k\ is\ A_k\ THEN\ y_i\ is\ R_i, \quad (2)$$

where P_i – i-th production rule, $i = \overline{1, g}$; g – number of rules; $X_k = \{x_j\}$, x_j – input parameters, $j = \overline{1, k}$; k – number of input parameters; $Y_n = \{y_i\}$, y_i – output parameters, $i = \overline{1, n}$; n – number of output parameters; A_k – fuzzy set (terms of lingvistic variables); $R_n = \{R_i\}$, R_i – result of rule, which transformed fuzzy output parameters in exact parameters; Φ_j – frames composition, $j = \overline{1, c}$; c – number of frames; E_i – set of slots names, $i = \overline{1, b}$; b – number of names; V_i – set of slots value, $i = \overline{1, b}$; b – number of value; P_i' – production rule in the form (2); W_i – i-th method-procedure, is no required, $i = \overline{1, h}$, h – number of method-procedures .

Static knowledge about data domain are represented in the form of frame's hierarchical, and dynamic knowledge are represented as production rules.

Example of structure interdependence frames, which describe the diagnosis object in the knowledge base FDES is shown in fig. 3.

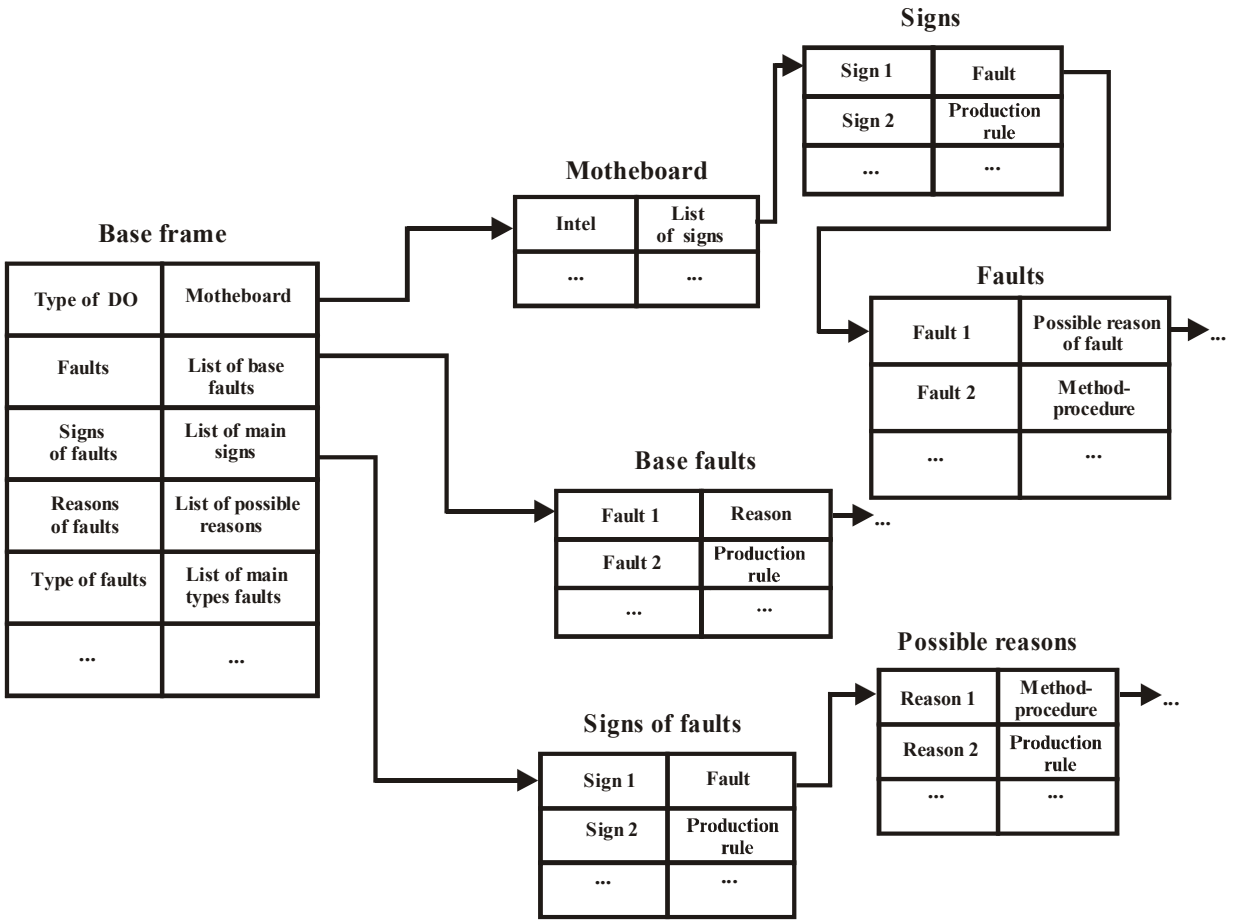

Fig. 3. Example of structure interdependence frames in the KB FDES

Knowledge base also consist:

– procedure-rules, which activate program for collection data about the diagnosis object at moment. Diagnosis program, as Motheboard Monitor, Aida 32 for the motheboards, show information about condition computer devices as in all, as about concrete hardware or program part of computer devices. The motheboards may have a integral test equipment. In that case, information about conditional the diagnosis object which give with assistance diagnostic reports without using external diagnostic programs;

– dictionary of terminology;

– files agreement of terminology;

– files agreement scales of lingvistic concept and etc.

The knowledge has a number of properties:

1) all information is represented as membership functions;

2) the level structuring, which represented with assistance of frames;

3) the relatedness, which represented with assistance of production-rules or methods-procedures;

4) the semantic metrics, which represented of associative relations. As the semantic metrics using the typical situations which frames defined.

The problem of self-descriptiveness, duplication evaluation and also consistency of knowledge in the KB FDES need the future researches.

Conclusions

Result of research are developed principles of FDES knowledge base construction of computer devices. Basis KB are chosen production-frame representation of knowledge which provides reservation subsumption hierarchies. Using production rules does possible to account of the fuzzy diagnostic information.

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