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APPLICATION POLARIMETRY FOR MEASUREMENT OF RELIEF

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Abstract. *The article discusses modern geodetic measurement methods of relief, their advantages and disadvantages. It is also offered a polarimetric measurement method of relief. This method is intended for measuring relief and can also be used to measure slope road and airport paving, railways to geometric description of the surface complex engineering objects, such as bridges, roofs of buildings, architectural elements.*

Keywods: curve surface relief; express – monitoring of relief; polarimetric measurement method; polarimeter; relief

1. Introduction

In modern terrestrial geodesy in the performance of measurement work the task is not only to measure with high accuracy, but in minimal time. Most existing methods that involve the use of geodetic instruments (theodolites, levels, lighttelemeter, tachometers, etc.) are characterized by high accuracy, but at the same time, the speed of measurement is low. Also, labor costs in carrying measurement process remain significant in spite of automation of individual operations.

2. Analysis of research and publications

Analysis of research and publications [1], [2], [3], [4], [5] showed that for measuring of relief, Geodetic instruments and measurement methods are used. They are characterized by high precision, low speed and significant labor metering process.

3. Formulation of Article purposes

Since there is a need to conduct highly accurate measurements of the relief at high speed, thus arises the problem of developing a method of measuring of the relief that would ensure reduction in measurement time and at the same time ensure high measurement accuracy.

4. The main material

Let us consider the existing methods for measuring of the relief. The most widespread is the method of measurement, which is implemented using a theodolite. Theodolite - geodetic instruments for measuring horizontal and vertical angles, distances, azimuth. With a theodolite topographic surveys are performed to generate topographical maps and plans for which project construction, land surveying. Sides angle that should be measured, projected on the limb using a moving plane sighting telescope. In this case plane of vizier alternately combined with each side angle, directing collimation axis of the telescope at a point lying on the side of the angle. As vizier target, used vertically held milestones established at sighting point. Angle determined by the calibration device – alidade. Features of the measurement method cause low performance of modern geodesic instruments. In particular, during the measurement for determining the coordinates of an arbitrary geometrical point of relief it is necessary to focus its image, and then to measure taking in to account the reference directions using levels, gyroscopes, accelerometers. And this takes some time.

The above drawbacks are absent in satellite geodesic measurement systems. Here the measurement is performed using four satellites. The distance from each satellite to a user receiver, is measured, and then based on the known coordinates of the satellites, using the formula for calculating the distance between two points to determine the position coordinates of the user receiver. Three measurements are enough to calculate the coordinates of the point. The fourth measurement is necessary in order to determine the difference in time between satellite clock and the receiver clock. In determining the distance of satellite systems they measure the phase of the electromagnetic wave. In carrying out the measurements by satellites exclusively relative (differential) method are used, as they provide the highest accuracy. In relative measurements two receivers and the same constellation of satellites are used. The results of these measurements determine the geometric axis projection on the coordinate system baseline that connects the receivers, the distance between them, and the angles that characterize the direction of the baseline. This allows measurements of macro- and meso-relief using GPS [3].

By analogy with satellite systems, terrestrial measurements can be carried out also quickly when they measure azimuth plane of polarization of the light wave, instead of parameters directional propagation of electromagnetic waves, ie the use of polarimetric measurement methods [5, 7].

The use of polarimetric measurement method in terrestrial geodesy and other fields can solve the problem of providing high-precision, continuous and rapid measurement process.

Measurement accuracy is reached through the use of polarimeter and providing speed – the presence of a moving base on which polarizer and the light source are set.

Structurally, the base may be represented as carts, wheels or other moving object.

The proposed method provides a significant reduction of time spent on measuring work, as it provides almost complete automation. The method also provides removal of processing measurement results outside the field of measurement, enabling measurements with high accuracy. It allows to conduct rapid monitoring of areas whose relief is constantly changing, for example, the runway at the airport. In the simplest case, the method can be implemented using a polarizer and light sources installed on a moving basis, analyzer, information processing and storage device.

The method is as follows (Fig.). After determining the value of the derivative at each fixed point towards an unknown function using integration, describing the path traveled by the measuring device. Curved lines of this path will determine the relief. The value of the derivative at each point of the curve relief equals angular coefficient of the tangent line.

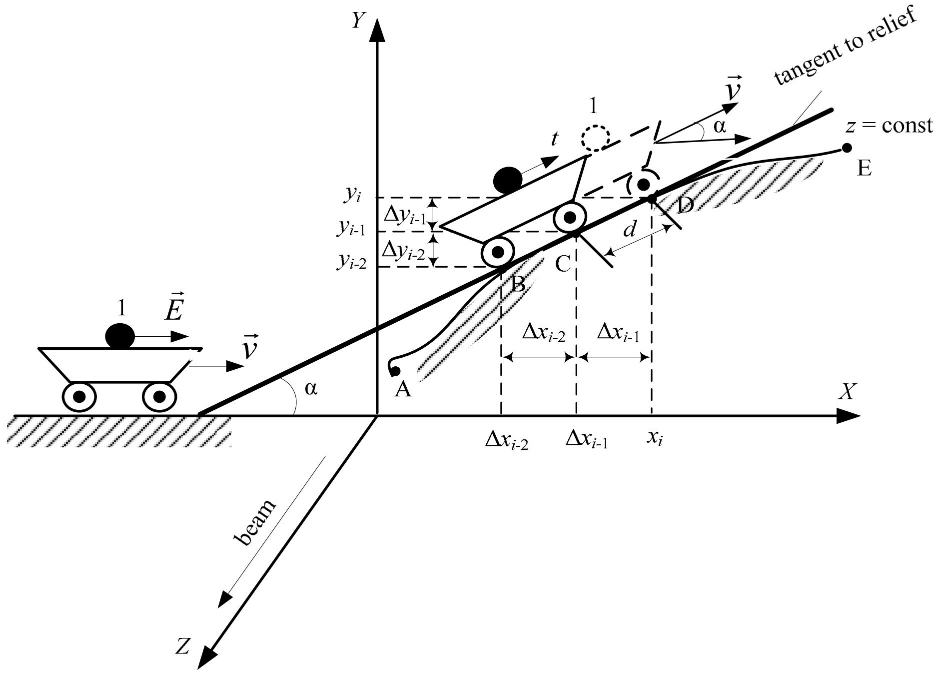

Fig. Scheme of polarimetric measurements of relief:
1 - platform; 2 – laser

The angular coefficient of the tangent is defined tangent of angle of tangent slope relative to the horizon. The angle of inclination measured with high accuracy by polarimeter.

Denote the length of relief from point A to point E through S, the distance between the points of contact wheel platform with a surface relief (points B, C and D) through d, speed of movement of platform – v.

Angle α measurement is performed at intervals Δt.

Thus the quantity of measurement equal to N.

$$\Delta t = \frac{d}{v};$$

$$N = \frac{t}{\Delta t} = \frac{S}{d}.$$

The current i-th measurement value of x and y in uniform motion of platform on the surface relief is:

$$x = x_n = \sum_{i=1}^{n} x_i; \quad x_i - x_{i-1} = d\cos\alpha_i;$$

$$y = y_n = \sum_{i=1}^{n} y_i; \quad y_i - y_{i-1} = d\sin\alpha_i.;$$

$$x = x_n = \sum_{i=1}^{n} x_i = \sum_{i=1}^{n} d\cos\alpha_i = d\sum_{i=1}^{n}\cos\alpha_i;$$

$$y = y_n = \sum_{i=1}^{n} y_i = \sum_{i=1}^{n} d\sin\alpha_i = d\sum_{i=1}^{n}\sin\alpha_i.$$

For measured values construct dependency $y_n = f(x_n)$ or $y = f(x)$, which describes a curve surface relief.

5. Conclusions

The article offeres a polarimetric measurement method of relief. Unlike existing methods, it provides high accuracy measurements by making processing of measurement results outside the measurement area, high speed and low expenditures of labor of the measuring process by automating the measurement process.

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В.Д. Тронько[1], В.Г. Романенко[2], А.Є. Клочан[3]. Використання поляриметрії для вимірювання рельєфу місцевості
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Статтю присвячено проблемі використання поляриметрії для вимірювання рельєфу місцевості. Запропоновано поляриметричний метод вимірювання. У порівнянні з наявними методами вимірювання поляриметричний метод забезпечує скорочення часу вимірювання й при цьому забезпечує високу точність. Він забезпечує неперервність і високу точність вимірювання завдяки застосуванню поляриметра, високу швидкість і низькі трудозатрати вимірювального процесу за рахунок автоматизації процесу вимірювання.

Ключові слова: експрес-моніторинг рельєфу; крива поверхні рельєфу; поляриметр; поляриметричний метод вимірювання; рельєф місцевості

В.Д. Тронько[1], В.Г. Романенко[2], А.Е. Клочан[3]. Использование поляриметрии для измерения рельефа местности
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Статья посвящена проблеме использования поляриметрии для измерения рельефа местности. Предложен поляриметрический метод измерения. В сравнении с существующими методами измерения поляриметрический метод обеспечивает сокращение времени и при этом обеспечивает высокую точность. Он обеспечивает непрерывность и высокую точность измерения за счёт использования поляриметра, высокую скорость и низкую трудоемкость измерительного процесса за счёт автоматизации процесса измерения.

Ключевые слова: кривая поверхности рельефа; поляриметр; поляриметрический метод измерения; рельеф местности, экспресс-мониторинг рельефа.

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