Intent Research Scientific Journal-(IRSJ)
**ISSN (E):** 2980-4612
Volume 2, Issue 4, April -2023
**Website:** intentresearch.org/index.php/irsj/index

# IMPROVING THE METHODS OF PLANNING LINEAR STRUCTURES USING MODERN TECHNOLOGIES

Tashpulatov Sarvar Anvarovich
Professor, Tashkent architecture and construction university.

Reypnazarov Elburus Muratbay o'g'li
Master 2 kurs, Geodesy and cartography (applied geodesy)

**Abstract**
A description of geodetic methods corresponding to the current level of development of the coordinate base is presented. The importance of improving methods for assessing, predicting and controlling the deformed state of the earth's surface and rock mass is emphasized. The issue of satellite positioning technology for creating reference surveying networks is considered, in terms of assessing the accuracy of determining the coordinates of points when using one or several base stations. The original technology of observation of Earth's surface deformations in undermined territories is shown, which makes it possible to obtain the spatial position of the displacement trough.

**Keywords**: geodetic measurements, reference mine surveying networks, survey, satellite determinations, earth's surface, observations, deformations, displacements, digital terrain models.

During operation enterprises, one of the main points is the correct (accurate) implementation of design solutions and control of the condition of underground tunnels and linear structures of workings or their constituent elements. Compliance with these circumstances is mainly ensured by the normative methods of mine surveying and geodetic work.

The article draws attention to the state and ways of improving mine surveying and geodetic techniques in the field of creating a reference network, building models of linear structures and underground metropolitans of their objects and observing deformation processes. All three directions are interconnected and can be considered in a single coordinate system. This is important when considering a mining facility as a single system.

The development of methods for constructing a mine surveying reference network is undoubtedly determined by the use of satellite measurement

Intent Research Scientific Journal-(IRSJ)
**ISSN (E):** 2980-4612
Volume 2, Issue 4, April -2023
**Website:** intentresearch.org/index.php/irsj/index

technologies. In fact, global navigation satellite systems (GNSS) constituted an alternative, and in some cases replaced the planned and altitude justification when transmitting coordinates to survey points (coordinate network thickening). In addition to simplifying the creation of a coordinate base, the use of GNSS can significantly improve accuracy, which is very important in modern mining conditions.

Satellite detection technology [1, 2] includes the use of base stations. An important scientific and practical question arises about their quantitative sufficiency and accuracy of application. Below are the results of satellite determination studies using one 2 and 3 base stations.The second aspect of the development of mine surveying and geodetic support is associated with the creation of models of mining facilities, which can significantly improve the quality of engineering and technical solutions for planning and safety of mining operations. Improvement in this area is very effective with the use of laser scanning systems [3] and surveys from unmanned aerial vehicles [5].

The use of the first allows you to get a digital model of a quarry in one act of shooting. The advantage over tacheometric survey in informational content due to the resulting point cloud. This allows you to build object models with high accuracy. The total station is very effective when used in measurements of special guidance devices (poles, prisms, etc.). This is a device for determining the coordinates of points. It is advisable to use a laser scanner when shooting surfaces and determining their position in space. It should be noted that the use of electronic devices in underground mining, in conditions of dust and shock hazard is very limited.



Intent Research Scientific Journal
IRSJ

ISSN (E): 2980-4612
Volume 2, Issue 4, April -2023
Website: intentresearch.org/index.php/irsj/index

Recently, the use of filming with the use of unmanned aerial vehicles (UAVs) has become increasingly popular. The mobility of measurements, their simplicity and relative cheapness make this method very promising. The question is the accuracy of shooting. Upon reaching an accuracy corresponding to a scale of 1:500 [4] and larger, shooting from a UAV will provide a wide range of tasks to be solved in the development of mineral deposits in an open way.

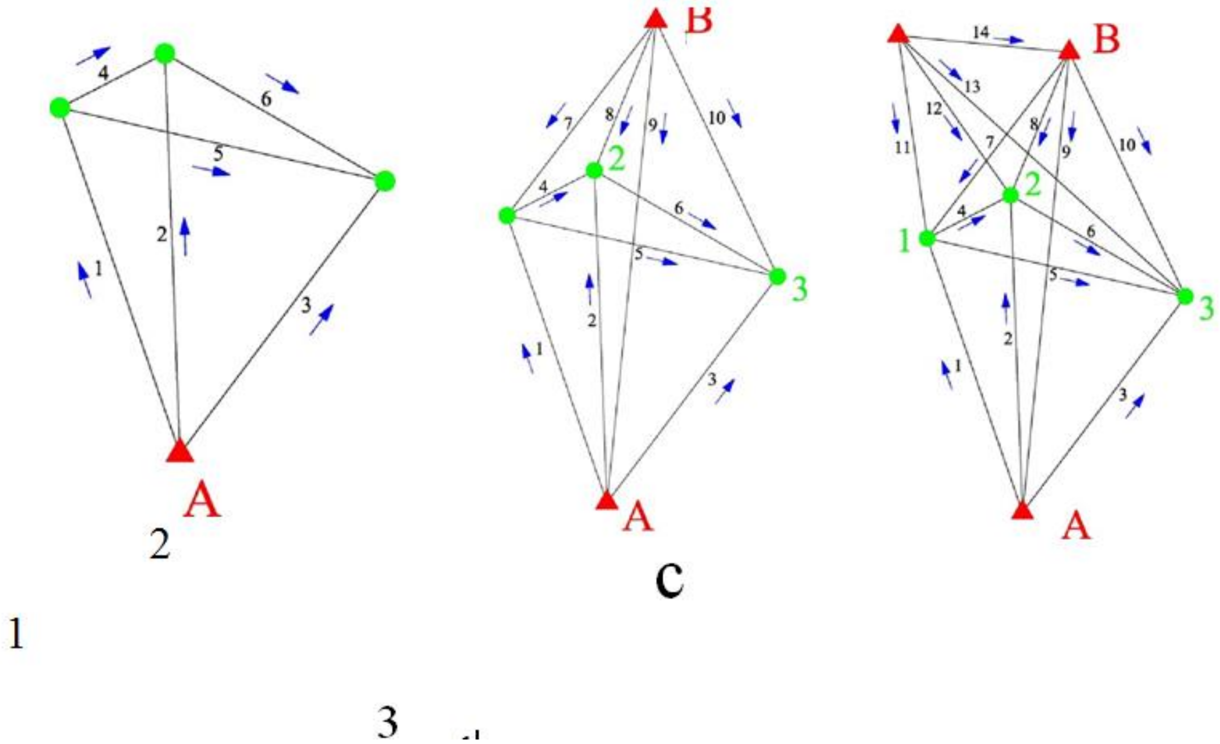
A parameter that determines the possibilities for planning various construction (where you can build and where you can't), protect objects and develop mining operations. Secondly, it is impossible to qualitatively solve any issue of safe and efficient mining operations without knowing the parameters of the displacement of the rock mass and the earth's surface.

Regulatory documents related to the calculation of the parameters of the displacement of the earth's surface [9] and the observation of the displacement of rocks, the earth's surface and undermined structures [10] are largely outdated. Thus, the Rules of Protection [9] are developed for the conditions of the speed of advancing of clearing works up to 150 m and for the lengths of longwalls up to 120...150 m. Today, these parameters are exceeded many times. As for the observation methods in [6], the mine surveyor and geodetic instrumental base and technologies have changed radically over the past 30 years and, most importantly, the possibilities of improving the accuracy and information content of observations have increased.

Intent Research Scientific Journal-(IRSJ)
**ISSN (E):** 2980-4612
Volume 2, Issue 4, April -2023
**Website:** intentresearch.org/index.php/irsj/index

In the technical literature, there are a lot of descriptions of the use of GNSS for building special networks, especially for the needs of geodesy, but there are quite a few descriptions of its use in mine surveying [2]. When planning its creation, it is advisable to perform an accuracy assessment. At the design stage, it makes it possible to choose the optimal variant of its construction. Accuracy assessment is performed using computer technology that implements the least squares method.

Below is an analysis of the results of modeling the construction of geodetic (surveyor) networks. The accuracy of three determined points was estimated, the coordinates of which were calculated from measurements using the triangulation method, as well as from the results of satellite determinations (satellite network). In this case, three options for the network are considered: based on one, two and three strong points.




Models for constructing geodetic networks (a - a network based on one reference point; b - on two reference points; c - on three points) 1 and 2

Intent Research Scientific Journal-(IRSJ)
ISSN (E): 2980-4612
Volume 2, Issue 4, April -2023
Website: intentresearch.org/index.php/irsj/index

Table 1 Coordinates of original control points

| Items | X,m | |
|---|---|---|
| A | 186340,237 | 116137,221 |
| B | 187571,339 | 128270,883 |
| | 183067,008 | 128709,672 |

**Table 2 Directional angles and side lengths of geodetic networks**

| Side | Network (Fig. 1, a) | | Network (Fig. 1, b) | | Network (Fig. 1, v) | |
|---|---|---|---|---|---|---|
| | Length, m | Directional angles, deg. | Length, m | Directional angles, deg. | Length, m | Directional angles, deg. |
| A-1 | 7653 | 340,7927 | 7653 | 340,7927 | 7653 | 340,7927 |
| A-2 | 8366 | 357,8501 | 8366 | 357,8501 | 8366 | 357,8501 |
| A-3 | 7133 | 37,0449 | 7133 | 37,0449 | 7133 | 37,0449 |
| 1-2 | 2478 | 62,8104 | 2478 | 62,8104 | 2478 | 62,8104 |
| 1-3 | 6986 | 102,6835 | 6986 | 102,6835 | 6986 | 102,6835 |
| 2-3 | 5326 | 120,0351 | 5326 | 120,0351 | 5326 | 120,0351 |
| B-1 | | | 6175 | 217,3843 | 6175 | 217,3843 |
| B-2 | | | 4078 | 202,2621 | 4078 | 202,2621 |
| B-A | | | 12196 | 185,7935 | 12196 | 185,7935 |
| B-3 | | | 7133 | 154,5395 | 7133 | 154,5395 |
| C-1 | | | | | 5398 | 171,9564 |
| C-2 | | | | | 5148 | 144.9128 |
| C-3 | | | | | 10229 | 132,2591 |
| C-B | | | | | 4526 | 95,5639 |

Modeling the construction of geodetic networks by the method of triangulation The network accuracy was estimated using the least squares method. Below are the known calculations with specific values. First, we calculate the matrix of weight coefficients (Q) of the identified items:

$$Q = (A^T P A)^{-1}, \quad \textbf{1.}$$

Where A is the matrix of parametric correction equations, P is the matrix of weights of the measurement results.

We calculate the coefficients of the matrix of the parametric equation amendments.

For angle measurements;



Intent Research Scientific Journal
IRSJ

$$Ax_i = \rho\frac{\sin a_{ij}}{s_{ij}};\; Ay_i = -\rho\frac{\cos a_{ij}}{s_{ij}};\; Ax_j = -\rho\frac{\sin a_{ij}}{s_{ij}};\; Ay_j = \rho\frac{\cos a_{ij}}{s_{ij}}. \quad (2)$$

For linear measurements:

$$Ax_i = -\cos a_{ij};\; Ay_i = -\sin a_{ij};\; Ax_j = \cos a_{ij};\; Ay_j = \sin a_{ij}, \quad (3)$$

$i$, $j$ Indices corresponding to point numbers, $a_{ij}$ and $S_{ij}$ correction angle and line length, $\rho$ number of seconds in radian equals 206265.

We determine the coefficients of angular and linear measurements of weight howling matrix $\rho$

$$P_{\beta i} = \frac{\mu_0^2}{m_\beta^2} = 1;\; P_{si} = \frac{\mu_0^2}{m_{s_i}^2}, \quad (4)$$

Where $\mu_0^2$ a priori root mean square error (RMS) of the weight unit is equal to 1; $m_\beta$ is the standard deviation of the measured angle, at the design stage, we assume that $\mu_0 = m_\beta$; $m_{s_i}$,(RMS) is the standard deviation of the measured distances (S)with the passport accuracy of the instruments equal to $5+3\times10^{-6}\times S$, sm

Based on the approximate coordinates, we determine the directional angles and distances, the differences between the true and approximate values of the directional angles $(l_{ai})$ and distances $(l_{si})$ which are the coefficients of the matrix of the vector of free members L.

We calculate the standard deviation of the position of an arbitrary point in the network relative to the starting point:

$$M_{xy} = \sqrt{m_x^2 + m_y^2}, \quad (5)$$

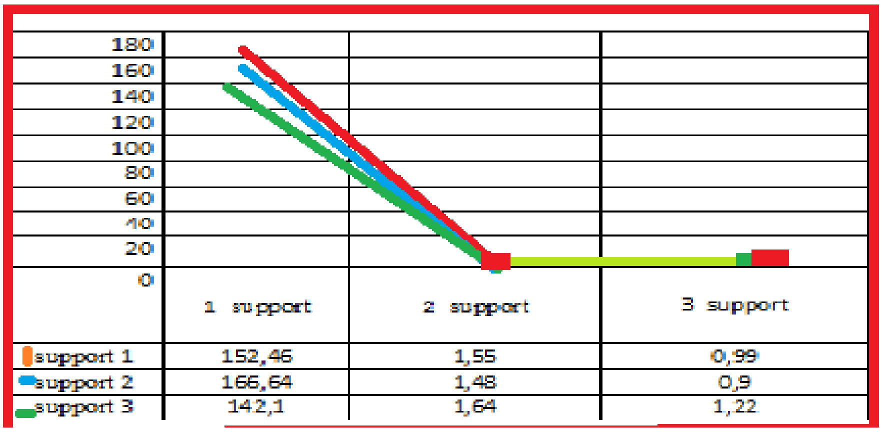
Where $m_x = \mu\sqrt{Q_x}$, $\mathbf{m_y} = \mu\sqrt{\mathbf{Q_y}}$ $m_y = \mu\sqrt{Q_y}$, where $Q_x$ and $Q_y$ are the corresponding diagonal elements of the matrix of weight coefficients of the determined points; $\mu$ - is a posteriori RMS unit of weight determined from the expression:

$$\mu = \sqrt{\frac{V^T PV}{n-t}}, V = A(-QA^T PL) + L, \quad (6)$$

**Intent Research Scientific Journal-(IRSJ)**
**ISSN (E):** 2980-4612
Volume 2, Issue 4, April -2023
**Website:** intentresearch.org/index.php/irsj/index

Where V- are the corrections to the calculated values, n is the number of all measurements, t is the number of necessary measurements.

According to the specified algorithm, an analysis was made of the accuracy of geodetic networks built using the triangulation method. The results are shown in fig. 2.




**Rice. 2.** Evaluation of the accuracy of the triangulation network depending on on the number of reference points

As follows from the consideration of Fig. 2, the accuracy of determining the position of items 1,2 and 3 is higher in networks based on two and three reference points. At the same time, the difference between the cases when the reference points are one and two points is significant (by two orders of magnitude), while the difference between the options when the network is based on 2 and 3 points is small and differs by fractions of a centimeter.

Assessment of geodetic networks built using GNSS technology

Estimation of the accuracy of determined points of geodetic networks relative to reference points can be performed by analogy with the algorithm shown above. The difference from the triangulation network is that the matrix A consists of measurable vectors. Its coefficients are 0, 1 or -1 depending on the directions of the measured vectors.

The diagonal coefficients of the weight matrix P are calculated by the formula

$$-P_i = \frac{\mu_0^2}{m_{изм}^2}, \qquad (7)$$

ISSN (E): 2980-4612
Volume 2, Issue 4, April -2023
Website: intentresearch.org/index.php/irsj/index

where $\mu_0$ is the measurement error in terms of a vector with a length of 1 km; $m_{iизм}$ — RMSE of the vector measurement in plan, calculated by the formula

$$m_{iизм} = \sqrt{R^2 m_{inac}^2 + 2m_{iц}^2}\,, \qquad (8)$$

Where $m_{inac}$ is the passport accuracy of satellite measurements of vectors in the plan, $m_{iц}$ is the receiver antenna centering error on tripods, R is the radio visibility coefficient. For the case under consideration, we have

$$m_{inac} = (5 + 3\times 10^{-6} \times D_i), мм\,;$$

$$m_{iц} = \frac{h0,2\tau'}{\rho'}, \qquad (9)$$

Where h is the tool installation height; $\tau$ -is the division value of the circular level of the optical plummet, $\tau$ = 8; p = 3488

If the points of the geodetic network are located in open areas, then the coefficient of radio visibility R=l. Otherwise R=2.

We calculate RMSE the standard deviation of satellite determinations of points in terms of $m_{iплан}$: plan

$$m_{iплан} = \mu_0 \sqrt{Q_{i,i}}\,. \qquad (10)$$

The results of assessing the accuracy of the determined network points relative to the reference points for three models of geodetic networks are shown in fig. Z.

As can be seen from the examination of Fig. 3, the accuracy of determining the position of points 1, 2 and 3 in satellite networks is significantly higher than in a network built using the triangulation method. The dependence of the increase in accuracy on the number of reference points is observed, but is not so pronounced. Based on the results of the above calculations, it can be recommended when creating geodetic (surveying) networks to focus on both the number of reference points (base stations) and the method of creating a geodetic network (ground-based or using GNSS technology).



Intent Research Scientific Journal
IRSJ

Fig. 3 Assessment of the accuracy of the geodetic network, the planned coordinates of the points of which are determined using GNSS technology

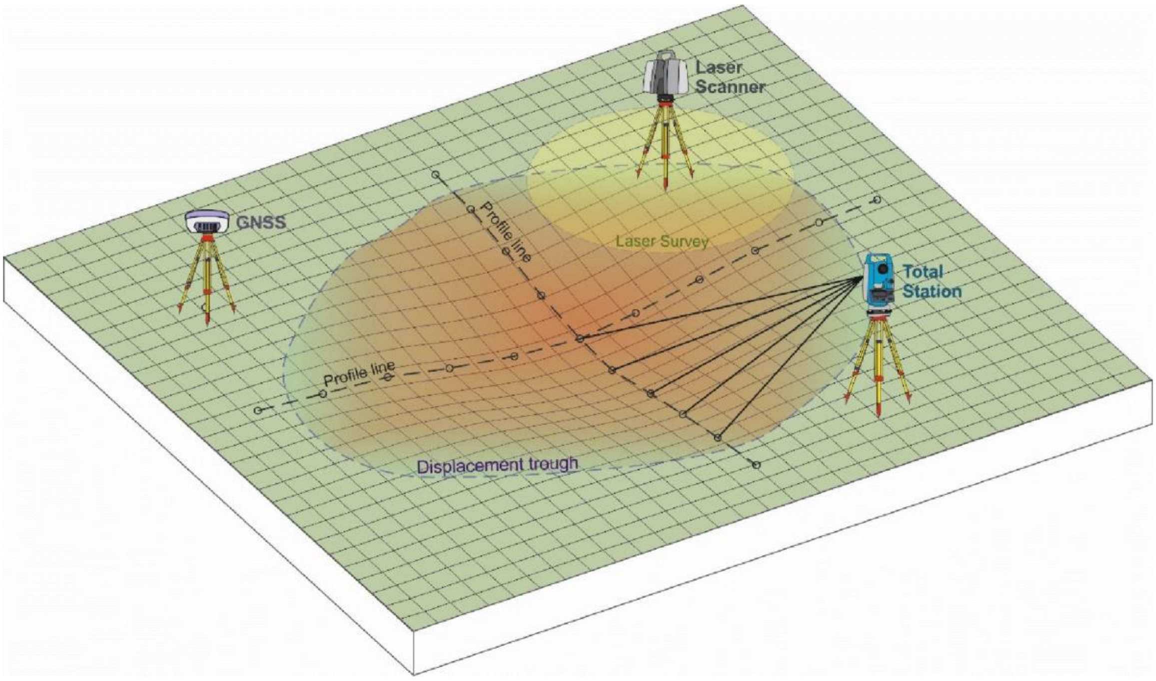
The importance of mine surveying and geodetic observations of the movement of the earth's surface in mining was emphasized above. As a result of underground mining in undermined territories, deformations of the earth's surface occur, which can have a negative impact on natural and man-made objects (buildings, structures, lakes, etc.) located in the zone of influence of mining.

In order to control the process of displacement on the earth's surface, special observations are carried out. ("Instructions for displacement observations [10]) fixed the observation technique, including geometric leveling and measuring the distances between the reference lines of profile lines using steel tape measures. Taking into account the foregoing, the improvement of technologies is already necessary today.

The developed monitoring technique includes several types of surveys at once (Fig. 4):creating a survey justification using satellite definitions; shooting profile lines with an electronic total station; situational survey of the displacement trough by laser scanning; detailed shooting of undermined objects by means of an electronic total station and a laser scanning system.

Intent Research Scientific Journal-(IRSJ)
ISSN (E): 2980-4612
Volume 2, Issue 4, April -2023
Website: intentresearch.org/index.php/irsj/index

The choice of equipment is determined by the requirements for accuracy at a particular stage of observations and is based on a mathematical analysis of measurement errors. The analysis made it possible to conclude that the most accurate measurement method is electronic tacheometry, which is used to observe the reference lines of profile lines during the process of displacement. To achieve the required accuracy, regulated by the normative document [10], surveys must be carried out in accordance with the developed recommendations [11].




Rice. 4. Scheme of surveys at the observation station using modern electronic geodetic equipment

To establish the survey parameters, specialized software systems have been developed for the use of an electronic total station and a laser scanning system. The created programs allow you to set all kinds of parameters that characterize the observation station and the equipment used, and perform a single or multiple analytical calculation of accuracy.

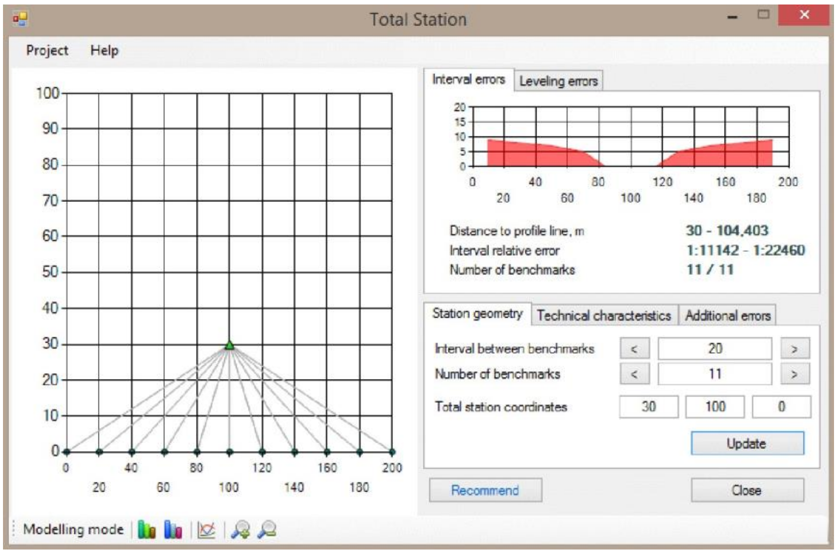
On fig. 5 shows the working window of the program for modeling shooting conditions for an electronic total station.

The program includes two modes of operation: simulation of conditions at the station and calculation of errors based on the results of field observations.

In simulation mode, the user works with three blocks: an interactive work block based on instant recalculation errors, a block of initial data and an information

**Intent Research Scientific Journal-(IRSJ)**
**ISSN (E):** 2980-4612
Volume 2, Issue 4, April -2023
**Website:** intentresearch.org/index.php/irsj/index

block containing actual results of calculation of observation errors. Of particular interest is the initial data block, which allows you to set the unique parameters of the observation station: take into account or omit certain errors when surveying, specify the number of reference points and the intervals between them, position the instrument at a certain distance from the profile line, set the technical characteristics of the equipment, etc




Rice. 5. Window of the software complex SIMULATION of stations when shooting with an electronic total station The most important function of this program is the presentation of survey recommendations: the user sets the variable boundaries of the simulation (the limit of movement of the instrument, the interval between the reference points and their number, the list of instruments for survey), and the program performs multiple calculations to determine the most favorable observation parameters in terms of accuracy. The program is also capable of performing calculations in the calculation mode based on the initial data loaded by the user.

The user calculation mode also includes a procedure for finding the optimal tool standing point.

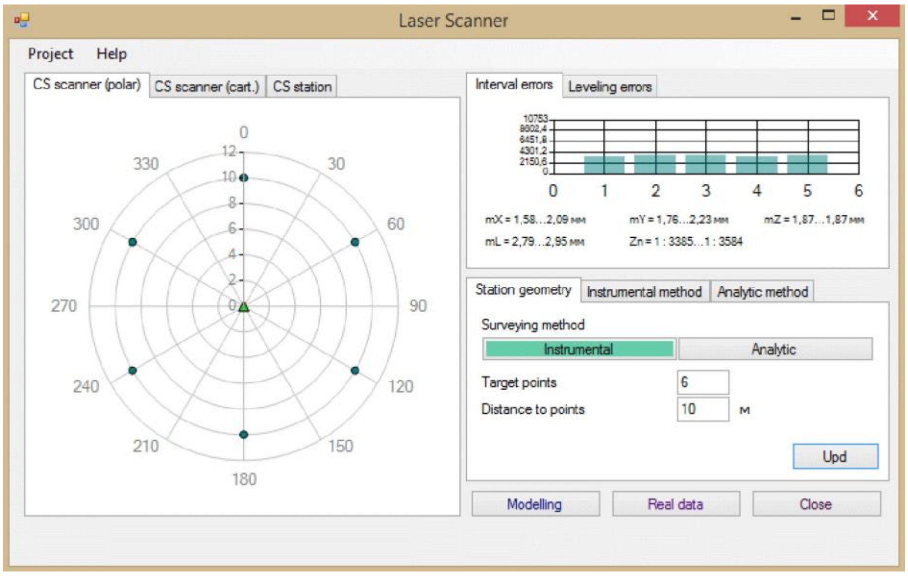
As for assessing the accuracy of laser scanning, following the example of the development described above, a software package for modeling observation conditions using laser scanning systems was created (Fig. 6). The program takes into account the errors inherent in a particular type of observation, i.e. errors that occur exclusively with laser shooting. At the same time, for the convenience of the user, the concept of the complex remained unchanged: the program operates



Intent Research Scientific Journal IRSJ

in two modes and allows you to prepare recommendations for conducting geodetic observations.

The developed software was tested on the basis of field observations. The base for experimental surveys was the territory in the zone of influence of the mine <<Stepnaya>> PSP (“Mine Administration Pershotravenskoe>> (Donbass, Ukraine). Observations were carried out using an electronic tacheometer and a laser scanning system.




Rice. Fig. 6. Window of the software complex SIMULATION of stations when shooting with a laser scanning system.

At the stage of laying the survey substantiation, a combined method was used, in which a wireframe network is created by means of satellite observations, and its thickening and shooting of the profile lines of benchmarks is carried out using an electronic total station. As for observations, surveys were carried out for the 1st profile line, consisting of 37 benchmarks. The measurements were carried out in three steps using a Sokkia Set 530 RKZ total station with an angular accuracy of 5” and a linear accuracy of 2 mm + 2 mm/km. The percentage of correspondence between the results of measurements and the forecast of the mathematical model for all benchmarks of the profile line averaged about 87 o.

As part of the experimental surveys for the profile line references, observations were made using the Riegl LMS Z420i laser scanning system, with a maximum measured distance of 1 km, distance measurement accuracy of 4 ... 10 mm (depending on the mode), scanning speed of up to 11000 points / sec . The percentage of correspondence between the measurement results and the

Intent Research Scientific Journal-(IRSJ)
ISSN (E): 2980-4612
Volume 2, Issue 4, April -2023
Website: intentresearch.org/index.php/irsj/index

prediction of the mathematical model for laser scanning averaged about 83%. Situational survey of the displacement trough was also carried out using the laser scanning system mentioned above. Both software packages can be successfully used in the process of monitoring the earth's surface at various enterprises in order to improve the efficiency and quality of work. This technique allows you to build a spatial shear trough. This is important when determining the boundary conditions when modeling the stress-strain state of a rock mass with different software systems [7, 8], and also due to the need to accurately describe the boundaries of the influence of mining operations on the earth's surface when resolving controversial issues of property owners.

Thus, the article outlines the prospects for the development of mine surveying and geodetic support at mining enterprises. Of course, in this article it was not impossible to highlight all the nuances of the topic. Thus, the promising method of radar interferometry was not noted [12]. In a number of sources, there are cases of its use in monitoring buildings and structures, where the accuracy of determining point shifts of 1-2 mm is achieved. At the same time, when observing the deformations of the earth's surface in undermined areas, it has so far been possible to reach the accuracy of the centimeter range.

In the field of developing new methods for monitoring deformation processes, it is very interesting to study the use of deformation network models as a monitoring tool. On the one hand, the reliability of tracking the deformation process is ensured by analyzing spatial changes in the positions of model elements (in some cases, measurements at each observation cycle can be performed without reference to reference points from free stations). On the other hand, it becomes possible to unambiguously interpret the type of deformation using software packages for calculating the stress-strain state of a rock mass.

Conclusion: in order to improve the quality of survey activities, one should remember the established rules for conducting surveys. Engineers carry out a number of activities to collect all the necessary data that are the basis for creating a project and calculating estimates for engineering geodetic, engineering geological, engineering hydrometeorological surveys, as well as laboratory studies of building and soil materials (DSM).

A great responsibility rests with the geodesy service, which is obliged to provide reliable data of topographic measurements, with new generation devices, errors are minimized and practically eliminated in favor of surveyors.



Intent Research Scientific Journal
IRSJ

The introduction of innovative equipment in all structures of road construction will work as a single mechanism, and will undoubtedly set a good pace in the development of the network of roads and airfields. And from an economic point of view, saving money on engineering and geodetic surveys.

**References**

1. Instrukcija po razvitiju syemochnogo obosnovanija i syemke situaci i rel'efa s primeneniem global'nyh navigacionnyh sputnikovyh sistem GLONASS i GPS, GKINP (ONTA)- 02 -262 -02.
2. Sovremennoy maksheyderskoy geodezicheskoy obespecheniy ekspulatasiyi gornih predpreyatii.
3. M.G.Mustafin, E.N.Grishinkova, J.A.Yenes, G.I. Xudyakov
4. Junes Zh.A., Mustafln M.G., Morozova V.D. Sozdanie opornoj markshejderskoj seti c ispol'zovaniem tehnologii sputnikovogo pozicionirovanija// Markshejderskij vestnik. 2017. N! 2 (117). S. 25-28.
5. Mustafln M.G., Kazantsev A.I., Valkov V. A. Monitoring of Defor-mation Processes in Buildings and Structures in Metropolises // Procedia Engi-neering. N! 189. 2017. R. 729 - 736.
6. Beregovoi D. V. , Younes J. A. , Mustafln M. G. Monitoring of Quarry Slope Deformations with the Use of Satellite Positioning Technology and Unmanned Aerial Vehicles // Procedia Engineering. N! 189. 2017. R. 737 - 743.
7. Mustafln M.G., Panchenko A. V. Osobennosti deformirovanija pribortovogo mas-
8. Siva gornyh porod s raznoj krivolinejnost'ju borta v plane// Zapiski Gornogo instituta. 2013. T. 204. S. 66-68.
9. Geoinformation system for geomechanical monitoring of ore depos-its using spaceborn radar interferometry methods / Z. T. Kozhaev, M.A. Mukhamedgalieva, M.G. Mustafin, B.B. Imansakipova// Gornyi Zhurnal. N! 2. 2017. R. 39 - 44.
10. Kuzin A. A. , Grishchenkova E.N., Mustafln M.G. Prediction of Natural and Technogenic Negative Processes Based on the Analysis of Relief and Geological Structure // Procedia Engineering. N! 189. 2017. R. 744 - 751.
11. Determination of parameters of intensive flat coal seams mining technology in the conditions of negative effect of mining operations on the daily surface

/ 0.1. Kazanin, M.G. Mustafln, A. A. Meshkov, A. A. Sidorenko// Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu. NO. 2015. R. 51-56.
12. Pravila ohrany sooruzhenij i prirodnyh ob#ektov ot vrednogo vlijanija podzemnyh gornyh razrabotok na ugol'nyh mestorozhdenijah. PB 07-269-98.
13. Instrukcija po nabljudenijam za sdvizheniem gornyh porod, zemnoj poverhnosti i podrabatyvaemymi sooruzhenijami na ugol'nyh i slancevyh mestorozhdenijah: utv. Minugleprom SSSR 30.12.87. M.: Nedra, 1989. 96 s.
14. Grishhenkova E.N. Matematicheskoe modelirovanie uslovij s#jomki nabljudatel'nyh stancij metodom jelektronnoj taheometrii // Izvestija vysshih uchebnyh zavedenij. Geodezija i ajerofotos#emka. Moskovskij gosudarstvennyj universitet geodezii i kartografii. M. 2017. NPS. S. 49-53.
15. Mustafln M. G. , Omarova A.K. Mozer D. V. Primenenie radar-noj skanirujushhej sistemy GPRI-2 pri monitoringe sdvizhenija poverhnosti Zemli// Zapiski Gornogo instituta. 2012. T. 199. S. 286-289.