DIGITAL ELEVATION MODELLING ON CARTOMETRIC DATA

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Determination accuracy for digital elevation model (DEM) marks depends on input information obtaining methods and assigning ways and on mathematical elevation modelling methods. Basic input information obtaining methods for DEM construction are: geodesic, photogrammetric, cartometric, and in last years — terrain scanning method. The method choise depends on two main factors: point marks determination accuracy and economic efficiency.

When analyse general tendencies for methods application, geodesic method and terrain scanning are used on small areas when high accuracy for point marks determination needed; photogrammetric method is used in wide scales range from small-scale to large-scale, often for topography production renewal and for survey of dynamic processes, concerned with terrain elevation. Determination accuracy for input points of digital models with photogrammetric method depends on photographing height, camera type, atmospheric impacts, aircraft movement, which effects on aerial photo image resolution and its measuring characteristics.

Cartometric method is connected with map scanning. Since elevation is small variable with time quantity, usage of topography maps for DEM construction is justified and economically efficient. Cartometric method is mainly used for large areas DEM construction, it may be used for applications solving when scanned map accuracy ensures DEM construction accuracy demands.

Basic input information obtaining methods for DEM construction are level, triangulation and bitmap models [Magnuszewski A. 1999].

It is mentioned in [Pozdnjakov A.V., Chervanev I.G. 1990], that integral system for elevation morphology imaging is structural-digital elevation model. Such the model is specified by frame lines, which define elevation structure, it is most economic model for input data number. However, note, that structural lines often are obtained on the base of input regular or level model. In the case of such information assigning it is rational to use triangular irregular model (TIN) for DEM construction.

Bitmap model is widely used in geoinformation system as very suitable for record and search of morphology characteristics, construction of declination maps and slope expositions.

In bitmap form DEM is construct directly on previously received input information or it is transformed from other model forms.

In DEM construction practice there is often used level model, especially in the case when modelling is based on map scanning. Digitizing contours process is simplified procedure, it does not need high qualified experts.

The investigation task is to compare transfer accuracy of main morphology details of elevation, reconstructed on level model with different software and with different mathematical functions usage for simulation.

There was used topography map plane table with scale 1 : 10 000 and with cross elevation profile 5 m for experimental research.

Map scanning was done with Scanexpress 1200 scanner with resolution of 300 dpi. Digitizing was done with program Digitals. There was digitized over 78 000 points with step of 0,5 mm on contours curve up to 1 sm at the areas with unsugnificant morphology changes. Area elevation is foothills type with number of hollows, with heught differences of 300 m.

3D Studio max and Surfer 8 [www.discreet.com/3dsmax/] software were used for DEM construction. Received after scanning file is transformed into DXF, after that it is imported into 3D Studio max, Terrain modifier allows to construct area 3-d model with triangulation method (TIN-model).

Triangulation network is at fig. 1, and reconstructed 3D-model at fig. 2.

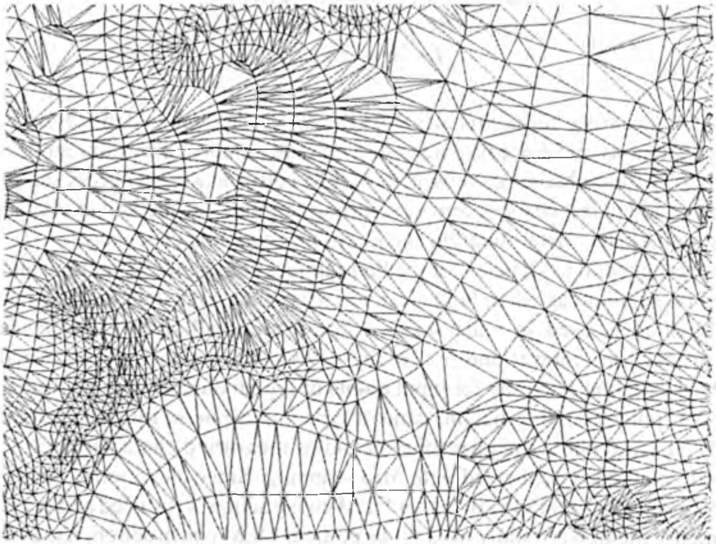

Fig. 1. The part of triangulation network

Fig. 2. 3D-model reconstruction with 3D Studio max software

Visual image of 3D-models, construct on contours demonstrates accurate and detailed transmission of elevation morphology characteristics, only in narrow hollows one can see terrace effect. However when level model is used the information is sugnificant, so small input elements of construction allows to get precise surface reconstruction. Not uniform rational B-splines are used to obtain smooth surface.

Advantages of 3-D model construction with 3DStudio max software are in possibilities to proceed to large-size image, to improve visualization accuracy. There is large tool-kit assigned for work with obtained area model and different engineering solutions comfortable design in this software. The point of special interest is option which allows to map different layer information (contours, hydrography, roads, settlements etc.) at constructed model and option to change model's attitude position, to look at it from different sides and with different angles of light source, that is important for morphology details and dynamic changed finding.

Let us imagine the same model constructiom with Surfer 8 software and with usage of Kriging method for simulation as type of collocation model [Бурштинська, 2002]. Variogram, which has linear type, presented at fig. 3, is build to obtain statistic elevation characteristic.

We chose 8 points in octant for elevation modelling, model discretization step is 10 m. Modelling parameters depends on elevation type, they are chosen on the base of previous researches, shown in [Burshtynska Kh., Dorozhynskyy A., Zazulyak P., Zajac A., 2003]. DEM construction accuracy particularly depends on model discretization. The fig. 4a presents image of input (dots) and build by DEM (solid lines) elevation contours. Its analysis illustrates high accuracy elevation modelling, only in narrow hollows and with small declination of bottom slope one can observe smoothing contours. The fig. 4 presents the same image of contours where the model discretization step is 25 m.

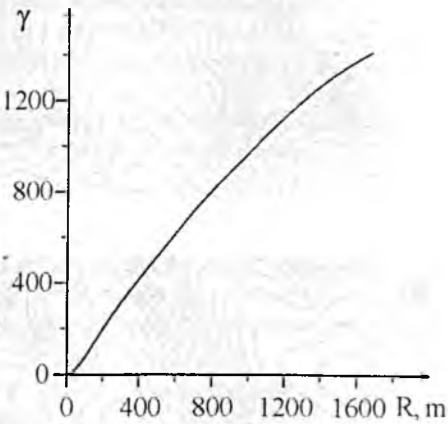

Fig. 3 Variogram

The sugnificant distortion of the morfological details in the place of the sharp bends of contours is caused by increasing sampling. Table shows the accuracy estimation of construction DEM used by Kriging method and TIN model. It is done with 6859 points random selected on contours. The accuracy estimation establishes on improvement in DEM construction with Kriging method on Surfer software.

Table. Accuracy estimation for DEM construction with Kriging method and triangulation

Method	DEM step, m	Minimum deviation, m	Maximum deviation, m	Standart deviation, m
Kriging	10	-2,3	2,9	0,3
triangulation		-6,8	6,3	0,4
Kriging	25	-5,3	3,7	0,8
triangulation		-5,4	3,5	0,9

a)

b)

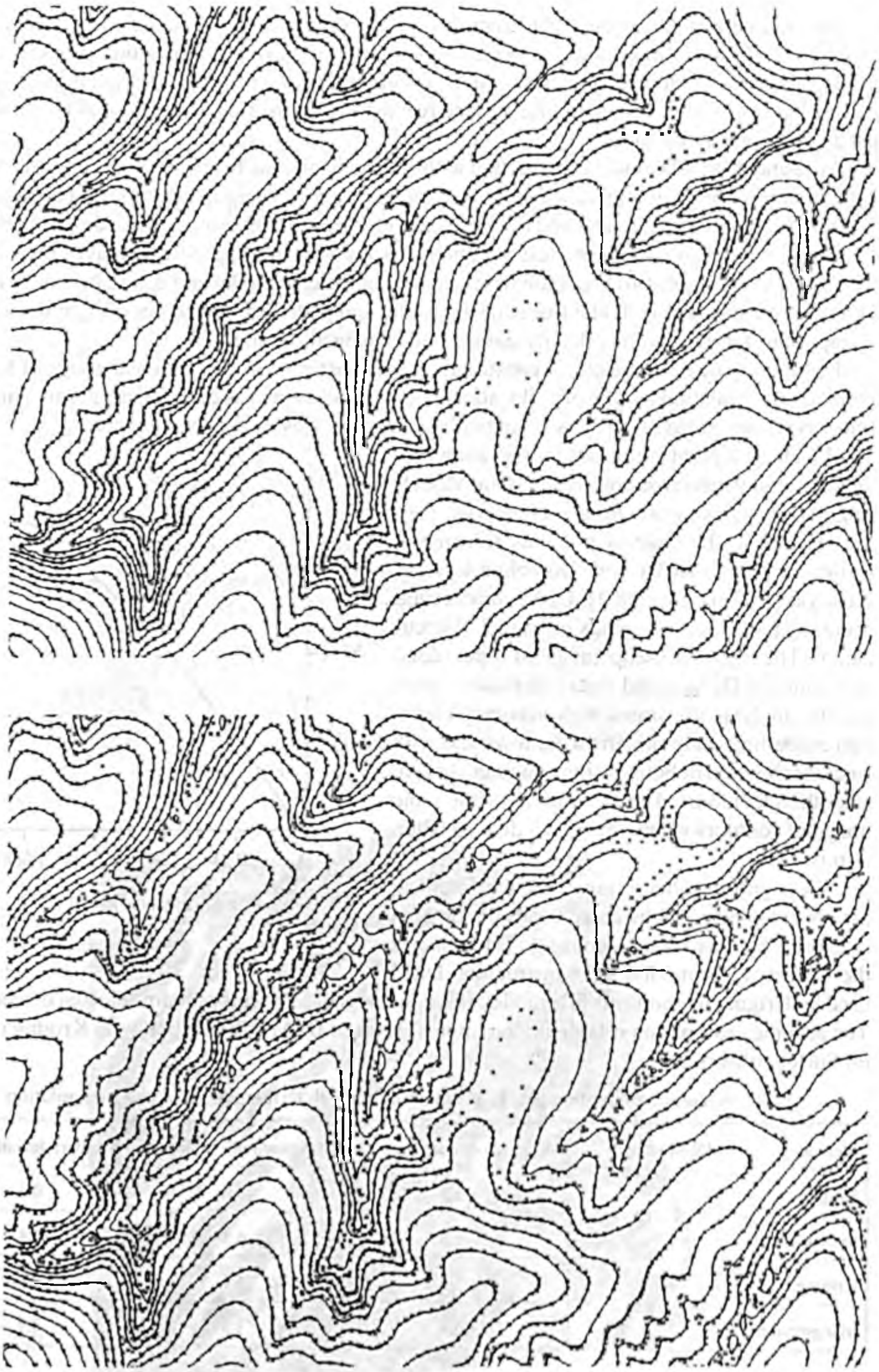

Fig. 4. The restoration image of sontours simulated with Kriging method using Surfer 8 software: a) sampling 10 m; b) sampling 25 m

Streszczenie

Cyfrowe modelowanie rzeźby z wykorzystaniem danych kartometrycznych

Mając dane kartometryczne z wykorzystaniem pakietów oprogramowania 3D Studio Max i Surfer 8 przedstawiono eksperymentalnie otrzymany cyfrowy model rzeźby. W 3D Studio Max model reliefu zbudowano metodą triangulacji (TIN) ze zgładzaniem niejednorodnymi funkcjami B-zespolonymi. W pakiecie oprogramowania Surfer 8 wysokoprecyzyjne odtworzenie modelu można osiągnąć z wykorzystaniem metody Kriginga pod warunkiem prawidłowo zadanych parametrów modelowania.

Abstract

Presented research results show us efficiency of proposed method usage for DEM construction with 3DStudio max software. Using of TIN model as method of DEM construction in in obtained of input information by level model demands a couple of input data, but allows to reconstruct small elevation details with high accuracy.

In Surfer 8 software it is appropriate to use Kriging method for digital modelling, still it is necessery to assign input modelling parameters correspondingly to the elevation type.

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