Methodology improvement of geodetic work on the basis of geoinformation technologies

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Abstract. In the system of topographic and geodetic works, the introduction of modern technologies based on GPS and GLONASS satellite systems, geoinformation systems, digital and laser-electronic measuring and computing techniques, as well as laser scanning technologies is a modern requirement. Currently, the relevant authorities in the maintenance of state cadastres are working on the creation and formation of a cadastral database. In this research, the results of scientific research on the significant contribution to the development of the Republic by eliminating the inconveniences of geodetic work in mountainous areas of the Republic were given. According to the results, the resulting territorial points were combined according to a scheme (abris) created for use on the ground, and an electronic digital map of the geo-database of the region was formed.

Keywords: geodetic measurements, geoinformation systems, GPS, GLONASS, cadastral, ArcGIS

1. Introduction

After gaining independence, our country requires sustainable science-based development in industry, construction, manufacturing and many other sectors of the economy [1]. In the system of topographic and geodetic works, the introduction of modern technologies based on GPS and GLONASS satellite systems, geoinformation systems, digital and laser-electronic measuring and computing techniques, as well as laser scanning technologies is a modern requirement.

In recent years, as a result of the rapid development of science and technology in all areas, it is possible to determine the spatial position of points using a new modern satellite method [2, 3]. In this way, the spatial position of points on the ground can be determined at any time and under the conditions of satellites and their ground receivers, as well as antennas.

One of the problems that people have been interested in since ancient times has been to find out where their planet Earth is. A person can easily determine their position relative to the objects around them [4]. What if there were no such objects around, but there was an empty desert or a vast ocean floor? For centuries, this problem has been solved using the sun and stars. In particular, geodesists, geologists, and others have used geodetic reference points through which measurements have been made or paths have been identified, but it is not always possible to use these methods [5].

At present, a number of measures have been taken by the relevant authorities in the maintenance of state cadastres to create and establish a cadastral database [6-8]. Territorial branches and divisions of
the State Research and Design Institute "Uzdaverloyiha" maintain the state land cadastre, while the state cadastre of buildings and structures is formed by the state enterprises of territorial land management and real estate cadastre [9].

A single system of cadastres is being submitted to the Republican Information Analysis Center (RICC). The reliability and quality of the database is increasing through the use of modern equipment, technologies and software in the creation and maintenance of the database of state cadastres in the Center of Unique Systems of State Cadastres (CUSSC), Uzbekistan. Currently, some companies and organizations use Magellan ProMark-3 and STONEX S-3 GPS receivers [9, 10]. Due to the fact that this navigator has a frequency of 1 and 2, the following inconveniences occur in the topographic survey of buildings and structures:
- satellite connection error;
- uncertainty of the detected point values in connection with the satellite;
- ensure that the regional values of the point are in place;
- errors in the processing of values in the Geographic Information System (GIS);
- Uncertainty in the planning of the area in the software belonging to the GIS family;

Due to the above inconveniences, we consider it expedient to implement the following software method technology to eliminate the problems in the regions and to fulfill the task of our government in a timely, quality and efficient manner [4, 8-9]. At present, summarizing the survey values of modern GPS and traditional Teodalit geodetic instruments, we will consider the method of overcoming the above shortcomings and the formation of ArcGIS software belonging to the family of geographic information systems:
- When the GPS receiver antenna is 360° open or away from buildings, it is fixed to the optimal location to obtain latitude and longitude values;
- the theodolite is fixed to the formed point and directed to the fixed point and the base is created;
- A level bar is placed at the corners of the object to be filmed to determine the distance and angles relative to the base;
- The angles of all objects on the threshold of the area to be surveyed are determined relative to the base [5];

2. Methods
Once the value of the object angles was determined by the above sequence, the values are entered into the ArcGIS program and the geodata for CUSSC was formed as follows [1, 7]:
- A database is created using ArcGIS software;
- Latitude and distance values determined using GPS are imported into ArcGIS software;
- The angle values of the imported base points are determined in the ArcGIS program;
- If the angles in place are determined clockwise relative to the base, the values are calculated using the following formula and formed in the geodatabase \( \alpha = B - \beta(n) \);  
- If the angles in place are determined counterclockwise relative to the base, the values are calculated using the following formula and formed in the geospatial database \( \alpha = B + \beta(n) \);

where:
\( \alpha \) – The angle to be determined in ArcGIS,
\( B \) – the value of the base aspects in ArcGIS,
\( \beta \) – determined steering angles relative to the ground base,
\( n \) – sequence according to the number of corners.

If it is possible to determine the North Pole relative to the compass in place, then the following formula can be used to enter values in ArcGIS [8].

\[
\alpha = 360^0 - \beta + 90^0
\]

where:
\( \alpha \) - The angle to be determined in ArcGIS,
360° – Poles exchange,
β - defined steering angles to the north in place,
90° – The difference in poles [9, 10].
For instance:

3. Results and Discussions
For instance, in this method, the values obtained using the above formula change because the sequence of geographic poles and azimuth angles was radically different from the poles and azimuth angles in ArcGIS. The figure 1 showed the difference between the geographic and the poles in ArcGIS. Geographical polar structure has different. The exchange of poles can be seen in the geographical polar structure, which differs significantly from the polar structure. In other words, in the geographical structure, the exchange of poles can be seen moving counterclockwise from 270 degrees to 0/360 degrees (Figure 1).

![Figure 1. Difference between geographic and poles in ArcGIS](image)

However, in the polar structure in ArcGIS, this figure is completely different, it can be seen that the rotation of the poles from 270 degrees to 0/360 degrees is counterclockwise (Figure 1).

| 1 point ---- 380° 00’ 00’” | 1 point = 19 meters |
|-------------------------------|---------------------|
| 2 point ---- 288° 35’ 00’”   | 2 point = 9 meters  |
| 3 point ---- 245° 30’ 00’”   | 3 point = 53.5 meters |
| 4 point ---- X                | 4 point ---- X       |

| 1. 360-308.00 + 90 =142.00   | 1.142 grad 19 meters |
| 2. 360-288.35 + 90 =161.65   | 2. 161.65 grad 9 meters |
| 3. 360-245.30 + 90 =204.7    | 3. 204.7 grad 53.5 meters |
| 4. point ---- X              | 4. The point is determined based on the available points. |
According to Table 1, four points were taken at certain degree and distance. Clearly, the first point was in distance of 19 meters, where the degree was $380^\circ$, followed by the second where the distance was 9 meters with $288^\circ$, the third point had 53.5 meter and 2450, and the last point distance and degree can be identified based available points (Table 1).

According to Figures 2 and 3, the experiments were almost the same in the both methods. In the both methods, 4 points were taken, and the point was obtained from navigator.

![Figure 2](image)

**Figure 2.** The first proposed method of geodetic measurements.

However, the main difference between these two methods was that in the first method main point was based on north pole, whereas it was based on basis point, accordingly distance of the field and its location were calculated in the theses two methods (Figures 2 and 3).
Figure 3. The second proposed method of geodetic measurements.

The base values obtained in the navigator are imported into the ArcGIS software. To form thematic layers in the created database, it is advised to press Ctrl + G and write the values of angles and lengths on the resulting label using the above formulas, resulting in the dotted lines. The resulting territorial points were combined according to a scheme (abris) created for use on the ground, and an electronic digital map of the geo-database of the region was formed. At the end of the work, a table of attributive data related to the object was completed and submitted to the State Cadaster Chamber in the prescribed manner.

4. Conclusions
1. It should be noted that in all regions of the country there is a lack of funding for modern geodetic instruments (electronic taxometers) required for modern geodetic field research in all regions, and in mountainous areas using 1-frequency GPS navigators. It is no exaggeration to say that overcoming the shortcomings of the past will solve the current problem.
2. Processing the values of traditional and modern geodetic instruments in modern software and analyzing the results will create a number of conveniences for professionals in the field.
3. If the development of experiments and formulas required for the elimination of these shortcomings is introduced in enterprises and organizations, we would be able to fulfill the tasks of our government in a timely manner, without errors and shortcomings.

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