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CREATING A 3D MODEL OF THE PLANNED CONSTRUCTION AREA OF THE NPP IN AUTOCAD CIVIL

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Annotation. *This article presents the AutoCAD Civil of the area where a nuclear power plant is planned to be built. in a programme A 3D model has been created . AutoCAD Civil in article The program is considered a universal program for performing work in the field of geodesy, topography, general plans, as well as the design and reconstruction of linear objects (roads, railways, utility networks). The main feature of the program in this work is a dynamic design model, which allows you to quickly and without errors make changes to the project at any design stage and in any model image.*

For this purpose, importance is attached to issues of carrying out various geodetic surveys in the area where NPP construction is planned, processing the obtained results in special programs and creating a 3D model. During the implementation of these geodetic measurements, the data obtained using modern GNSS devices were visualized and cartographically modeled on the basis of GAT technologies.

Keywords: *Nuclear power plant, AutoCAD Civil, 3D model, dynamic, GNSS , RTK, 1st class, leveling, GRID, TIN, three-dimensional model, Delaunay triangulation.*

Annotatsiya. *Ushbu maqolada atom elektr stantsiyatsi qurilishi rejalashtirilgan hududning 3D model AutoCAD Civil dasturida yaratilgan. Maqolada AutoCAD Civil dastur geodeziya, topografiya, bosh rejalar, shuningdek chiziqli obyektlarni (yo‘llar, temir yo‘llar, kommunal tarmoqlar) loyihalash va rekonstruksiya qilish sohasidagi ishlarni bajarish uchun universal dastur hisoblanadi. Ushbu ishdagi dasturning asosiy xususiyati dinamik dizayn modeli bo‘lib, u har qanday dizayn bosqichida loyihaga va modelning istalgan tasviriga tez va xatosiz o‘zgartirishlar kiritish imkonini beradi.*

Shu maqsadda AES qurilishi rejalashtirilgan hududda turli geodeziya tadqiqotlarini o‘tkazish, olingan natijalarni maxsus dasturlarda qayta ishlash va 3D modelini yaratish masalalariga ahamiyat berilmoqda. Ushbu geodezik o‘lchovlarni amalga oshirish jarayonida zamonaviy GNSS asboblari yordamida olingan ma’lumotlar GAT texnologiyalari asosida vizuallashtirilgan va kartografik modellashtirilgan.

Kalit so‘zlar: *Atom yelektr stantsiyatsi, AutoCAD Civil, 3D model, dinamik, GNSS, RTK, 1-sinf, nivelirlash, GRID, TIN, uch o‘lchovli model, Delaunay triangulyatsiyasi.*

Аннотация. *В данной статье представлен AutoCAD Civil местности, где планируется построить атомную электростанцию. в программе создана 3D модель. AutoCAD Civil в статье Программа считается универсальной программой для выполнения работ в области геодезии, топографии, генеральных планов, а также проектирования и реконструкции линейных объектов (автомобильных, железных дорог, инженерных сетей). Главной особенностью программы в данной работе является динамическая модель проектирования, которая позволяет быстро и без ошибок вносить изменения в проект на любом этапе проектирования и в любое изображение модели.*

Для этого придается значение вопросам проведения различных геодезических изысканий в районе планируемого строительства АЭС, обработки полученных результатов в специальных программах и создания 3D-модели. В ходе реализации этих геодезических измерений данные, полученные с помощью современных ГНСС-приборов, были визуализированы и картографически смоделированы на основе технологий GAT.

Ключевые слова: *Атомная электростанция, AutoCAD Civil, 3D-модель, динамика, GNSS, RTK, Класс 1, нивелирование, GRID, TIN, трехмерная модель, триангуляция Делоне.*

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Introduction

AutoCAD Civil The 3D program is universal, allows you to organize the work of all groups of designers in a single interface environment, and also provides the basis for reading and processing data from modern GNSS systems. AutoCAD Civil When registering cartographic data in a 3D program, this allows you to automatically obtain detailed information about the place. Depending on the tasks posed in the research work, the terrain description is automatically generated into a relief model (DEM) or a model is created in semi-automatic mode (DEM) [1].

Based on the requirements of the present time, it is necessary to create a 3D model of the planned NPP construction area, conduct various geodetic surveys at the site and increase the possibility of widespread use of the results obtained. When carrying out these geodetic measurements, modern GNSS instruments and geodynamic surveys based on GAT technologies are used. Develop proposals and recommendations for creating a 3D model.

Research Methods and the Received Results

Geodetic surveying was carried out by determining the coordinates of the Nuclear Power Plant (NPP) geodynamic polygon (GDP) points using GNSS devices to create a 3D model of the planned NPP construction area. The coordinates of the points in the GDP are set based on the SK 42 coordinate system. A set of GNSS geodetic satellite rovers was implemented using GNSS Trimble R8s, CHCNAV i90 rovers of the same accuracy. These rovers have very high measurement accuracy in static and RTK modes, and the reports obtained from them are suitable for modern applications. Their constructive view is shown in pictures 1-2.

Figure 1.Trimble R8s

Figure 2. CHCNAV i90

In the 3rd stage, called the construction of a digital model of the NPP geodynamic landfill terrain, based on the results of the first class leveling, before creating a 3D model of the area, a digital model of the site was created in the geographic information systems (GAT) software AutoCAD Civil. In the creation of this digital model, the coordinates of the benchmarks established in GDP were first determined using GPS devices, and then they were redeveloped using GAT. The obtained results are uploaded to the AutoCAD Civil program according to the GDP reference Figure 3.

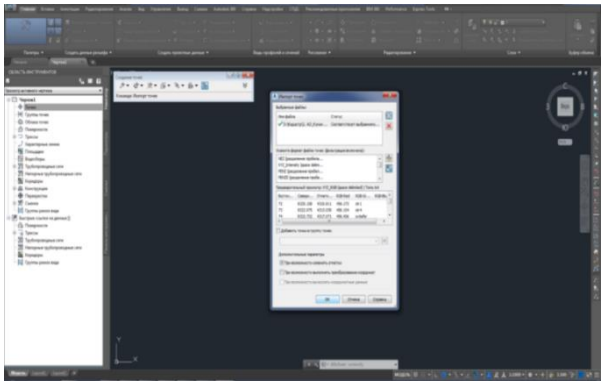

Figure 3. AutoCAD Civil working status

GNSS working rovers are ready to determine the coordinates of the NPP geodynamic polygon (GDP) points, and performing geodetic satellite surveying requires knowledge and experience. At the stage of organizing field survey work, the reference points for the installation of GDP GNSS satellite rovers were determined. These selected points acted as a support, and the rest acted as a worker. When choosing base stations and conducting measurement work, it is necessary to meet the following requirements:

- taking into account that there are no obstacles for reception of radio signals of navigation satellites in an open area, 15º and above the horizon;
- the absence of sources of electronic noise in the line of sight;
- ensuring the safety of GNSS working rovers during monitoring work;
-reliable fixation of the point center;

- the presence of conditions for getting to the point by a convenient road, stopping vehicles and placing employees.

The NPP geodynamic polygon (GDP) fully meets the above requirements and has been measured by GNSS rovers and the measured data has been downloaded in high resolution format.

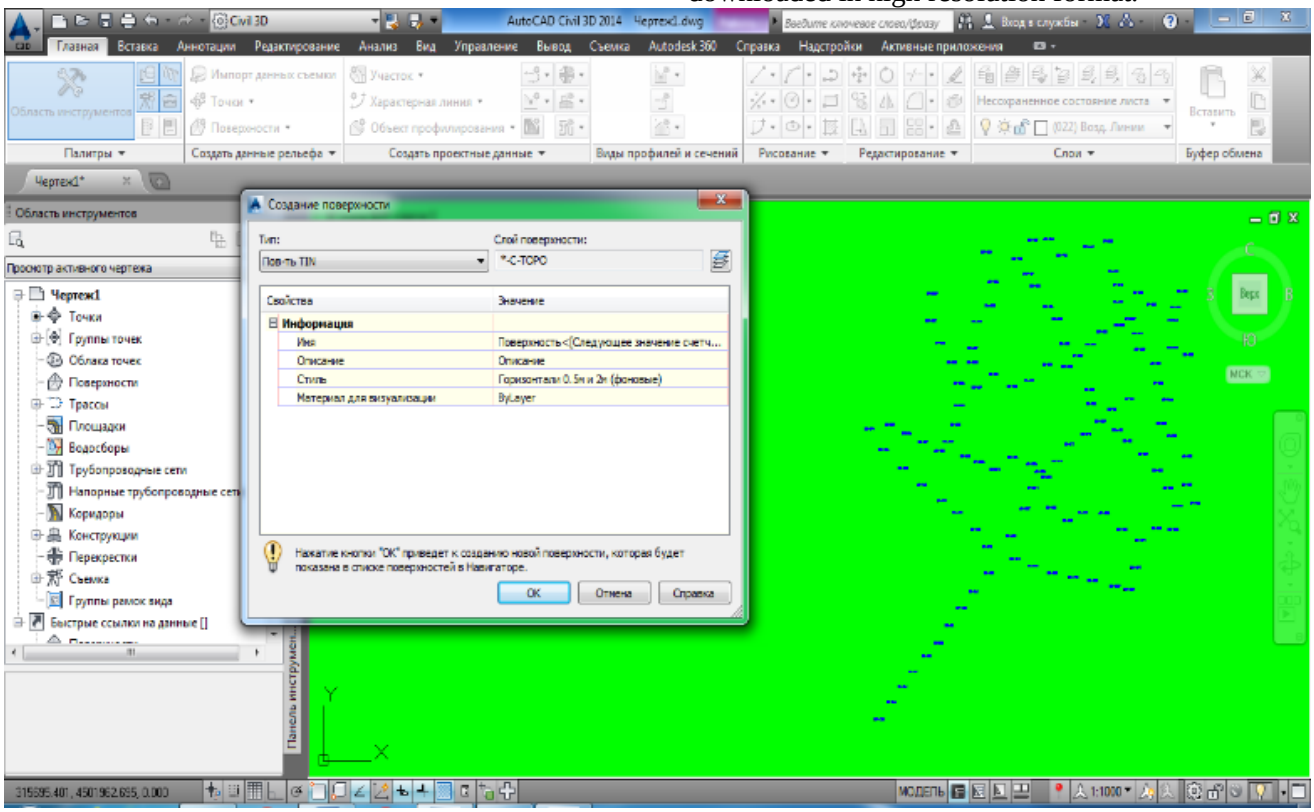

Figure 4. Loading csv files into AutoCAD Civil 3D.

Based on this data loaded into the program, the basis is laid for creating GRID and TIN location models. AutoCAD Civil 3D GRID model is one of the ways of representing spatial information in a program, in many literature related to research, the GRID model is defined as follows: Global Resource Information Database - (network, simple network) “Global natural resource database” [2] .

When you create this GRID model, the program automatically places rows and columns of information into the database. In this case, the characteristics of each geographical object are displayed as equal size .

The GRID model uses data obtained in order, i.e. by squares. This method of creating a three-dimensional model is used in places where the terrain is not complex and in work that does not require high precision. In this case, the coordinates are produced on the basis of the resulting marks in the form of solid square or rectangular cells in the form of pixels covering the grid, Fig. 5.

Data stored in the GRID format is used to reflect land use types, soil types, water surfaces, real-life events, air temperature and land topography .

The TIN model is a model in the form of a network of non-contiguous triangles, defined by nodes and edges covering the earth's surface in geographical objects (Triangulation Irregular Network) [6].

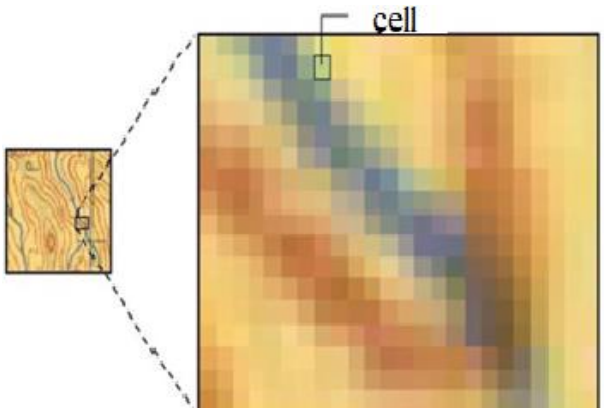

Figure 5. Representation of the GRID model

When creating a TIN model, data from nodes, edges and triangular surfaces is used:

• node – geospatial representation of a triangle with X, Y, Z coordinates.

• edge – the position of the triangle in 3D space.

• surface - the surface of a triangle in 3D space.

A TIN model is a part of the earth's surface in 3D space that has the following characteristics:

• The TIN model allows you to obtain an accurate vertical representation of a specific part of

the earth's surface using a variable density of Z-value nodes and rotation lines;

• TIN model is the basis for 3D surface visualization;

• The TIN model allows the user to perform comprehensive terrain analysis (elevations, slope calculations, area area calculations, volume calculations, vertical profiles along a line, analysis of the general appearance of the earth's surface).

A set of points with X, Y, Z coordinates is the initial data for building a TIN model. According to it, a network of adjacent isolated triangles is created from this set of points. The problem of constructing a triangle with a set of points is one of the main problems in computational geometry . Many other tasks depend on this; it is widely used in computer graphics and geographic information systems for modeling triangular surfaces and solving spatial problems [3].

The most commonly used triangulation in AutoCAD Civil 3D is the Delaunay triangulation, named after the mathematician Boris Nikolaevich Delaunay (1890-1980). According to the Delaunay definition , a triangle forms a triangular mesh in a triangulation network if the circle has no other intersection points rotating around that triangle. The bounding circle of any triangle does not contain points from the set [5].

One of the algorithms for constructing a Delaunay triangle is based on the formation of Tessen or Voronoi polygons. To do this, the earth's surface is divided into regions, each point of which is closest to a specific network node - the generating point. The resulting boundaries are called Thiessen polygons or Voronoi polygons. Two points are connected by a line in a Delaunay triangle if their Thiessen polygon has a common boundary. This method gives the desired triangles. Thiessen polygons are also used in proximity analysis [7].

The study examined the above-mentioned GRID and TIN models and found that the use of the TIN model is highly effective in creating a digital 3D model of the GDP territory.

When creating the GDP TIN model, the 1st class leveling results obtained in field research were processed in Credo programs and saved in a special format. The csv file data was then loaded into AutoCAD Civil 3D. To create a digital TIN model of the territory, a triangulation of irregular triangles was created Fig. 6.

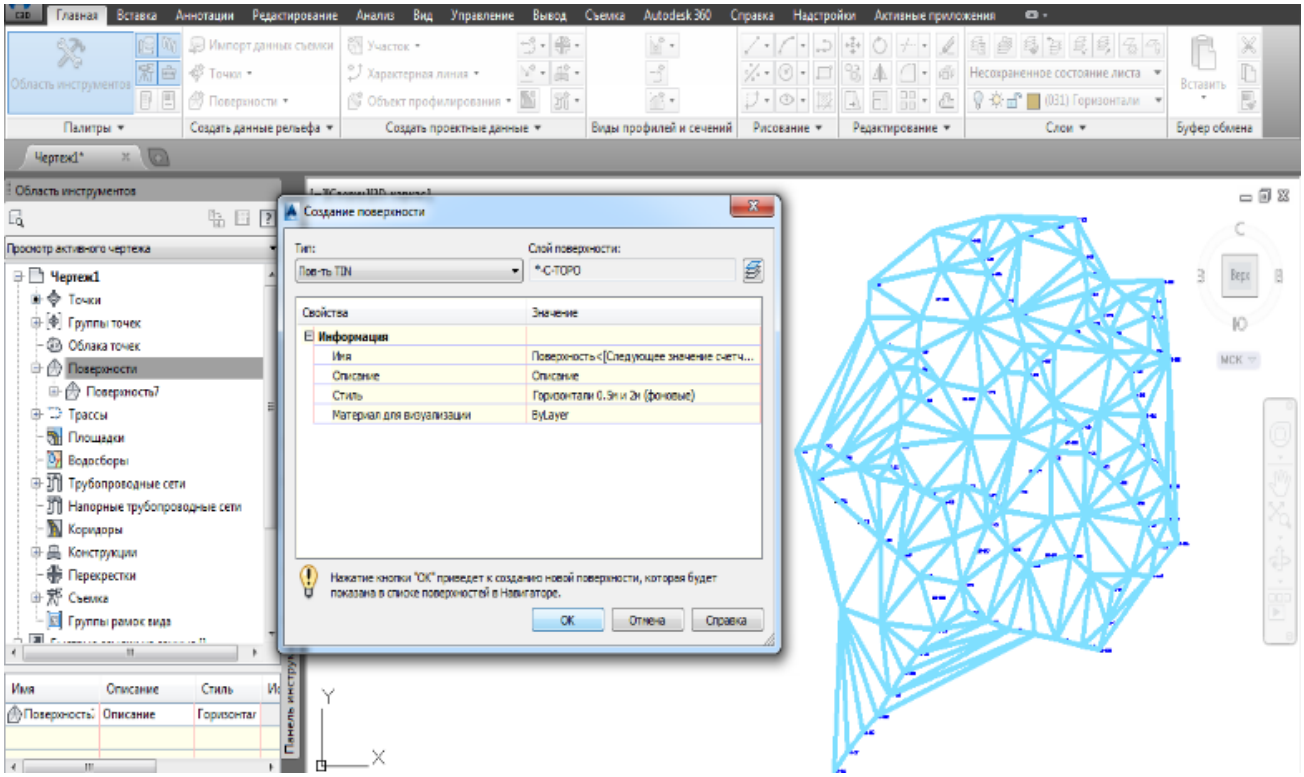

Figure 6. Forming triangulation of irregular triangles in AutoCAD Civil 3D

3D using Delaunay space triangulation Model creation is very efficient. When creating a TIN model, nodes are randomly distributed on the surface, and extracted labels are placed according to the spatial representation. Because of this, the points from which the height marks are derived are unevenly spaced. When creating this TIN model, the values of specific points and the values between them are automatically interpolated to maintain data accuracy. Figure 7.

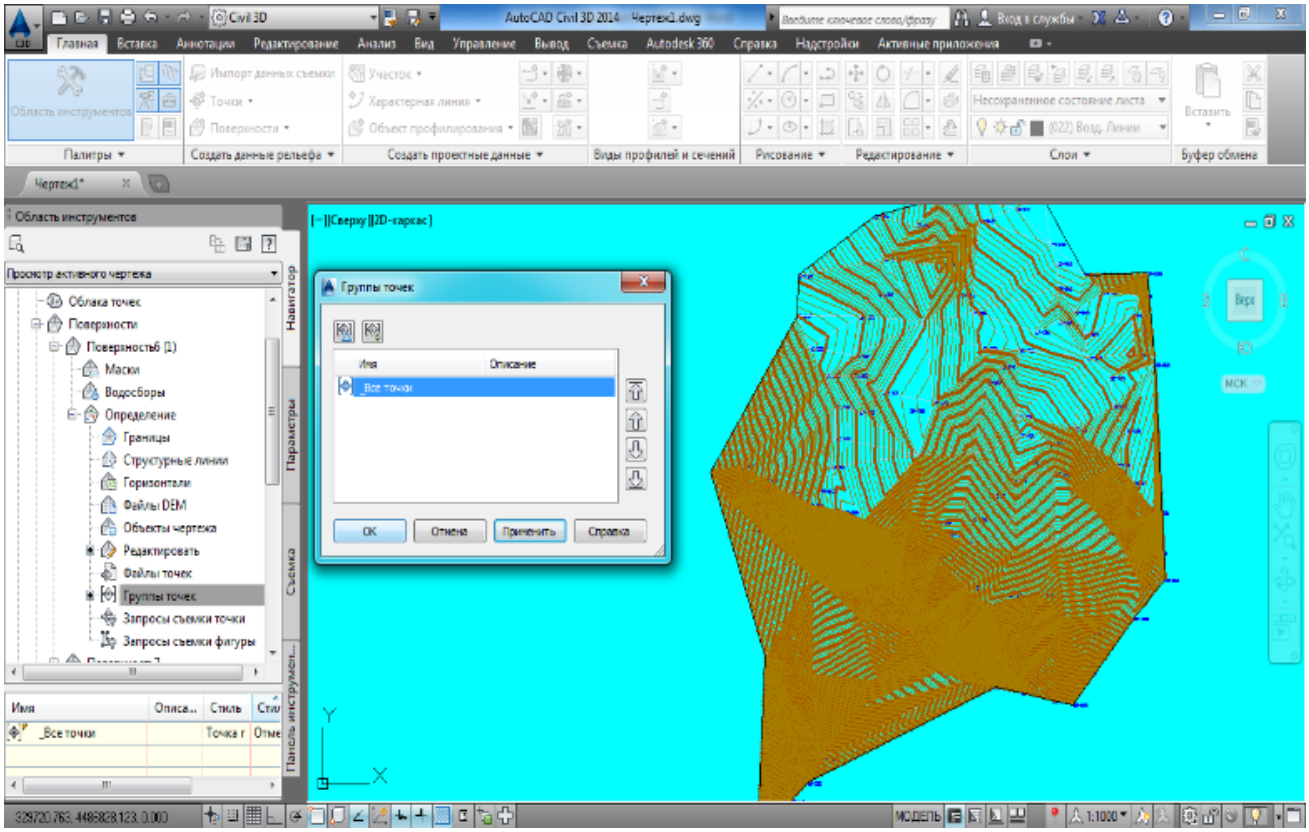

Figure 7. Numerical model of GDP

When creating a digital 3D model, the main directions were checked and assessed for compatibility with real reality, and the vectorization and segmentation processes were carried out. A set of linear objects that form a layer type, and the coordinates of points that approximate the curves corresponding to these objects, are depicted on horizontal lines by a sequence of coordinates in Fig.8.

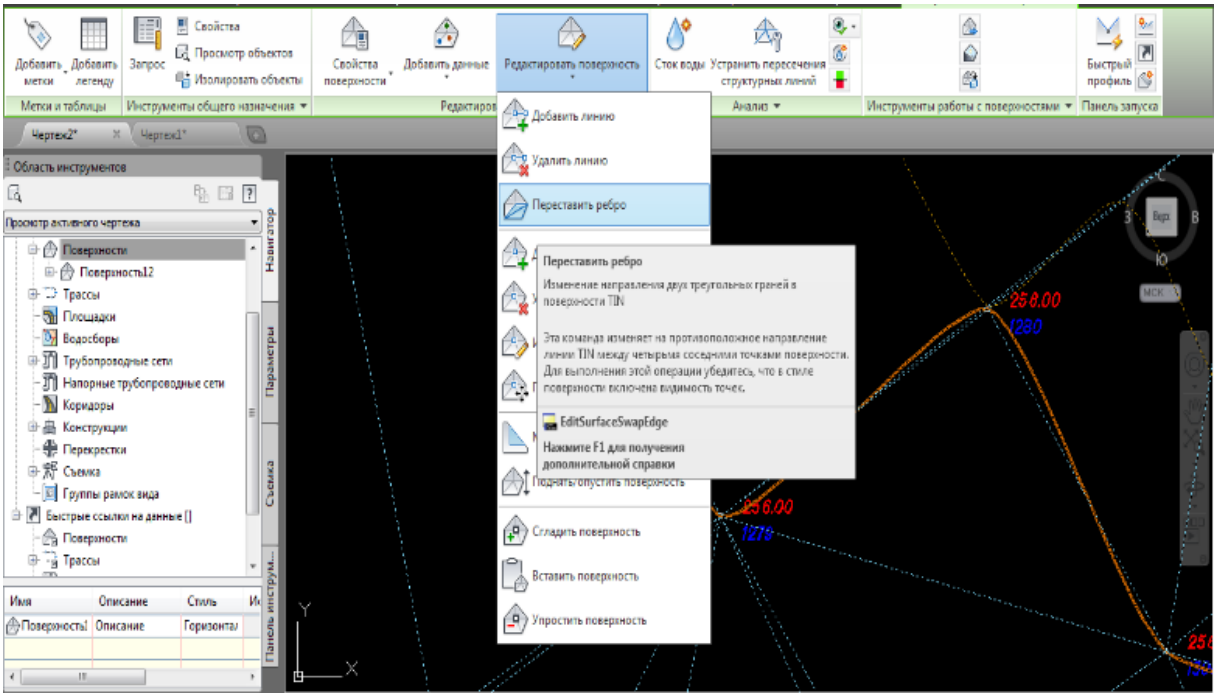

Figure 8. In AutoCAD Civil Segmentation process in horizontal digitalization

Many studies have interpreted the process of horizontal remodeling in different ways. When creating a digital relief model, special attention was paid to processing the source data, visualizing the resulting marks on contour lines, mutual comparison of points, checking the characteristic points of

contour lines and segmentation processes. research work Figure 6-8.

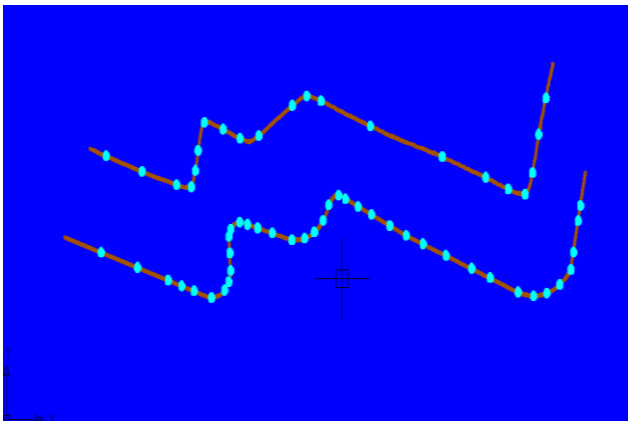

Figure 9. View after the segmentation process when digitizing contour lines

After processing the contours, the digitization process was carried out by dividing them into segments. Moreover, the more characteristic points of horizontal lines, the more clearly the model is visualized. Segmentation – This is the process of dividing a digital image into several segments , which is used in image analysis. provides some comfort.

digital 3D terrain model is a complex process that requires the user to have certain skills and the ability to work with geoinformation technologies [8].

The digital 3D model of GDP in the AutoCAD Civil 3D program was visualized based on the leveling results as follows.

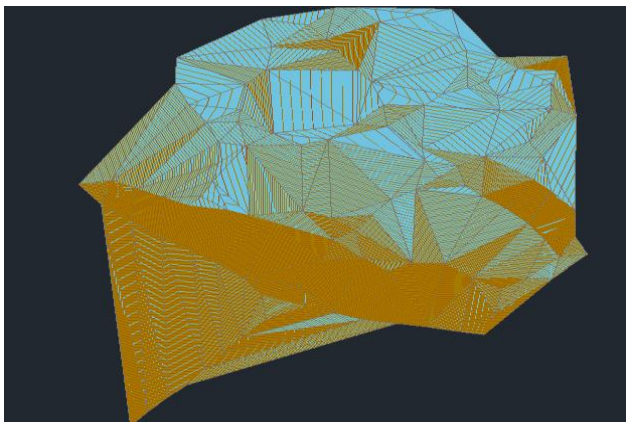

Figure 10. 3D GDP model Conclusion

5 – 4 – BSEC in the GDP area _ horizontal digitalization Certainly And fuzzy segmentation work as a result harvest was region digital model and 3D terrain models _ shown .

NPP GDPs were digitized using a straight line function, that is, the method of one-dimensional approximation and approximation of third-order functions by polynomials. The use of a third-order function when digitizing contour lines in the GDP zone is the basis for creating a more accurate digital terrain model.

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