ТЕОРЕТИЧНІ ТА ПРИКЛАДНІ ПРОБЛЕМИ
І МЕТОДИ СИСТЕМНОГО АНАЛІЗУ

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MODEL OF THE LEVEL ESTIMATION OF DANGER SITUATIONS IN THE PROBLEMS OF COMPLEX OBJECTS OPERATION

N.D. PANKRATOVA, M.R. SLOTA

Abstract. The model of information support estimation of the decision maker (DM) based on a study of qualitative indicators of informedness, which characterizes the completeness, accuracy and timeliness of DM informedness , is presented. On the basis of these characteristics the level of danger situations in the operation of complex objects is formed. In implementing the model are used the methods of one-parameter classification with operations of fuzzy sets and strong intersections, as well as methods of interval classification with the operations of union and intersection of fuzzy sets, and also with operations of strong union and intersection of fuzzy sets. The proposed methods allow classifying the situation to inform DM about the validity and security of the decision with the available information support. The proposed model is based on a study of qualitative characteristics of informedness of DM and can be used to estimate the level of danger situations in the problems of the complex objects operation.

Keywords information analysis, qualitative characteristics of informedness, classification, recognition, danger level, integrated indicator of informedness.

INTRODUCTION

Reality constantly requires of reasonable administrative decisions, such as implementation of innovative technologies, companies moving to the new markets, complex technical systems management, and the solution of complex social issues. Decision making — generally speaking, is the result of the intellectual activity based on the specific information, their experience, knowledge and intuition that allows decision-makers move to a certain conclusion on the way to the necessary actions. Well-grounded decision should be aimed at achieving the desired results in a certain field.

Modern technologies has greatly facilitated and improved the process of forming solutions. Nowadays, there are numerous tools and software products that are based on mathematical modeling, forecasting, prediction, which allow to form effective management decisions. However, analysis of the global crashes and disasters that have taken place over the past decades shows that the scale of the losses can be substantially reduced due to the timely formation and realization of the rational solutions in the emergency and critical situations. The key problem is the timely and reliable information support of decision-makers.

Information analysis is a vital tool for formalization and solving of system problems. Its objectives are to ensure of the necessary and technologically possible level of information support reliability and validity of the decision on applied systems tasks, and this is an important tool for decision-makers support and the process of decision. The issue of data analysis is quite relevant in our time and therefore many scientists around the world bring variations of their problem vision and mathematical formulations for effective solutions that have long been set, but still haven't completely solved tasks.

The main feature of the existing approaches and methods is that they are focused primarily on evaluation the amount of data only. But practically data of quality indicators, such as completeness, reliability, timeliness, and several others are not estimated. At the same time validity and the effectiveness of the application system tasks solutions directly depend not only on the quantity of information, but also on its qualitative characteristics [1].

Several authors have focused their attention on the analysis of the qualitative characteristics of a specific information type, in particular the financial [2–4]. Some researchers have suggested methods for converting qualitative characteristics into quantitative. And, as a consequence, processing of these characteristics is made via usual for mathematicians methods [5, 6].

Development of American scientists in this direction aimed at the financial sector and focused on the development of useful and interesting for large financial corporations methods. For instance, the paper [4] contains some interesting ideas about the formalization process of the selections phase of useful information for the formation of an investment portfolio. The paper presents not only theoretical knowledge, but also the general mathematical formulation and results of researches. The authors also provided the main advantages and disadvantages of proposed methodologies and how business can be developed using the efficiency of their activities.

In the papers the questions of informational analysis from the perspective of decision-maker's study of the quantitative and qualitative characteristics of information, evaluation of their impact on the accuracy, completeness and timeliness of systemic task solution were considered [8–10].

In this article, we consider the model of information support evaluation of decision-makers that is based on qualitative indicators of their informedness, on the basis of which the level of situation danger is formed and the decision-making procedure is provided.

PECULIARITIES OF THE TASKS CLASSIFICATION AND CRITICAL SITUATION RECOGNITION IN THE INFORMATION ANALYSIS

Taking into account the construction of a general theory of the mathematical model and analysis of information, we define key features in the formulation the problem of the situations recognitions and its classification.

In general, tasks that are under consideration in model assessment of decision-maker's information support are also similar to a conventional pattern of tasks recognition, including many mathematical classification methods. Each situation from the variety of object recognition, as well as image, may be classified according to certain set of attributes for a specific class. The main goal is to build such a rule (functional), which allows to classify objects of observation with the lowest possible error.

However, within the framework of the system approach there are additional conditions which are not considered in the conventional pattern recognition tasks. There are some of the most essential.

1. Analysis of qualitative characteristics of information substantially depends on the subject area and so each application is unique in its own way and will require an individual approach to its formalization.

2. In the process of analysis and classification there is no guarantee of the input data completeness.

3. Formation of the qualitative characteristics of information often has a fuzzy character.

4. Unlimited space recognition features significantly complicates the process of situations classification.

5. Because of the lack of criteria for assessing the critical situation there are some difficulties with error estimation of constructed models.

Therefore, to solve such tasks it's advisable to use a set of new models, methods, techniques to determine the level of result consistency. Also, it is worth considering the fact that the analysis of the qualitative characteristics of information involves the development of methods for the transformation of these characteristics in the numerical equivalents. These methods should be integrated into the general mathematical model of system tasks, as shown in [8].

Based on the characteristics of the above we formulate the most important requirements for the models and methods that can be applied to tasks of classification and recognition level of danger situations.

1. Consideration of the fuzziness and incompleteness of the initial information.

2. Focusing on the processing of large quantities of data in real time.

3. Performance of methods to ensure the timely formation of the results.

4. The lack of standard training sample in the form of a finite set of data about the characteristics of each class of the accepted classification is determined by the principal unbounded feature space.

The concept of informedness is important for the analysis of information support of decision-makers [8]. Under the informedness of decision-makers will understand the change in the level of uncertainty of knowledge about a situation or object of analysis as a result of receiving information. The level of informedness of decision-makers is an indicator of the knowledge level about the subject of analysis or research. Quantitatively, awareness of decision-makers will be characterized by the magnitude of the level of uncertainty resulting from the changes of knowledge information. Pay attention to the fundamentally important factor: with receiving information knowledge level of uncertainty can be reduced, if the information is accurate, but it may also increase if the information is intentionally distorted (i.e. received misinformation) or invalid (i.e. not confirmed by experience calculations, documents or otherwise), or contrary to the available information.

The level of uncertainty of knowledge may be evaluated on the basis of different approaches. In particular, it can be estimated on the basis of the adaptation of quantitative methods described in [1, 5] or using the methods [10].

Let us note only the most essential qualitative properties of information, which are fundamentally important in solving problems of systems analysis, in particular, problems of estimation of the degree and level of risk in normal, abnormal, and critical situations. Among these properties are uncertainty, inaccuracy, incompleteness, fuzziness, untimeliness, noncredibility, and contradictoriness. It is evident that the formed decision should have the required level of quality and efficiency. For this, during its formation, it is necessary both to provide appropriate levels of completeness, reliability and timeliness of informedness of the situation in order to minimize the extent and level of risk. Determining the most important features from the perspective of decision-makers, in systems analysis are completeness, reliability and timeliness. Therefore, the qualitative characteristics of decision-makers awareness will determine the following properties [8]:

Completeness of informedness is a property that characterizes the conformity of the quantity of information received by a decision maker to the quantity of information required for decision making.

Timeliness of informedness is a property that determines the conformity of a decision maker's time resource for forming and making decisions to the time resource from the moment of receiving information to the moment of solution realization.

Credibility of informedness is a property that characterizes the conformity of the information received by a decision maker to the actual state of the situation.

It should be noted that the results of the solution of system tasks are directly dependent on the level of decision makers informedness (DMI).

In this case, proceed as follows [9].

1. Form indicators of completeness I_N, timeliness I_T, and credibility I_C of decision makers informedness, that will take into account the degree and the level of influence of each of the input parameters on the degree of the decision-maker's objectives achievement.

2. Offer the classification of a given set of situations S_0 according to a single system of interrelated indicators I_N, I_T, I_C or according to a single integrated indicator of DMI.

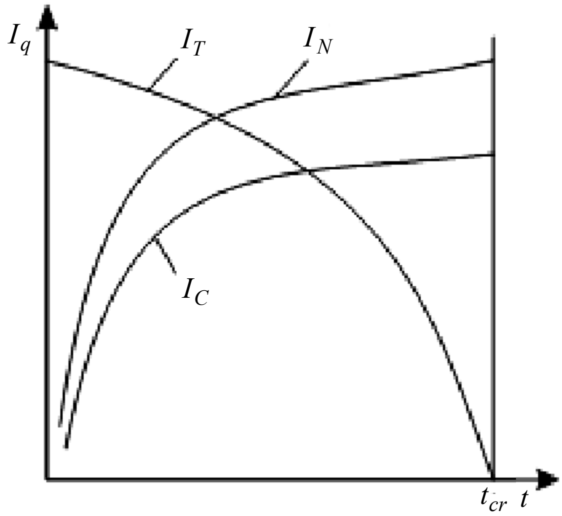
3. To develop techniques and procedures of the specific situation recognition supplies S_K from a given set of situations S_0 to a certain class of objects to the introduced classification.

When forming the general level of DMI the specific properties and introduced indicator's features I_N, I_T, I_C should be taken into account. Here are the most important properties of these indicators:

- the level of DMI is growing continuously from the increasing of all of the indicators I_N, I_T, I_C or from one of it;
- if the level of general DMI increases in its completeness, credibility and timeliness it changes according to non-linear law, in particular: the growth of DMI level gradually slows down as it approaches completeness of performance and credibility to their limits (Figure);

- the level of DMI of the integral index in case of reducing the value of a private performance below a certain threshold value cannot be compensated by increasing the values of other indicators;
- with zero meaning of any of the indicators I_N, I_T, I_C general level of DMI of the integral index is also zero.

During the solution formation, which starts at the moment $t = t_{fn} = 0$ and ends at the moment $t = t_{cr}$, the additional information is received, and this leads to an increase in the completeness, credibility and the amount of information. It follows that the completeness and credibility indicators I_N, I_C in general are the increasing functions of time. However, for the indicator of timeliness I_T the dependence is qualitatively different, due to the tight interrelation since the end of the formation of decision and the moment of its implementation. Given the fact that the time realization is fixed and it is determined by external factors, it is possible to state that the index of timeliness is a decreasing function of time [8].



Distribution of qualitative characteristics of awareness

From the above it follows that there is a contradiction between the level of completeness and credibility of DMI on the one hand, and the level of timeliness on the other. Therefore practically important task is to find a rational compromise between the levels I_N, I_T, I_C in the process of decision formation taking into account the requirements of the reduction of time during its formation. To solve this task it is needed to take into account the dependence I_N, I_T, I_C from time that is to put $I_N = I_N(t),\ I_T = I_T(t),\ I_C = I_C(t)$.

The functional dependence of the parameters is determined for variety of situations S_0. It is more convenient to represent this relationship in the form of polynomials. Firstly, it makes it possible to determine the polynomial coefficients by usage of known techniques of interpolation, and secondly, according to the theorem of Weierstrass any continuous function polynomial can be approximated by polynomial with any desired accuracy. Therefore, hereinafter:

$$I_C(t) = \sum_{k=0}^{N_C} a_C t_k \tag{1}$$

$$I_N(t) = \sum_{k=0}^{N_N} a_N t_k \ . \tag{2}$$

$$I_T(t) = \sum_{k=0}^{N_T} a_T t_k \ . \tag{3}$$

THE CONSTRUCTION OF THE MODEL FOR DETERMINING THE RISK SITUATION

Construction of the task solution model for the classification and determination of the danger level of the situation involves the following steps.

Step 1. Classification of hazard classes of possible situations and the definition of a set of risk factors. Depending on the subject area and the specific application task the first stage it is necessary to carry out procedures that will implement the peculiarities of the classification. First of all, we need to create classes on the level of danger of the critical situations that denote the variety

$$\Omega = \{\omega_k, k = 1..K\}. \tag{4}$$

Each class of danger should be characterized by a certain criterion in the form of membership function. Universal set is determined. Most often, the universal set X is defined by time interval $[0, T_{cr}]$, where T_{cr} is the time of decision making. After this point of time even the most reliable information is of no value.

During the system operation there is an influence of its sets of uncontrollable risk factors

$$\Phi = \{\Phi_j \mid j = 1...m\}. \tag{5}$$

The final step for the first stage is to define a set of situations

$$S = \{S_i \mid i = 1...n\}. \tag{6}$$

Each situation S_i from the variety (6) under the influence of risk factors (5) may move to a different danger class ω_k (4). Such change may occur over a period of time, and its duration is unknown a priori, and that depends on the amount and duration of exposure properties $\Phi_j \in \Phi$.

It is necessary to define a valid period of time T_0 for the formation and implementation of solutions for which the probability of a transition situation S_i in one of the danger classes (4) will not exceed the predetermined value $\eta = \eta_{ad}$.

Step 2. The construction of a situational factor grid of connections and influences. By situational factor grid will mean:

$$\overline{A} : \Phi \times S \longrightarrow [0;1]. \tag{7}$$

Where Φ is a multiple risk factors $\Phi_j \in \Phi$ (5), S is a set of situations of DMI $s_i \in S$ (6).

Since the sets (5) and (6) are finite, mapping (7) can be set in the form of a matrix $|A|_{m\times n}$, which elements are Boolean variables that are showing the effect of risk factors Φ_j on situation S_i.

Step 3. Definition of private indicators for situational informedness-factorial components. The definition and formation of private indicators informedness fundamentally are not formalized for arbitrary domains. Each task requires an individual approach, as input data, which is owned by the decision-maker may have a different specificity and semantic foundation that significantly affect the determination of the level of awareness of DMI. In addition, specific tasks may include an analysis of additional indicators of private DMI except imposed (1)–(3). This step is a separate task of information analysis and requires the usage of additional mechanisms.

Later on we shall assume that for each situational factor component of the vector of private DMI indicators in the form of (1)–(3).

Step 4. Determining the danger level of current situation. The danger level of the current situation $s_i \in S$ is characterized by the vector of private DMI indicators and risk factors. Denote $I_C^{ij}(t)$ is the indicator of the completeness of DMI of the *i*-th situation under the influence of the risk factor *j*. Similarly $I_N^{ij}(t)$ is the reliability indicator of DMI and $I_T^{ij}(t)$ is the timeliness indicator of DMI. The transition probability of the situation S_i under the influence of factor $\Phi_j \in \Phi$ in danger class $\omega_k \in \Omega$ depends from the change in time completeness $I_C^{ij}(t)$, credibility $I_N^{ij}(t)$ and timeliness $I_T^{ij}(t)$ of DMI. The probability η_{ij} of such event determines the following ratio

$$\eta_{ij} = 1 - \lg(1 + a_{ij} I_{ij}(t)) ,$$

$$I_{ij}(t) = I_C(t) I_N(t) I_T(t) .$$

To make a decision, it is needed to find a rational compromise between the levels $I_C(t), I_N(t), I_T(t)$ to reduce the time for its formulation and implementation. Indicators of completeness $I_N^{ij}(t)$ and credibility $I_C^{ij}(t)$ of DMI grow with time. Along with the increased time of risk exposure level $\Phi_j \in \Phi$ the level of timeliness DMI reduces $I_T^{ij}(t)$ according to its properties. And, as a consequence, the length of formation time, acceptance and implementation of solutions is reducing, to prevent transition of the researched situation in one of the danger classes $\omega_k \in \Omega$ (4).

As a result, to determine the danger level of the situation, it is necessary to define the acceptable time resource in a period $T_0 = [T_1; T_2]$, $T_0 \in X$, where X is the universal set. For this the following inequality is solved

$$0 \le 1 - \lg(1 + I_{ij}(t)) \le \eta_{ad} . \tag{8}$$

Step 5. Classification of the situations in accordance with the imposed danger classes. At this stage it is necessary to formalize a fuzzy classification of the situation, considering the previous step of acceptable time resource or the implementation of solutions.

At the universal set X for each danger class Ω, the fuzzy characteristics are introduced $\mu_k(x), x \in X$ in the form of membership functions for $\omega_k \in \Omega$.

The general approach to the classification of situations can be described by an algorithm that consists of three basic steps:

Step 1. The fuzzification of the input parameters.

Step 2. Fuzzy composition of situational factor components.

Step 3. Defuzzification of internal parameters and outputs activation.

The first step involves the classification of fuzzification, what is the reduction to fuzziness of input parameters, namely resource of the acceptable time T_0. After fuzzification the vector of affiliation degrees:

$$\overrightarrow{\mu_k} = \mu_k(T_0), \ k = 1..K ,$$

to danger classes (4) are be obtained.

The second step is to assess the impact of each risk factor $\Phi_j \in \Phi$ on situation $s_i \in S$ and the formation of average or maximum rate, which is transmitted to the next stage (the input of the activation function) to activate the exit. In the offered model this process is called a process of internal factor of the composition (or convolution).

For composition, is possible to use the operations defined on fuzzy sets. Given peculiarity of the process, the most consistent operation will be at the intersection of attitude fuzzy sets [11]. In this case analysis of the results will also include the ratio of the strong intersection. As a result we get a set of convolution μ_{ik}.

This stage has a great deal of flexibility, as there are many options for setting fuzzy relation on the set of parameters for the composition.

There is the union of fuzzy sets of A and B with the following membership function

$$\mu_C(x) = \max\{\mu_A(x), \mu_B(x), x \in X\}. \tag{9}$$

The strong union of fuzzy sets of A and B with membership function is used

$$\mu_C(x) = \begin{cases} \mu_A(x) + \mu_B(x), & if \ \ \mu_A(x) + \mu_B(x) < 1, \\ 1, & if \ \ \mu_A(x) + \mu_B(x) \ge 1. \end{cases} \tag{10}$$

The intersection of fuzzy sets of A and B with membership function is used

$$\mu_C(x) = \min\{\mu_A(x), \mu_B(x), x \in X\}. \tag{11}$$

Strong intersection of fuzzy sets of A and B with membership function in the following form is applied

$$\mu_C(x) = \mu_A(x) \cdot \mu_B(x), \ x \in X. \tag{12}$$

For activation of the output it is necessary to set parameters μ_{ik} via activation function for each ω_k.

As the function of activation will take the Heaviside function

$$\rho(x) = \begin{cases} 0, & x < \eta_{\max_i}, \\ 1, & x \ge \eta_{\max_i}, \end{cases} \text{ where } \eta_{\max_i} = \{\max_k \mu_{ik}\}. \tag{13}$$

Danger class (4), to which corresponds the value of the function (13) $\rho = 1$ is model's output parameter.

As a part of the proposed classification methodology we can identify two classification algorithms.

Simpler algorithm is a one–parameter classification of situations. For the entrance to the classification one parameter is supplied. According to the general model of tasks solving, in the early stages for each danger class (4) a personal membership function is formed. The set of functions is received

$$I = \{\mu_k : X \longrightarrow [0;1] \mid k = 1..K\}, \text{ where } K = |\Omega|. \qquad (14)$$

Often for this type of classification as the only parameter is taken the length of time interval, that is the time which the decision-maker has for solution formation and implementation.

Another algorithm is the interval classification of situations. This algorithm takes into account the situation that can be characterized by a vector of intervals that are obtained by solving the inequality (8). Interval classification of situations, according to the general model, is includes three steps. If the interval is described with beginning and the end, that is two-dimensional case for (14). We describe the input parameter by ratio

$$T = \{T_{ijl} \mid i = 1..n,\ j = 1..m,\ l = 1..L\},\ \ T_{ijl} = [T_{ijl}^{-}; T_{ijl}^{+}].$$

After fuzzification step and finding the $T_{ijlk} = \mu_k(T_{ijl})$ the following parameters are determined

$$T_{ijk}^{-} = \min_{l} T_{ijkl}^{-},$$

$$T_{ijk}^{+} = \max_{l} T_{ijkl}^{+}.$$

Further, in accordance with the general model for solving problems, the fuzzy relations (9)–(12) are used. In result we get a vector of intervals $[T_{ik}^{-}, T_{ik}^{+}]$. These values are passed to input of the activation function (13).

The method of classifying interval takes into account subjective assessment of the membership function which is not only a resource of time, but also other factors such as the desired time of the beginning of formation of a decision or a planned time of solutions realization. This method, as well as the previous one, include several variations and allow adjusting the classification logic of the specifics of the task.

EVALUATION OF DANGER LEVEL OF SITUATIONS DURING POWER TURBOGENETATOR OPERATIONS

The use of the proposed model is considered on the example of the classification system task, recognition and prevention of critical and catastrophic situation functioning turbine generator power. There were determined the set of risk factors and situations.

Risk factors are $\Phi = \{\Phi_j \mid j = 1...6\}$:

- decrease of the frequency to 49,7 Hz;
- increase of the frequency to 50,1 Hz;
- erroneous actions of the operating personnel;
- the failure of emergency control;
- natural phenomena;

- emergency shutdown of high power.

Situations are $S = \{S_i \mid i = 1..4\}$:

- changing Power Electric;
- transfer Power Electric units on its sources;
- asynchronous Power Electric mode;
- separation of the power systems into parts.

For this task, a lot of danger classes has been formed as follows: $\Omega = \{\omega_1,..,\omega_4\}$:

ω_1 —secure situation;

ω_2 — critical situation;

ω_3 — emergency;

ω_4 — catastrophic situation.

For the problem of recognition and prevention of critical and catastrophic situations on the example of the functioning of turbine generator power is impossible to form the training set as a finite set of data, so analysis methods will use the methods of matching results. Other words, we will classify the critical situation.

For the study (8) the parameter η_{ad} has changed in range of [0,5; 0,95]. Also, there were observed fluctuations in the result of the classification after changing the type of membership function and its settings.

It should be noted that the four classification algorithms were implemented in the study. The first two are variations of the one-parameter classification method, while the other two are the methods of interval classification. Next, the following definitions are accepted:

M1 is a one-parameter classification methods with the operation of the intersection of fuzzy sets;

M2 is a one-parameter classification method with the operation of a strong crossing;

M3 is a method of interval classification with the operations of union and intersection of fuzzy sets;

M4 is a method of interval classification with the operations of a strong union and intersection of fuzzy sets.

The first stage of the analysis was to study the results with fixed parameters and types of phase transitions and changes. This step allowed to determine whether results are consistent with the classification of the real situation. With increase of η_{ad} the time on the formation and implementation of solutions reduces, therefore, must increase the danger of the situation. Aggregated results for all methods in the fixed parameters of membership function are given in Table 1.

Table 1 Classification results of the change η_{ad}

M	η_{ad}					
	0,5	0,6	0,7	0,8	0,9	0,95
M1	ω_1	ω_1	ω_1	ω_2	ω_2	ω_2
M2	ω_1	ω_1	ω_1	ω_2	ω_2	ω_3
M3	ω_1	ω_1	ω_2	ω_2	ω_3	ω_3
M4	ω_1	ω_1	ω_2	ω_3	ω_3	ω_3

All the methods are responding on increasing of the value access η_{ad}. However, as follows from the results above, methods of interval classifications are more sensitive.

The second stage of the study was application of a sensitivity analysis methods to the membership function type. Worth noting that the various membership functions have a number of excellent options, and therefore a change of the membership function requires a small adjustment of the dispersion parameter. At this stage, there was a slight change in the classification of the results, especially for large values η_{ad}. Summary results in Table 2 reflect these changes.

Table 2. The study of the classification sensitivity according to the type of membership function

MF	M											
	M1			M2			M3			M4		
	η_{ad}											
	0,5	0,8	0,95	0,5	0,8	0,95	0,5	0,8	0,95	0,5	0,8	0,95
Triangular MF	ω_1	ω_2	ω_2	ω_1	ω_2	ω_3	ω_1	ω_3	ω_3	ω_1	ω_3	ω_3
Gaussian MF	ω_1	ω_2	ω_2	ω_1	ω_2	ω_2	ω_1	ω_2	ω_3	ω_1	ω_2	ω_3
Bell-MF	ω_1	ω_2	ω_3	ω_1	ω_2	ω_3	ω_1	ω_2	ω_3	ω_1	ω_2	ω_3

Also, an analysis of classification sensitivity to a change of membership function parameters of the fixed type took place. It has been studied how changes the result of classification of the situation at a constant level of information support of decision-makers, if the informedness requirements changes. Of course, the change of the criteria of danger class should significantly affect the classification. Results of the study are shown in Table 3 for cases of selecting a permanent form of membership function — Gaussian MF. At the same time the variance σ^2 and mathematical expectation of a for danger classes ω_2, ω_3 and its ω_1, ω_4. Four sets of parameter were used for each danger class.

Table 3. Parameters of Gaussian membership function

N	ω_i							
	ω_1		ω_2		ω_3		ω_4	
	a	σ^2	a	σ^2	a	σ^2	a	σ^2
1	0	10	20	20	60	20	100	10
2	0	20	40	20	70	15	100	20
3	0	20	50	10	50	30	100	15
4	0	50	50	10	75	10	100	25

The results of the application of these four methods for fixing $\eta_{ad} = 0{,}7$ and different set of Gaussian parameters of membership function (from table 3, sets 1–4) are shown in Table 4. The right selection of parameters is one of the most important steps for effective and correct classification. It is important to create the requirements for danger classes as fuzzy marks from which, actually, the relevant membership functions are formed.

Table 4. The effect of the membership functions of the classification results

N	M1	M2	M3	M4
1	ω_2	ω_2	ω_2	ω_2
2	ω_2	ω_2	ω_2	ω_2
3	ω_2	ω_3	ω_3	ω_3
4	ω_1	ω_1	ω_1	ω_2

From the results shown in Table 2 and Table 4 we can summarize that the selection of the membership function parameters significantly affects the classification results. Note, that this process is fundamentally non-formalized, and therefore the task of correct choice of membership function depends on the intuition and experience of the investigator.

Also it has been proposed to determine the overall risk assessment for all situations s_i (6). In the proposed task were allocated 4 independent situations. Therefore, an overall assessment can be formed by an absolute majority. It was found that in most cases the algorithm gave consistent results. Table 5 shows the results in the form m/n, where m is the number of consistent results, $n=16$ the total number of situations. For this experiment were selected from membership function with the first set of parameters from Table 3.

Table 5. Consistency of assessment classification

MF/(m/n)	0,5	0,8	0,95
Triangular MF	$\frac{14}{16}$	$\frac{13}{16}$	$\frac{11}{16}$
Gaussian MF	$\frac{14}{16}$	$\frac{12}{16}$	$\frac{12}{16}$
Bell-MF	$\frac{13}{16}$	$\frac{14}{16}$	$\frac{12}{16}$

Thus, the proposed model has been applied to solve the systemic problems of classification and identification of critical and catastrophic situations, operation of turbo generator plant. The research was conducted on the basis of DMI figures about the functioning of the turbine generator. Classification results showed the effectiveness of the quality DMI of analysis methods for complex danger detection task situations. It can be concluded that the classification of the result depends essentially on the correct choice of the type of membership function and internal parameters. This process is essentially non-formalized and or this reason the problem of correct choice of membership function depends on the intuition and experience of the decision-maker.

CONCLUSIONS

The problem of classification and recognition of the danger level of critical situations, which is important for the formation of the necessary and technologically possible level of information to ensure the reliability and validity of the decision of applied system tasks, was under the consideration. The paper presents model of classification and the danger level of the situation recognition, as a part of a system methodology.

Considering the features of the tasks of qualitative information analysis, traditional methods of classification and pattern recognition cannot be applied in this field. So, a classification model and recognition of critical situations, which is fully compatible with the general theory of information analysis, were proposed. The model is based on an analysis of private decision-maker's indicators of informedness, defined as a function of time. On the basis of these qualitative characteristics the danger level of the situation is formed, that is, how balanced, rational and appropriate the solutions will be based on available information. In case of poor informedness indicators, decision-maker will be notified that a decision is taken at the existing information support is undesirable or even dangerous. The proposed methods allow classifying the situation for reporting it to decision-maker about validity and safety of a decision with the available information support.

Analysis of the results of classification on the example of the real task revealed the strengths and weaknesses of the proposed model and algorithms of its realization. It was revealed that the classification algorithms are sensitive to fluctuations in the parameters of membership function and essentially depend on the particular application.

The proposed model of classification and recognition of dangerous situations in tasks of informational analysis may be applied in conditions of incompleteness and fuzziness of the initial information, when taken into account expert assessment, as well as the presence of a certain amount of data in the domain that is being investigated.

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