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DESCRIPTION OF OBJECT MODELING METHODS IN AutoCAD ENVIRONMENT

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The main objective of the work is to develop a program for the construction of computer graphic models of real objects in three-dimensional space, as well as of relief perspectives of compositions in interactive mode formed by means of various objects.

For the development of the program, the following baseline data can be used:

a) the geometric description of a real object or a composition formed from several objects (i.e. shape, dimensions and mutual position of the objects);
b) as a starting point, a three-dimensional graphical model of a real object or a composition of several objects in any computer graphics system.

The choice of the first version of the baseline data is not recommended because there will be a need to repeat the development of already existing programs intended for the three-dimensional graphic modeling of objects. Therefore, we choose the second version of the baseline data. In case of selecting this option, the construction of the relief perspective graphic model of the object can be carried out by modifying the already built three-dimensional graphical model of the object. This approach is justified if the fairly high level of development of modern computer graphics and such a wide market of various computer software means intended for the automation of graphic modeling and graphic information processing are taken into account.

Keywords: baseline data, graphical model, composition, relief perspective, modeling, surface, three-dimensional set.

Introduction.There are well-known leaders in the market, one of which (if not the first) is the automated graphic system **AutoCAD**, that implements the modern 3D (three-dimensional) modeling and design technology. Since the **AutoCAD** system has the widest possibilities for graphical modeling and modification of the above mentioned models compared to other similar systems, it is world-renowned and is considered to be the most suitable one for solving the problem proposed by us, therefore it is thought appropriate to develop a relief perspective construction program to be implemented in this very environment□ Programs designed for **AutoCAD** can be developed (or introduced) in a number of programming languages, including **C**, **C++, Visual Basic, AutoLISP**. The latter, that is the **AutoLISP** language, appeared to be the most suitable among these languages, as it can fully use

AutoCAD graphic database and is efficiently dealt with. Thus, we will present the developed program in the **AutoLISP** language.

The real possibility for the existence of any model is primarily due to the accurate geometric modeling of the object, during which the geometric properties of the object are reproduced: shape, dimension and position. The following two main methods of geometric modeling of objects are used in AutoCAD.

Modeling by means of two-dimensional surfaces. The essence of this method is that only the two-dimensional closed surface of the projected object is modeled, which is formed as a combination of the simplest faces (plane and curve). This method is more often used in the design of complex, dynamic surfaces, especially in such cases where high accuracy and aesthetic requirements are needed for the designed surface.

Three-dimensional solid modeling. The essence of this method is that not only the surface of the projected object is modeled, but the entire three-dimensional set of the points bounded by it is also projected, in case of which the model is formed as a combination of the simplest bodies. This method is more often used in the design of such parts of the machines that can be obtained by stamping and cutting.

The abovementioned methods of geometric modeling should not be confused with the modes of projecting the model on the screen. In **AutoCAD,** the following projecting modes are used.

• ***Wireframe mode (2D Wireframe).*** The model is depicted by means of one-dimensional lines. On the screen, only the frame is visible constructed with the edges of the object.

• ***Invisible line exclusion mode (Hidden).*** This mode allows to take away the edges of the object which are invisible in the current view.

• ***Shade mode (SHADEMODE).*** The current view presents a painted **(**shade mode) model of the object.

• ***Render mode (RENDER).*** Thi**s** mode allows to obtain a realistic model of the object in successive steps, taking into account its material, light and color properties.

In order to clarify the peculiarities of the geometric modeling methods, let's consider the modeling process of the object (real object) depicted in Fig. 1, applying each of the methods listed above.

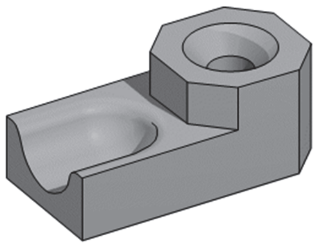
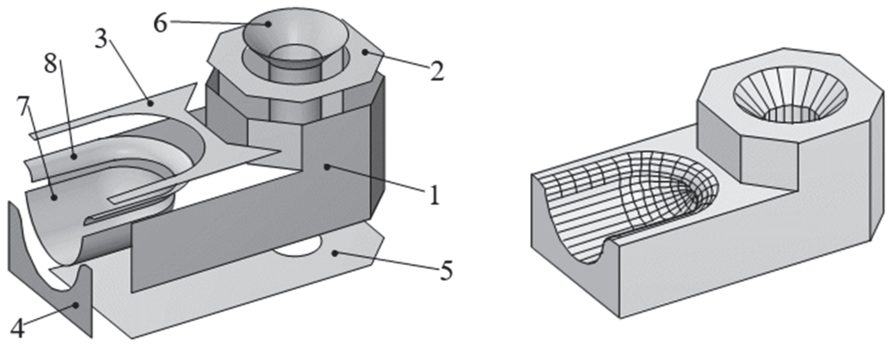


Fig.1. Object modeling

In order to obtain the geometrical model of an object with the help of **k** two-dimensional surfaces, it is necessary to perform an analysis of the shape of the given object, during which its surface is mentally divided into such separate simple faces (plane and curve), each of which can be matched (approximated) to the geometric model with any plain or textured surface having a certain accuracy built in the **AutoCAD** system [1-6].

In our example, the surface of the object being considered can be divided into the following component parts (Fig.2a).

Component **1** consists only of flat sessions and can be built with the implementation of **3D Face** command.



a) b)

Fig.2: a - Division of the object surface into component parts, b- The geometric model of the object constructed by the method of surfaces

Components **2, 3, 4, 5** are smooth regions **(Regions**) that can be constructed with the help of respective lines by means of the **Boundary** command.

Components **7, 8** are surfaces of revolution, for the construction of which it is necessary to have the respective nodes (generatrices) and axes of revolution. The construction is performed with the help of the **Revolved Surface** command. Component **8** can be obtained as Kuhns surface which is defined by four lines (edges) connected to each other. The surface construction is realized by means of the **Edge Surface** command. After having constructed the above mentioned components of the surface of the object, it is necessary to check the accuracy of their mutual position and include them in a single group. This is possible with the help of the "**GROUP**" command.

Fig. 2b shows the geometric model of the considered object built by the method of surfaces, which is depicted by the modes of excluding both the frame and invisible edges.

In the case of k three-dimensional solid modeling, an analysis of the shape of the object is also performed, during which, however, it is necessary to mentally divide the object into such separate simple parts, the combination of which will make it possible to form a very composite body modelled by the given object.

The main core of the solid geometric model of the very object considered above can be formed and constructed by using rectangular parallelepipeds **A, B**, cylinders **C, D** and sphere **E** (Fig. 3a). By combining the parallelograms **A** and **B,** subtracting bodies **C, D, E** from the obtained result, we get the composite body the image of which in the frame mode (excluding invisible faces) is shown in Fig. 3b.

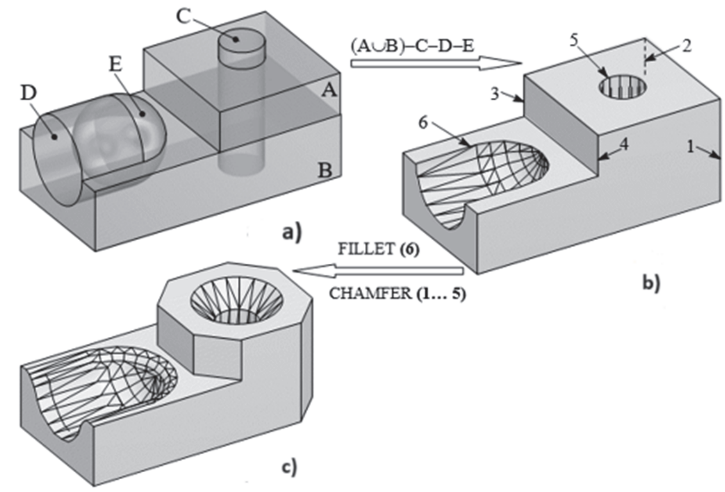


Fig. 3. Three-dimensional solid modeling: a,b,c

After chamfering **1, 2, 3, 4** rectangular and **5** circular sharp edges (sides), as well as filleting **6** sharp edges (FILLET) of the obtained body we get the finished complete solid geometrical model of the object under consideration, depicted in Fig. 3c.For developming the program for the construction of the graphical models with **k** relief perspective of the real object, we choose as a baseline object the graphical model formed by means of surfaces as the coordinates of the lattice points (nodes of the polyhedron) necessary for its geometric transformation stored in the graphic database of the **AutoCAD** system in the form of special lists, the application of which while programming, can be available through special functions of the **AutoLISP** language.

Graphical models of surfaces in **AutoCAD** are generally built by means of the approximation method. In other words, the curved surface is replaced by such a semi-circular face surface the vertices or lattice points of which (nodes) belong to the curved surface. In order to build the lattice, it is necessary to propose a two-parameter array of lattice points (nodes), a matrix of dimension **M*N**. **M** and **N** are the number of the lattice points selected in the respective directions. For example, the lattice depicted in Fig. 4a is constructed using a 5*5 array of points (the total number of the lattice points is equal to **25**).

The denser the lattice, the more accurately the curved surface being modeled is approximated. Besides, during the model visualization process, **AutoCAD** provides us with the opportunity to smooth the lattices, in the result of which we obtain a rather smooth graphical model of a curved surface (see Fig. 4b).

It is obvious that any surface can practically be modeled by means of proposing the lattice method.

The designed primitive for constructing graphical models of arbitrary curved surfaces is the lattice, which is an ordered combination of faces and is perceived as a whole. The construction of the lattice is performed with the help of **3DMESH** command.

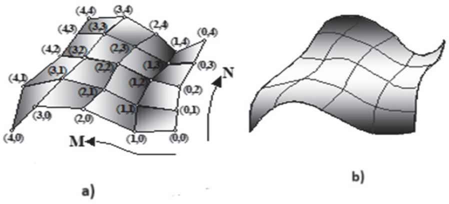


Fig. 4. Construction of graphical models of curved surfaces: a,b

The command is carried out as a result of a simple dialogue, at the beginning of which it is required to specify the dimensions of the lattice, that is, the number of lattice points in directions **M** and **N** (**m** and **n**).

After that, in a certain order (see Fig. 5) all the lattice points are presented. In every direction any point from 2 to 256 can be proposed. The command ends after the last lattice point has been presented. But the list of the lattice points of the polyhedron approximating the constructed surface is stored in the graphic database of **AutoCAD** under a special name (code) created for the given primitive.

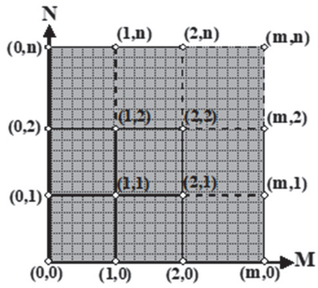


Fig. 5. Presentation of lattice points

Conclusion. In order to obtain a geometrical model of an object with the help of two-dimensional surfaces, it is necessary to perform an analysis of the shape of the given object, during which its surface is mentally divided into separate simple faces (plane and curve), each of which can be combined (approximated) with a certain accuracy to any geometric simple or formed surface.

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AutoCAD ՄԻՋԱՎԱՅՐՈՒՄ ՕԲՅԵԿՏԻ ՄՈԴԵԼԱՎՈՐՄԱՆ ՄԵԹՈԴՆԵՐԻ ՆԿԱՐԱԳՐՈՒԹՅՈՒՆԸ

Կ.Հ. Սողոմոնյան, Մ.Գ. Բակունց

Աշխատանքի հիմնական խնդիրն է մշակել ծրագիր՝ եռաչափ տարածության իրական օբյեկտների, ինչպես նաև զանազան օբյեկտներից ձևավորված կոմպոզիցիաների ռելիեֆային հեռանկարների համակարգչային գրաֆիկական մոդելները ինտերակտիվ ռեժիմում կառուցելու համար:

Ծրագրի մշակման համար որպես ելակետային տվյալներ կարելի է օգտագործել.

ա) Իրական օբյեկտի կամ օբյեկտներից ձևավորված կոմպոզիցիայի երկրաչափական նկարագրությունը (ձևը, չափերը և օբյեկտների փոխադարձ դիրքը);

բ) Համակարգչային գրաֆիկական որևէ համակարգում ելակետային իրական օբյեկտի կամ օբյեկտներից ձևավորված կոմպոզիցիայի եռաչափ գրաֆիկական մոդելը:

Ելակետային տվյալների առաջին տարբերակի ընտրությունը նպատակահարմար չէ, քանի որ այդ դեպքում անհրաժեշտ կլինի կրկնել արդեն գոյություն ունեցող այնպիսի ծրագրերի մշակումը, որոնք նախատեսվում են օբյեկտների եռաչափ գրաֆիկական մոդեավորման համար: ՈՒստի մեր կողմից ընտրվել է ելակետային տվյալների երկրորդ տարբերակը: Այդ տարբերակի ընտրության դեպքում օբյեկտի ռելիեֆային հեռանկարի գրաֆիկական մոդելի կառուցումը հնարավոր է իրականացնել այդ օբյեկտի՝ արդեն կառուցված եռաչափ գրաֆիկական մոդելի ձևափոխության ճանապարհով: Այս ճանապարհին արդարացվում է, եթե հաշվի առնենք ժամանակակից համակարգչային գրաֆիկայի զարգացման բավականին բարձր մակարդակը և գրաֆիկական մոդելավորման, ինչպես նաև գրաֆիկական ինֆորմացիայի մշակման գործընթացի ավտոմատացման համար նախատեսված բազմազան համակարգչային ծրագրային միջոցների բավականին լայն շուկան:

Առանցքային բառեր. ելակետային տվյալներ, գրաֆիկական մոդել, կոմպոզիցիա, ռելիեֆային հեռանկար, մոդելավորում, մակերևույթ, եռաչափ բազմություն:

ОПИСАНИЕ МЕТОДОВ ОБЪЕКТНОГО МОДЕЛИРОВАНИЯ В СРЕДЕ AutoCAD

К.А. Согомонян, М.Г. Бакунц

Целью работы является разработка программы для интерактивного построения компьютерных графических моделей реальных объектов в трехмерном пространстве, а также рельефных перспектив композиций, образованных из различных объектов.

Для разработки программы могут быть использованы следующие данные:

а) геометрическое описание реального предмета или композиции, составленной из предметов (форма, размеры и взаимное расположение предметов);

б) трехмерная графическая модель реального объекта или композиции объектов как отправная точка в любой системе компьютерной графики.

Выбор первого варианта исходных данных нецелесообразен, так как в этом случае придется повторять разработку уже существующих программ, предназначенных для трехмерного графического моделирования объектов. Поэтому выбираем вторую версию исходных данных. При выборе данного варианта построение рельефно-перспективной графической модели объекта может осуществляться путем модификации уже построенной трехмерной графической модели объекта. Такой путь оправдан, если принять во внимание достаточно высокий уровень развития современной компьютерной графики и достаточно широкий рынок различных компьютерных программных средств, предназначенных для автоматизации графического моделирования и обработки графической информации.

Ключевые слова: исходные данные, графическая модель, композиция, рельефная перспектива, моделирование, поверхность, трехмерный набор.