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SCENARIO APPROACH TO THE ENGINEERING OF INFORMATION MODELS, DESIGNED TO ENABLE THE ACTIVITIES OF OPERATOR IN AUTOMATED CONTROL SYSTEMS

The article deals with the problems of designing and development of information models system for data support of activities of air traffic operator in automated control system. The generalized analysis of operator's activities is conducted, the assessment of time expenditure for the fulfillment of different actions, concerned with the analysis of information models, is described, and the set of standard actions under different conditions of current air environment is selected. The selection of standard actions of the operator allows to form the algorithms or scenerios of his behavior, what, in its turn, serves as a basis for the engineering of information models. The application of intellectual information technologies enables to solve the task of current situation recognition and implement the synthesis and control procedure of information models. The use of operator's behavior scenario can improve the quality of data support engineering and provide the increase of operator's activities efficiency.

Keywords*: operator; information model; control; ergonomic engineering; operator's activities; decision making; scenario engineering.*

Introduction

In order to understand clearly notions and definitions used in the article, the notion "information model" is to be specified in the context introduced in the article. Information model (IM) is semantic or syntax description performed in the view of images. The description reflects properties, specifics and relations of the object observed (or the process, feature, system, situation, etc.). The information model is realized by means of display devices complex, which includes a complex of data displaying technical equipment as well as software implementation of information processing algorithms. The information model is a constituent of the information system in automated control systems (ACS).

Let's study the process of air traffic control on the grounds of dispatcher's behavior (hereinafter referred to as "operator") in airway traffic control center.

Operator's behavior model while solving the task of air object (AO) location definition, numerical strength, flight line, speed and altitude envelope can be represented by the following graph (Fig. 1) [1, 10].

The analysis of the present model using simulation tools [1] allows to define time expenditure for execution of certain operations, time expenditure for execution of the complex of operations concerned with different aspects of operator's behavior (work with automated working station (AWS), commands entry, etc.) as well as to conduct the analysis of his activities depending on used IM.

The researches of operator's behavior reveal that the structure and the properties of used IMs significantly influence the quality and the efficiency of operator's activities [2 – 6]. Present influence becomes greater when operator's behavior is studied in different substandard situations.

Such situations can be as follows: flight procedures violation, intruding aircrafts, flight of unidentified object, etc.

Thus, the conduction of further researches on the improvement of IM considering the peculiarities of operator's behavior in different conditions of the environment is immensely needed.

Literature review

A wide range of works [1, 2 – 6] is dedicated to the investigation of methods of IM development and control during the arrangement of data support of control problems solving.

Provided that, different types of information models and methods of their development are described. The basic of them are the following:

1. Text IMs [2, 3] are used for displaying the statical information. A principal mission of such ordinary information models is to display statical text data necessary within the process of operator's activities. Instruction manuals, operating procedures, active tasks lists, etc., which are represented to the operator in a form of text documents, can be deemed as an example of such IMs.

2. Algorithmic methods of IM development and control [3, 4] allow to form models, which display the algorithm of operator's activities. They can be divided into information-logical and command-data ones. These models are applied to control one compound object, e.g. power-generating unit, nuclear reactor, etc.

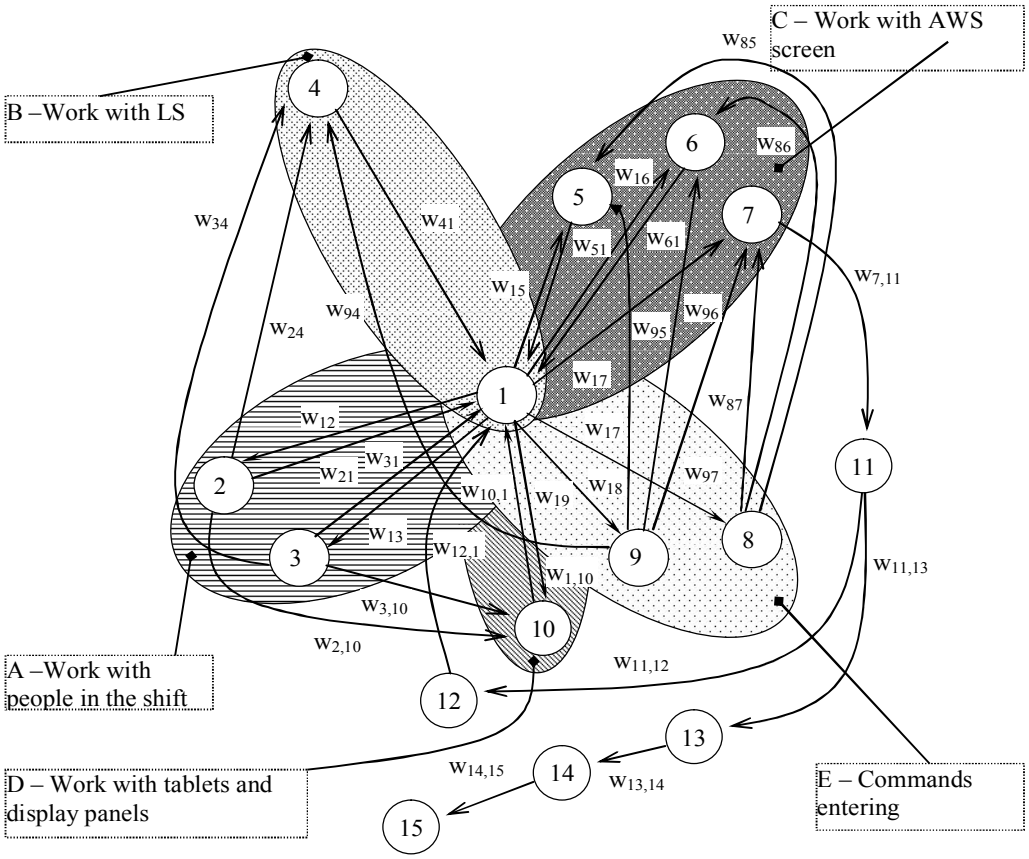

Fig. 1. Operator's behavior model while analyzing air environment

3. After the manner of information displaying and applied method of IM control can be distinguished [4 – 6] the next ones: graphic approach to data displaying with no concern of operator's behavior algorithm and graphic approach to data displaying with constrained concern of operator's behavior algorithm. The disadvantages of the first method are: IM displays the information necessary for solving of only one or two control tasks; displayed information does not correspond to the logic of operator's behavior; the analysis of the model requires considerable time loses.

4. IM control method, based on a graphic approach to data displaying with constrained concern of operator's behavior algorithm [2 – 6], allows to develop more advanced IMs. The disadvantages of the method are: restricted number of IM control programs; the lack of realization of immediate situation detection support; the lack of possibility of IM displaying parameters adaptable control; operator's behavior support is fulfilled with constrained set of control-problem algorithms.

Thus, issues, concerned with the buildup of IMs development and control methods, that could make possible the control of IM with taking into account the current situation and in accordance with tasks, solved by the operator while implementing air traffic control, are incompletely studied and described in the literature and require the further researches. The development of IM control methods with consideration of the stated requirements is possible if using intelligent method of informational criteria choice and modifying IM data items in accordance with the current environment and tasks, solved by the operator.

Main body

The analysis of the literature enables to take up the position that the further prospect of IM development and control methods elaboration is the use of intelligent methods. However, the implementation of such an approach is possible in terms of immediate identification task solving of the situations occurring in the air area. Currently, there is one approach, which allows to solve this task [7 – 9], is described. Still, it's use causes the necessity to develop the multitude of IMs and data items, which could help to represent the variety of situations occurring in the air area and their peculiarities.

Four groups of IM are distinguished to form IM:

- defining group: represents specific characteristics of the situation and allow to fulfill the assessment in whole, defines its belongment to a definite class;
- additional group: characterizes the details of the situation, presents it's peculiarities for solving specific tasks in the current conditions;
- auxiliary group: displays the information about the IC, whose data are received on the grounds of supplementary analysis and conversion, defining auxiliary IC as well as those IC, that can't be obtained clearly;

- static group: characterizes the static data, assisting while solving specific task of the current situation assessment. The development of IM structure is to be conducted on the basis of IC choice stages, stated above.

Not all the available IC are used during the formation of base IM, but only those that possess minimum combination and provide the understanding of the current situation by the operator.

Thus, it is necessary to reconsider the approach to the realization of IM synthesis and control process in order to keep a check on the current air environment. Herewith, the current situation is to be a key determinant for all actions of the operator. In this case his behavior won't be disordered; indeed it will conform to the rules and algorithms, specific to the given situation. For instance, in case when it is need to prevent aircrafts collision the operator is going to solve the task in restricted area of environment and he will not supervise those objects which possess no threat.

Consequently, it is reasonable to assume that the operator must act on the grounds of pre-arranged scenario (algorithm), formulated for all possible situations. In this case, the whole process of his activities can be presented in a form of the set of scenerios and transitions between them.

So, considering Fig. 2 and the singled out scenerios, the quantity of IMs can be restricted, and their relations can be identified in accordance with possible situations. The example of suchlike set of scenerios, possible transitions and used IMs is represented in Fig. 2.

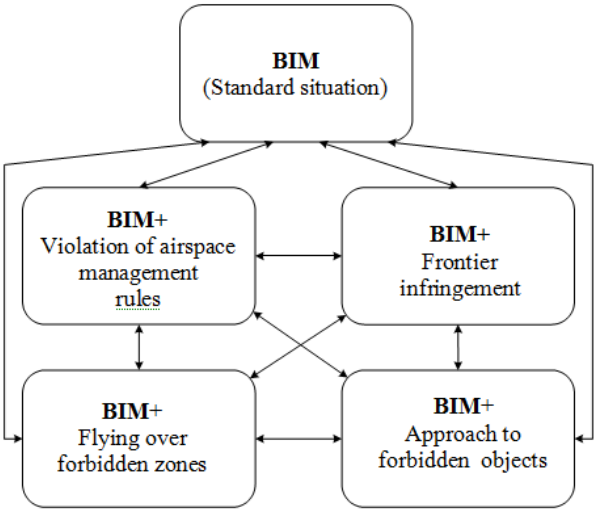

Fig. 2. The structure of IMs, providing data support of operator's behavior

Thus, a new approach to the designing of data support system of operator's behavior on air traffic control is offered in the article. We shall call the present approach as scenario engineering of operator's behavior data support system. *The scenario engineering of operator's behavior data support system* should be understood as the process of the development of operator's behavior data support systems, which is based on scenarios analysis results of his activities in current environment (situations).

Each situation should be described by own information criteria, which will characterize it uniquely. This will help to avoid user's information overloading, simplify the process of IM dynamic synthesis and control.

To solve the task of IM control and prevention of operator's information overloading, the mandatory requirement of successful functioning of such system is the development of current situations recognition system.

Certainly, the question "what should be done if the situation, which doesn't conform to any of described in the system, appears?" can arise. This question always arises in case of intellectual systems use. The conducted researches with the use of situations recognition system reveal [7 – 9], that the absence of new situation description in knowledge base leads to the error of identification. But in practice such situation is rarely appears unexpectedly. It comes up during the transforming from already known situations and rarely can disorientate the operator.

The other side of the question is that the operator hasn't got well-defined protocol of actions in such conditions, so the IM control system switches to a mode of general IM displaying. This mode corresponds to a base information model. The corresponding report emerges in supplementary display devices or the parts of the screen, designated for displaying of additional information, to show the data on features of the situation or appearing threats.

Conclusions

The approach to the development of information models system for the information support of operator's activities on air traffic control is suggested in the article. Main features, taken as a basis of the offered approach, are:

1. Use of intellectual technologies of IM synthesis and control.
2. Accommodation of background research and modeling of operator's behavior.
3. Revelation of specific scenerios of operator's activities.
4. Comparison of behavior situations and scenerios.
5. Engineering of IMs, which correspond to operator's behavior scenerios.

Such an approach to IM engineering is caused by the fact that operators of air traffic control are obliged to work in conditions of dynamic change of the current situation. Environment change dynamics can be characterized as high and very high. It is also should be noted that the air traffic control system is an open-end system and can be affected by lots of factors: from technical to

political. Under such conditions the use of mature methodologies for IM development can lead to uncontrollable information overloads and lowering of the effectiveness of operator's activities. Application of the proposed method allows to restrict the number of IMs, conduct their setting and adjustment as well as to provide the operator with the supplementary information in case of unpredictable change of the current situation. The use of intellectual technologies can help to realize mechanisms of the best practice accumulation and relatively easily modify synthesis and control system without the necessity to rework system in whole.

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СЦЕНАРНИЙ ПІДХІД РОЗРОБКИ СИСТЕМИ ІНФОРМАЦІЙНИХ МОДЕЛЕЙ ДЛЯ ІНФОРМАЦІЙНОГО ЗАБЕЗПЕЧЕННЯ ДІЯЛЬНОСТІ ОПЕРАТОРА АВТОМАТИЗОВАНИХ СИСТЕМ УПРАВЛІННЯ

М.А. Павленко, А.І. Тимочко, П.Г. Бердник, А.С. Шевченко

У даній статті розглядаються питання проектування і розробки системи інформаційних моделей для інформаційного забезпечення діяльності оператора автоматизованих систем управління повітряним рухом. Пропонується провести аналіз діяльності оператора, оцінити витрати часу на виконання різних дій пов'язаних з аналізом інформаційних моделей, і виділити набір стандартних дій в різних умовах складної повітряну обстановку. Виділення стандартних дій оператора дозволяє скласти алгоритми або сценарії його дій, що в свою чергу служить основою для розробки безлічі інформаційних моделей, що забезпечують інформаційну підтримку аналізу обстановки та прийняття рішень. Реалізація даного підходу можлива при використанні інтелектуальних інформаційних технологій. Це підвищує якість розробки системи інформаційного забезпечення, дозволяє синтезувати і управляти інформаційними моделями і забезпечує підвищення оперативності діяльності оператора при управлінні повітряним рухом.

***Ключові слова**: оператор, інформаційна модель, управління, ергономіка, діяльність оператора, прийняття рішень.*

СЦЕНАРНЫЙ ПОДХОД К РАЗРАБОТКЕ СИСТЕМЫ ИНФОРМАЦИОННЫХ МОДЕЛЕЙ ДЛЯ ИНФОРМАЦИОННОГО ОБЕСПЕЧЕНИЯ ДЕЯТЕЛЬНОСТИ ОПЕРАТОРА АВТОМАТИЗИРОВАННЫХ СИСТЕМ УПРАВЛЕНИЯ

М.А. Павленко, А.И. Тимочко, П.Г. Бердник, А.С. Шевченко

В данной статье рассматриваются вопросы проектирования и разработки системы информационных моделей для информационного обеспечения деятельности оператора автоматизированных систем управления воздушным движением. Предлагается провести анализ деятельности оператора, оценить затраты времени на выполнение различных действий связанных с анализом информационных моделей, и выделить набор стандартных действий в различных условиях складывающейся воздушной обстановке. Выделение стандартных действий оператора позволяет составить алгоритмы или сценарии его действий, что в свою очередь служит основой для разработки множества информационных моделей, обеспечивающих информационную поддержку анализа обстановки и принятия решений. Реализация данного подхода возможна при использовании интеллектуальных информационных технологий. Это повышает качество разработки системы информационного обеспечения, позволяет синтезировать и управлять информационными моделями и обеспечивает повышение оперативности деятельности оператора при управлении воздушным движением.

***Ключевые слова**: оператор, информационная модель, управление, эргономика, деятельность оператора, принятие решений.*