Methods of Building Visual 3D Models Based on Descriptive Geometry

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ABSTRACT

In this article the necessity of development and improvement of visual data models, methods of their use is clearly described. An approach to the construction of multicomponent visual 3D models is presented, which allows checking, interpreting and analyzing spatial information using the example of models based on descriptive geometry.

KEYWORDS: *3D modeling, visualization methods, visual images, data processing technology.*

The use of visual methods for analyzing and visualizing information has numerous advantages, one of which is the high speed of understanding the general meaning of the data and discovering the features it contains. A separate direction in visual data analysis is the creation of 3D models - three-dimensional graphic images capable of having a diverse information basis.

The aim of the research is to substantiate the relevance of the use of three-dimensional visual models in the analysis of complex heterogeneous data. The effectiveness of using visual 3D models is due to the fact that associative figurative thinking of a person is connected to the analysis of information. In many cases, the creation of such a model allows solving numerous spatial problems for which any other solution is difficult. An important feature of 3D modeling is the ability to create models, both real spatial objects and non-existent ones. A separate task, which in the general case does not have an unambiguous solution, is the creation of models in the absence of information about the spatial characteristics of the original objects.

The three-dimensional space in which the model is created has an intuitive associative relationship with the coordinate representation familiar to the observer. Therefore, 3D models are a convenient way to represent information about real spatial objects, making it easy to recognize and visualize. In many tasks, the created 3D models can be considered as a compact and effective way of representing and solving all kinds of problems.

In addition, the modeling space can play an important role in combining the presentation spaces of models that have completely different information content. This makes it possible to supplement the perception of each of these computer animation models with new information, as well as to significantly speed up the interpretation of the data offered to the observer. As a result, when creating visual 3D models, there is often a desire to use the modeling space to combine models of all data that are relevant to the problem under study. One of the estimated parameters of a visual model is its information value, which is determined both by the number of information sources connected to the model and by the speed of data visualization. Questions that arise when developing visual 3D models from descriptive geometry are as follows:

- the general formulation of the problem for the solution of which the model is created;
- data sources whose participation in the formation of the model is mandatory;
- ways of presenting data of different types in a single three-dimensional space for creating a

model;

- ways of additional processing of the initial data and options for including the results into the model, subject to an increase in the information value of the model;
- assessment of the accuracy (detail) of the initial information required for correct visualization, as well as possible options for simplifying the model;
- determination of data visualization methods that allow interpreting them as efficiently as possible, taking into account all the available components of the model.

It is known that the use of a computer in the classroom of engineering graphics plays an important role in the successful development of students' spatial representations, since the computer has great capabilities to demonstrate spatial processes. In order to show spatial processes and develop spatial representations among students, we have created more than two hundred computer animation models (CAM) using engineering graphics.

Computer animation models are animated (dynamic) images that make it possible to visually observe and understand all existing spatial processes in descriptive geometry and drawing courses.

Colored computer animation models must meet all the requirements of the principle of clarity and didactics, as well as complement the text and reveal their scientific meaning.

The practical side of animation models is that with their help it is easy to understand, comprehend abstract concepts and spatial processes of which cannot be explained in words or other traditional means.

Computer animation models must meet the following requirements:

- each animation model must be logically complete;
- fully reveal the scientific meaning of abstract concepts and spatial processes;
- correctly written CAM script from the point of view of the subject;
- animation models must meet all the requirements of didactics;
- while creating CAM, take into account the age, physiological, psychological aspects and needs of students;
- CAM should complement each other.

In the aggregate, CAM should be a single, logically complete complex.

Taking into account these requirements and existing problems, with the help of the 3Ds max graphic program, we have created over a hundred computer animation models for descriptive geometry on the following topics: projection methods; point, line and plane in a rectangular projection system; solution of positional and metric problems on the relative position of points, lines and planes; methods of transforming a drawing, intersecting surfaces with a plane and determining the true size of a section figure, etc.

As an illustrative example, consider the creation of a 3D model based on descriptive geometry. In general, such a model includes several computer animation models at once: a model that describes the structure of a modeled object, a surface model, objects (point, line, plane, etc.). For a number of reasons, each of these computer animation models can have its own source of one for modeling information. This information, in turn, can be of a different type (digital data, photographs, diagrams, drawings, etc.), as well as different detail or reliability.

The construction of such a model can pursue several goals: comparing information obtained from different sources, but having overlapping areas, modeling technological processes, searching for visual solutions for some tasks, and, finally, forming a full-fledged understanding of a complex system of spatial objects in the observer. In the latter case, the requirements for data accuracy are not as high as in modeling for solving spatial problems. In such a situation, it makes sense to assess the quality of all information sources connected to the model in order to determine the most accurate one and consider it as a reference when building a model.

At the next stage, the mechanisms for using the initial information are developed, which includes the possible conversion of data formats, the definition of appropriate procedures for modeling 3D geometry, as well as options for using data that do not correspond to the visual model in dimension. The answers to these questions can be obtained by identifying the software involved in creating the model. At the moment, there are a large number of programs designed for 3D modeling, both specialized, with three-dimensional modeling tools only for certain tasks, and universal, with a very large, constantly replenishing set of tools.

Together with the issues of importing external data, it is necessary to decide on the choice of the most correct one, from the point of view of the general purpose of creating a model, and their informative presentation. The search for an adequate metaphor of presentation is a separate independent task of modeling due to the fact that the presence of several information sources in a model can lead to the creation of computer animation models, the simultaneous perception of which in a single visual space becomes difficult. In addition, modeling and possibly animation of some objects can be a labor-intensive process from both technological and computational points of view. Usually, this concerns the modeling of complex objects. In addition, the model can contain data, the visual representation of which is conditional.

The tasks of choosing a representation at the modeling stage can be solved in different ways. In some cases, the capabilities provided by the modeling tools are used. For example, texturing is a powerful tool that sometimes avoids overly detailed re-creation of an object's geometry. In other situations, it makes sense to develop your own visual image for the data, which allows the observer to correctly understand the information contained in it, but does not create insurmountable difficulties in modeling. One of the common solutions is the use of color coding, which allows you to visualize scalar data on 3D surfaces with a good degree of clarity. If the information on the basis of which the model is created is of a more complex nature, then the question about the corresponding visual image can have a variety of answers. In any case, it must be remembered that the main priority is not the visual image of a separate information component of the model, but the general goal of its creation and the information value of the model determined by this goal.

Finally, in addition to resolving all design issues, it is necessary to develop another component of any 3D model. It is about defining ways of observing the model, examining it visually, and possibly changing the parameters that control the options for representing the model. There are quite a number of different techniques that allow you to effectively take advantage of the three-dimensional representation of data in visual models. These include, for example, a panoramic view, observing the model from any convenient point or from a selected angle, simplified (with reduced detail) presentation, the ability to exclude individual components from the visual image of the model, etc. The 3Ds package was selected as the modeling environment Max from Autodesk, which provides 3D modeling capabilities and meets the requirements of the problem being solved. This package is a fairly universal tool that allows you to effectively use it for the tasks of creating three-dimensional geometric objects of different types in a single spatial multicomponent model. In addition, 3Ds Max has tools for interaction (including at the level of data format exchange) with many other software products, as well as for working with textures. All this makes it possible to significantly simplify the creation of models of objects with complex geometry, no symmetry or regular structures. It is with such objects that one has to deal with when modeling most natural objects.

The efficiency of using visual 3D models for transformation and analysis of complex information has been substantiated. A visual 3D model with descriptive geometry has been built, which has the necessary means of observation and study. The information content of the model unites in a single visual space all sources of information available when creating the model. Provided the ability to supplement and expand the model when new data is connected, as well as mechanisms for combining heterogeneous information within a single model. The described technology in the general case can be applied to create visual 3D models of objects of a very different nature, degree of complexity and using sources of information of different types.

But we must take into account one thing, where and how, to what extent to use computer technologies in the process of teaching descriptive geometry, and their practical significance depends only on the skill of the teacher. Because live communication between students and the teacher, their emotional state, as well as the knowledge, ability, skills and professional training of the teacher is also not unimportant in increasing the efficiency and quality of teaching descriptive geometry.

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