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INFORMATION ANALYSIS METHOD ABOUT CURRENT SITUATIONS IN ACS OF SPECIAL OPERATIONS

Abstract. The relevance of improvement and difficulty of establishing ERP systems and methods of their development is considered. The features of the development of special mathematical and software implements strategy ERP system shows effective ways formalized description of the classes of recognizable situations in the form of membership functions corresponding regions of the feature space. In the course of developing automated ERP systems, it is necessary to apply direct methods for characterization of classes of recognizable situations. As shown by the analysis of typical SR tasks solved in ERP systems, in practice a feature space can contain many hundreds and even thousands of attributes. In this case, the number of examples of situations belonging to a particular class, as a rule, is limited to tens of units. Therefore, for classical learning algorithms, the required length of a training sequence for SR tasks of practical importance, as a rule, many times exceeds the disposable number of examples of environment. The source of information necessary for the construction of such a priori descriptions can be experts who can solve SR tasks in a non-automated way in conditions of psychological comfort.

Keywords: ERP system; recognition methods of situations; information subsystems.

Introduction

At the current stage of science and especially technology development more attention paid not to the technical but to the software implementation of various storage processes, transition process, information processing and analysis in the operation of the control system. It is the software part of the system is the main component of the price of control systems for their modification and development for today [1, 8-12]. Under such approaches, the intensive development of economic and mathematical control methods, the implementation of ECM into spheres of human productive activities possessing high speed response, logical flexibility, huge memory space, served as the basis for the development of special operations automated control systems (ACS of SO which qualitatively changed the management formula and significantly increased its effectiveness.

The category of ACS of SO is usually considered the implementation of the ERP system methodology - organizational strategy for the integration of production and operations, human resources management, financial management and asset management, focused on continuous balancing and optimization of enterprise resources through a specialized integrated application software package that provides a common data model and processes for all spheres of activity.

As is known, in any control systems, data reduction processes include the solution of the following groups of tasks:

- 1) capturing, accumulation and storing of status information;
- 2) generalization and analysis of information of orientation and the issuance of the processed information to various acceptors;
- 3) making recommendations for decision making or automatic formation of teams;
- 4) bringing terms to managed objects and monitoring their implementation.

The specific content of the tasks included in the above groups depends on the purpose of the SO ACS

and many other factors. ACS of SO may vary significantly by the specific weight occupied by different groups of tasks, by the degree of automation of their solution, the rate of information updating and the duration of its storage. However, in any control systems these groups of tasks are always present.

In most ACS of CO, it is possible to clearly distinguish the complexes of technical and software facilities which are responsible for solving the first two of the above listed groups of tasks. Such complexes are called information subsystems (IS).

IS can exist in two versions. Firstly, they can be an integral part of the ACS of SO. Secondly, IS can be organizationally and technically designed as a stand alone automated systems.

Terms of reference. Despite the above-mentioned variety of IS structures and the specific composition of the tasks, under their development and improvement it is necessary to solve very similar problems. Experience of development such systems has shown that especially significant difficulties is caused by the development and maintenance of special mathematical and software that performs the functions of generalization and analysis of orientation.

Therefore, the developer is difficult to achieve that the description of the formulation of the ERP system, compiled according to the experts, contains information sufficient to develop an algorithm for solving it, and to obtain all the necessary information, it is necessary to repeatedly contact the experts. These difficulties are compounded by the lack of adequate methods of formalized representation of expertise, clear non-programmers, as well as the above-noted variation of initial data for the development of algorithms.

These difficulties are typical in the development of algorithms and programs designed to solve almost all problems of assessing the situation in any ACS of SO.

The purpose is to find ways to improve the development of special mathematics and software technology that implements the ERP strategy.

To identify the nature of these difficulties and look for effective ways to overcome them, it seems

appropriate to abstract from the specific content of such tasks and information systems in which they should be solved.

Within the traditional technology development of special mathematical support and software the limitation is the necessity for interaction between capable specialists of the subject area – end user and experts and much weaker than it orients software designers, implementing the knowledge of experts in material object – programs. In the conditions when it is impossible to make completed mathematical setting of the problem, the different nature of the professional training of these two groups of specialists becomes a source of serious difficulties in the development of special mathematical support and software. These difficulties are exacerbated by departmental disunity since end users and experts in the traditional distribution of roles between them usually belong to different organizations and departments.

The problem of developing a new information technology focused on automating of the SR tasks solutions as a combined with general theoretical foundation set of methods and techniques, the formalization of expert knowledge and methods of their usage in the data analysis on the situation was not considered in the literature.

Main part

Abstracting from the specific content of the tasks of processing orientation solved in the IS, a generalized class of so-called situation recognition tasks (SR-tasks) (SRT) introduce into consideration.

This class includes information processing tasks that are solved by ERP systems, consisting in forming generalized conclusions about the current and (or) predicted environment by analyzing private orientation and, possibly, the results of solving other SR tasks.

According to this non-strict definition, the class of SR tasks is very wide. In particular, it includes all the tasks of processing the ERP system, more specifically, the detection of individual signs characterizing the state and activity of objects, as well as forecasting their actions through a comprehensive analysis and comparison of the signs that have appeared.

It follows from the definition that SR tasks in the general case form a hierarchy (Fig. 1).

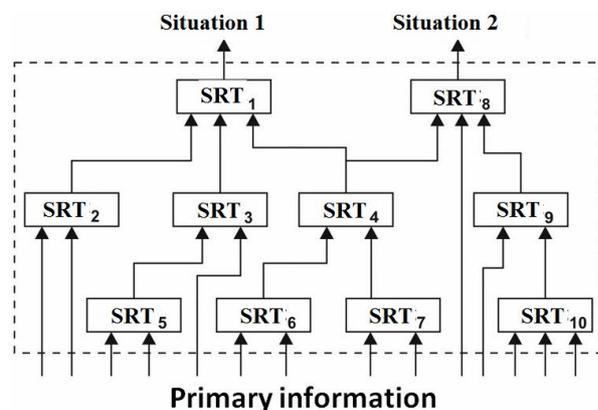


Fig. 1. Example of SR tasks hierarchy

Indeed, the results of tasks solutions that occupy the lower levels of the hierarchy can serve as input data for tasks of higher levels. This is in complete agreement with the generally accepted hierarchical principle of creating an IS ACS of SO. Thus, the object of study is rather impressive class of SR tasks, which occupies an important place in the processes of information processing that occur in the ACS of SO.

In order for better understanding the subject of this study and more clearly limiting its scope, abstract formulation of the problem of making a decision on pattern recognition is turned, slightly generalizing the classical formulation of the recognition problem given in the literature [2].

Let set (dictionary) of signs

$$Z = \langle \zeta_1, \zeta_2, \dots, \zeta_k \rangle \quad (1)$$

taking values from some feature sings Arbitrary implementation of the feature vector denote as $Z = \langle z_1, z_2, \dots, z_k \rangle$. The alphabet of classes of objects to be recognized is also specified, which can be assigned to a tuple of sets in the attribute space.

$$A = \langle A_1, A_2, \dots, A_k \rangle, \text{ where } \bigcup_{r=1}^k A \subset \Omega. \quad (2)$$

To make a decision on whether a certain object is described as a particular object, described by the feature vector Z , k close functions are set and $\mu_r(Z, A_r)$ take values on a certain numerical interval $[a, b]$. The results of calculating these values are handled by the decision rule.

$$r^* = DC \mu_1(Z, A_1), \mu_2(Z, A_2). \quad (3)$$

Environment recognition tasks are fully included in the above scheme. It is important to note that in the development of recognition systems, in general, a number of issues must be addressed, including the following:

- 1) Selection of feature dictionary Z ;
- 2) The choice of the alphabet of classes of objects A
- 3) Synthesis of membership functions $\mu_r(\bar{Z}, A_r)$;
- 4) Choice of optimality criterion C and decision rule synthesis D .

As a rule, the third of these questions is the most difficult. Its essence is reduced to the compilation of descriptions of areas of the attribute space corresponding to the situations to be recognized. In the particular case, in the stochastic interpretation of the problem recognition of situations, the posterior probabilities of belonging the vector Z to the classes of situations $A_r (r = 1, 2, \dots, R)$ can play the role of functions $\mu_r(\bar{Z}, A_r)$

At the same time, the choice of a way to solve the third question is much less dependent on a specific subject area than the others, which allows us to talk about creating universal methods for a fairly wide class of SR tasks. Therefore, from the point of view of improving the technology of developing special mathematical and software implements the ERP strategy, it is of particular interest to create effective ways to formalize the

description of classes of recognizable situations in the form of membership functions of the corresponding areas of the feature space. Accordingly, speaking of formalization and automatized solution of SR tasks, assumed that the dictionary of attributes, the alphabet of classes of recognizable situations, the optimality criterion and the decision rule are already chosen. Only the question of the synthesis of membership functions $\mu_r(\vec{Z}, A_r)$ remains unsolved.

In the literature devoted to the theory of pattern recognition [2–7], recognition systems are divided according to the method of constructing descriptions of recognizable classes into systems with training and without learning.

The systems with training are based on the procedures of structural and (or) parametric adaptation of the membership functions and the decision rule (3) in the process of processing the sequence of presented realizations of the feature vector, followed by instructions about their belonging to a particular class (while studying with a teacher) without such instructions (with self-study). When systems are creating without training, the so-called direct methods for constructing class descriptions are used. Such descriptions are also called a priori, since in systems with learning a priori descriptions of classes are usually used as an initial approximation to training.

With other things being equal, the possibility of creating a recognition system that has a satisfactory quality of functioning depends on the accuracy of the a priori description for systems without training, and on the length of the training sample for systems with training. Therefore, the decision whether to develop a recognition system or to resort to training or not is determined by the presence of an a priori description of the classes of recognizable objects and its accuracy. It is also necessary to take into account the presence of a training sample, the volume of which, in the absence of an a priori description or its insufficient accuracy should ensure the required quality of recognition training.

As a rule in the case of applied problems of recognizing situations, one should focus on the direct methods of describing classes, and learning can only be considered as an auxiliary method.

Obviously, the dimension of the feature vector in the general case strongly influences the quality of recognition, and the increase in the number of features

in the learning systems would seem to be accompanied by an increase in quality. However, this statement is true only under the assumption that there are no restrictions on the duration of training.

The [6] study demonstrates that the time complexity of the learning algorithm depending on the dimension of the feature vector in the general case has an exponential estimate. This means that with an increase in the number of features, the required length of the training sequence will be in terms of growth rate, many times greater than the dimension of the feature vector.

As shown by the analysis of typical SR tasks solved in ERP systems, in practice a feature space can contain many hundreds and even thousands of attributes. In this case, the number of examples of situations belonging to a particular class, as a rule, is limited to tens of units. Therefore, for classical learning algorithms, the required length of a training sequence for SR tasks of practical importance, as a rule, many times exceeds the disposable number of examples of environment.

Conclusions

In the course of developing automated ERP systems, it is necessary to apply direct methods for characterization of classes of recognizable situations.

The source of information necessary for the construction of such a priori descriptions can be experts who can solve SR tasks in a non-automated way in conditions of psychological comfort.

The latter means that:

- the expert has positive motivations for solving the SR tasks;
- the scope of problem is not more than the psycho-physiological capabilities of a person in perception and data processing;
- there are no strict limits on the time spent on the data analysis;
- there are no adverse effects of erroneous decisions.

Experts use informal knowledge about the structure of the attribute space, which, under favorable conditions, allows them to cope successfully with solving SR tasks. Therefore, the problem of constructing a priori descriptions of classes of recognizable situations is limited to the problem of formalization, or presentation of expert knowledge.

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Метод аналізу інформації про ситуацію, що складається в АСУ спеціального призначення

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Анотація. Розглянуто актуальність вдосконалення і труднощі створення ERP систем і методів їх розробки. Розглянуто особливості розробки спеціального математичного та програмного забезпечення яке реалізує стратегію ERP системи, показаний ефективний спосіб формалізованого опису класів розпізнаваних ситуацій у вигляді функцій приналежності відповідних областей простору ознак. При розробці автоматизованих ERP систем необхідно застосовувати безпосередні методи складання описів класів було розпізнати ситуацій. Як показав аналіз типових РС-завдань, що вирішуються в ERP системах, на практиці простору ознак може містити багато сотень і навіть тисячі ознак. При цьому кількість прикладів ситуацій, що відносяться до того чи іншого класу, як правило, обмежена одиницями-десятками. Тому для класичних алгоритмів навчання потрібна довжина навчальної послідовності для РС-завдань, що мають практичне значення, як правило, багаторазово перевищує число, що розташоване до прикладів ситуацій. Джерелом відомостей, необхідних для побудови таких апріорних описів можуть бути експерти, які вмiють вирішувати РС-завдання неавтоматизованим способом в умовах психологічного комфорту.

Ключові слова: ERP система; задачі розпізнавання ситуацій; інформаційні підсистеми.

Метод анализа информации про ситуацию, сложившуюся в АСУ специального назначения

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Аннотация. Рассмотрена актуальность совершенствования и трудности создания ERP систем и методов их разработки. Рассмотрены особенности разработки специального математического и программного обеспечения реализующий стратегию ERP системы, показанный эффективный способ формализованного описания классов распознаваемых ситуаций в виде функций принадлежности, соответствующих областей пространства признаков. При разработке автоматизированных ERP систем необходимо применять непосредственные методы составления описаний классов распознаваемых ситуаций. Как показал анализ типовых РС-задач, решаемых в ERP системах, на практике признаковое пространство может содержать многие сотни и даже тысячи признаков. При этом количество примеров ситуаций, относящихся к тому или иному классу, как правило, ограничено единицами-десятками. Поэтому для классических алгоритмов обучения потребная длина обучающей последовательности для РС-задач, имеющих практическое значение, как правило, многократно превышает располагаемое число примеров ситуаций. Источником сведений, необходимых для построения таких априорных описаний могут быть эксперты, умеющие решать РС-задачи неавтоматизированным способом в условиях психологического комфорта.

Ключевые слова: ERP система; задачи распознавания ситуаций; информационные подсистемы.