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FEATURES OF CREATING BASES OF GEOSPATIAL DATA FOR AIR NAVIGATION PROBLEMS

L. S. Chubko, ***S. O. Yasenev***

National Aviation University

yasenev91@gmail.com

The purpose of this article is to consider of motion mapping process using databases of geospatial data. This article presents features of spatially distributed information for determine the location of moving objects. It has been analysed the process of cartographic background in air situation display systems. It has been resulted methods for creating base map data in dynamical systems, taking into account the properties of digital maps and geodetic framework precision.

Keywords: spatially distributed information; geospatial data bases; display of objects; digital maps; relative location; geodetic framework; coordinates.

Розглянуто особливості подання просторово-розподіленої інформації для визначення місцеположення рухомих об'єктів. Проаналізовано процес картографічного фону в системах відображення повітряної обстановки. Наведено методи створення баз картографічних даних у динамічних системах із врахуванням властивостей цифрових карт і точності геодезичної основи.

Ключові слова: просторово-розподілена інформація; бази геопросторових даних; відображення об'єктів; цифрові карти; взаєморозташування; геодезична основа; координати.

Introduction

One of the main issues that define the problem of a dynamic object construction is availability of territorial maps and the possibility of drawing symbols of dynamic objects to the background of map. Cartographic information is used as part of air environment dynamic scenes that provides visual information about movement of dynamic objects.

So, it remains actual problem of constructing accurate air navigation maps, which are based on topographic maps. Thus, it is required geodetic and cartographic providing of flight safety, one factor of which is determining the exact coordinates, creating and updating maps and flight routes.

It is required accurate determination of location of dynamic objects, navigation aids, obstacles, terrain objects and other air navigation facilities to fulfill the requirements of air traffic and to improve the level of integrated security.

All this information should be supplemented with data of geodetic binding of air navigation benchmarks (ANB), buildings and structures. The current accuracy limit of determining ANB geodetic parameters is given in a document [1].

Formulation of the problem

The topicality of article is determined by a significant increase of velocity and number of moving objects and, consequently, the complexity of their reflection, recognition and interaction with them.

GIS is a source that provides cartographic information provision, which is necessary to build dynamic scenes that reflect the movement of objects in space and time on its background [2].

The selection of database (DB) building principle is crucial in tasks of finding and analyzing of cartographic data beginning from spatial static tasks of finding and analyzing geospatial data that require the use of operations of intersection of two cards and to the complex dynamic tasks that require real-time work, which inherent in the operational control systems [3].

Often it is necessary to solve problems that require the use of geometric search area in the analysis of air situation.

Therefore it is becoming necessary to automate some tasks of analyzing the situation, which have been good formalized. The processing time of large amounts of information can be significant, which could adversely affect the performance of such automated systems, leading to an increase of single processing time scope.

However, with the right selection and use of databases architecture and algorithms the number of simultaneously tracked objects can be increased several times, along with this it will be able to solve applied problems [4].

Analysis of research and publications

Analysis of the literature on cartographic providing of air situation display system showed that the optimal model of building cartographical databases (CDB), which can be used for air traffic control and flight safety, is georelational model [2–3], which is widespread.

Today, there are a number of creation and functioning CBD problems, which can be used to tasks of displaying aerial and ground conditions

[3–6]. The basis is graphic information — a cartographic representation of the terrain, the symbols of moving objects that appear on the cartographic background [7; 10]. Noting the basic functions of maps as models of reality, one must include the following functions: communicative, prompt, informative and predictive, noting especially operative.

To date, such scholars are working on this issue. There are O. Berlyant, B. Hoffman-Vellenhof, A. Liashchenko, J. Karpinski, D. Schetinin, S. Laletin, K. Legat, M. Wieser, A. Chechina, A. Kasim, M. Demers, E. Falkov, A. Koshkarev, V. Karakin, L. Mestetskyy, M. Vasyuhin, V. Shevchenko, M. Lysenko, B. Davidson, A. Bondarenko, V. Zolotukhin, V. Isaev, S. Kredentsar, J. Martin, N. Mukhina, V. Hulevets, M. Kasim et al.

Objectives

Creating a system of cartographic information about the area with the following reflection of aircraft on its background in the form of dynamic scenes is one of the main tasks of displaying air situation under the airport and at the surrounding areas [7].

Maps are used to determine the position of objects in space and visual display of the geographical environment and landmarks (salient features).

It should avoid excessive complexity of the map. Reducing complexity is done through submission of maps in assets of the most informative areas of characteristic features (landmarks), the following sets of contours and image compression.

The initial data are the working maps, plans, aerial and satellite images of the earth's surface, etc. The scales of the image must to be interchangeable for specific tasks depending on the area, flight altitudes, weather conditions etc. [8–9].

Statement of the main material

An important part of the display systems is software that provides a solution to all problems related preparation of initial data, the numerical processing of source data, obtaining statistical results, visualization of air and ground situation with the display of dynamic objects. The exchange of information is carried out through external (exchange) files. The required output of various cartographical terrain and obstacles data and dynamic objects with the following mapping this information into a dynamic visual image on the screen. For this purpose software system should be guided with the characteristics of the coordinate system which is made binding maps (Fig. 1).

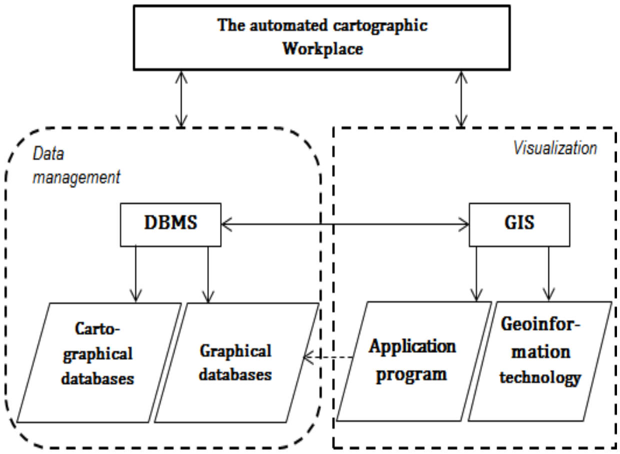

Fig. 1. Schematic diagram of the complex reflection

Use of maps as special models of geographical reality in the process of environment presentation organization in the systems of operative cooperation folds the cartographic method of research. It includes a visual analysis, cartometry and morphometric, graphical and mathematical analysis. It is reasonable to use the standard set-theoretic operations such as union in the formation of complex objects or intersection - when searching or the isolation of the facility and there is an important optimization problem - increasing reliability with simultaneous reduction of time costs [9]. The most important step – stowage of the mathematical model that is studying: the first step in this direction is parameterization, i.e. description of the selected elements and basic operations on it using certain parameters. In classical dynamical systems used only the so-called continuous parameters, i.e. variables that take any real values in the interval $[a, b]$ (where $-\infty < a < b < +\infty$). On generalized dynamical systems with continuous parameters discrete parameters can be viewed too. The special role is played with parameters which accept the eventual amount of values. They help to describe the processes and objects that cannot be described by conventional numerical parameters, and differ only qualitatively. The parameters describing the system, in general, change their value in time. Dependencies between parameters in accordance with it can use the values at different moments in time. For example, setting $z(f)$ may depend on the parameters $y(t-a)$ and $x(t-b)$ in the times preceding the point in time t. Finally, with well-defined functional dependencies (defined single-valued function) in generalized dynamical systems are widely used all sorts of probabilistic correlation [9–11]. Recent advances include object database view, multiple geometry objects, and interfaces. These supplement the existing database versioning, active representation and automated generalisation capabilities to give a complete and cost-effective flow line for multi-product generation. Problem is reflected in displays of spatially distributed information in the form of maps and dynamic objects on it. A database task is to save all the data of interest in one or more places, in such a way that eliminates unnecessary redundancy in advance. Naturally, the most significant factor in the life cycle of applications running on the database is the design stage. From being so carefully thought out structure database as clearly defined relations between its elements depends on the performance of the system and its information richness. To do this, use information model (IM) — a means of forming an idea of the data, their composition and use in specific circumstances. Using modern software packages can without touching IM, create complex DB, but if you want the information system worked quickly and took the minimum amount, cannot do without first analysing the problem using IM.

To describe the informational problems are three types of representations IM:

1. The conceptual — covers the whole problem in terms of administrative information system, ie the person responsible for the work on the whole database, whose idea of a future task should be summarized in a conceptual model;
2. The external — displays the picture of the problem in terms of a particular user, ie the person who solves the narrow task of the system at a particular workplace, which means that each information system will have multiple external representations in IM;
3. The internal — displays information about the representation problem based developer features and capabilities of a particular DBMS.

The main stages of BKD:

1. Identify information needs base map data;
2. Analyze real-world objects that you want to simulate the database and generate a list of them;
3. Put in correspondence the nature and characteristics — tables and columns (fields) in the notation of the selected DBMS (Paradox, dBase, FoxPro, Access, Clipper, InterBase, Sybase, etc.);
4. Determine the attributes that uniquely identify each object;
5. Develop rules that will establish and maintain data integrity;
6. Establish links between objects, to normalize tables;
7. Address the issue of the reliability of the data and, if necessary, secrecy of information.

In relational theory is one of the key concepts relevant. In the language of mathematics is defined as the ratio. Have asked *n* sets of U_1, U_2,..., U_n. Then *R* is the ratio of these sets if *R* is the set of ordered sets of the form $<u_1, u_2, ..., u_n>$, where u_1 — element in U_1, u_2 — element in U_2, ..., u_n – element in U_n. In this set of species $<u_1, u_2, ..., u_n>$ called tuples and sets U_1, U_2, ..., U_n — domains. Each tuple consists of elements that are selected from their domains. These elements are called attributes and their values — the values of attributes.

Model of dynamic scenes air situation

Presentation of the air situation as dynamic scenes, which is a graphical representation of the dynamics of aircraft movements on cartographic background, provides additional assistance operators in decision making under time limit [7, 11–12].

Construct a model of such a scene. The set of objects that are presented as part of an image, and vary widely in their information content, the nature of the processing and visualization, denoted by $U = \{u_i,\ i \in I\}$, where u_i — element of the sets of objects, I — set of indices. Element u_i make the description as a tuple, ie, submit it in vector form: $U_i = (U_{i_1}, U_{i_2}, ..., U_{i_n})$.

For the *n*-th element of the tuple is written inclusion relation $U_{i_n} \in Dom(A_{i_n})$. Therein A_{i_n} — attribute name that corresponds to the *n*-th element of the tuple, and $Dom(A_{i_n})$ — range of values the attribute with the name A_{i_n}. Attributes represent properties of objects of the image. Of course all the objects are divided into two classes: static *S* and dynamic $D{:}\, U = S \cup D$. The former includes cartographic objects, images, borders areas, corridors, etc. The second are mark aircraft, tracks, forms and more. It should be noted that from the standpoint of computer graphics such division is arbitrary, since the card can move, changing the relative position of its elements (for example, scaling or shear center). Among the set of objects *U* (or its subsets *S* and *D*) distinguish three types of objects (classes): thematic *T*, graphical *G* and spatial *P*. Thematic data describing meaningful (semantic) content of information graphical make the display language that uses symbols and natural language, spatial data reflect the geometric structure of the graphical model. The corresponding distribution of the original set of objects into classes related subsets described by its attributes. Contiguous classes are *T*, *G* and *P*, by definition, do not intersect: $T \cap G \cap P = 0$. They form the basis infology database of computer graphics. These objects are projected onto the graphical model *G*, which includes relevant graphics (images themed objects). Under echoing air situation it is using conventional, linear, polygonal graphic elements and text. Binding of elements (location and orientation) is accomplished by using spatial data model *P*.

To do this, there introduced regular (coordinate) grid in the earth coordinate system (it is based cartographic projection of the global coordinate system) into *G*.

On the set of content objects *T* asked a set of rules and defines the mechanism for selecting objects. Operation of interactive computer graphics system provides the appropriate tools, which is based on a set of functions (icons) is set to sets of objects. It seems most attractive operating environment *Windows*, which provides a convenient and versatile multi-window interface. It realized using a wide range of functions and operations. Flexible operating of environment that supports graphical mode is realized not only as a preset, but in giving the operator a certain freedom of choice.

Conclusions

Analysis of the known methods of cartographic representation of the process in the background air situation display systems can identify some features to consider when creating a base map data: multi-layered nature of digital maps, object-oriented nature of digital maps, and the size of the plot area on the map that is displayed its scale.

Need to decide on the establishment of functional connections. Depending on the nature of the data one can apply different design techniques, or change the viewpoint on the data. In an exploratory environment the dynamic symbol will be one of the strong alterative views on the data that supports knowledge discovery.

One must consider the results of simulation modeling and mapping requirements of dynamic scenes. The display system should represent a dynamic scene with a synchronous transformation of character images of moving objects in near-Earth space and cartographic background.

To ensure accurate mathematical foundations of digital maps should be formed such mapping database which should contain the coordinates of the objects and elements of their relative orientation.

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