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Classification of angle and distance measurement errors of electronic total stations

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Abstract: This article analyzes the errors in measuring electronic total stations (angle and distance using a laser beam), i.e. errors in measuring the angle and distance, and based on their results and developed recommendations. The methods for studying electronic total stations are indicated, which will allow the user to assess its accuracy when measuring the angle and distance using a laser beam in a production environment, to determine the error type and to develop methods to reduce the error influence.
Keywords: electronic total station, laser beam, angle and distance measurement, geodetic instruments geodesy, metrology.

Introduction

When viewing a traditional geodetic instrument accuracy, it was analyzed the the set of its specific parts, nodes, devices errors and their relative position.

Currently, linear distance measurement is performed using a laser beam. Modern geodetic angle measuring instruments, i.e. electronic total station, are a complex geodetic instrument combined with a complex for measuring angles and distances using laser light.

However, the development and improvement of laser distance measuring devices, the increasing demands on their accuracy and reliability, lead to the need to create new methods and tools for monitoring such devices metrological properties.

Therefore, at present, metrological control of electronic total station measuring systems using distance and laser distance measuring devices is an urgent task. Measurement error resulting from uncontrolled instrumental error of electronic total station can lead to unpredictable consequences. This explains the metrological control importance of electronic total station in geodetic work [1].

Research object and problem statement:

The purpose of this control is to check their performance and determine the error values during measurements. The electronic total station reliability should be ensured both during the production process phase and during periodic inspections. The measuring devices of electronic total station, modern measuring systems errors are subject to complex relationships, which have not been fully studied and can only be determined as an experimental studies result. By analyzing the geometro-optical basis of the measurement scheme, taking into account the laser handle formation properties, the expressions **x** and **y** measured by the photoelectric method are obtained by converting the linear deviations into angles α and β.

$$\alpha'' = \frac{X \cdot f_2^{/} \cdot \rho}{2L \cdot (f_2^{/} + b_{\max} + 2t)},$$

$$\beta'' = \frac{Y \cdot f_2^{/} \cdot \rho}{2L \cdot (f_2^{/} + b_{\max} + 2t)};$$

here $f_2^{/}$ - focal length of the autocollimator lens; ρ - the number of seconds on the radio; L- distance from rangefinder to reflector; b_{max} is the distance from the main rear plane lens to the plane of analysis in the rays formation at the smallest sight distance.

To get into the problem of analyzing the electronic total station errors effect, we see their classification given in Table 1. We can divide all total station errors into several groups: violation of the geometric device scheme and orientation error; target correction error; error of direction and angle calculation systems;

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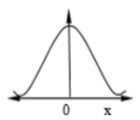
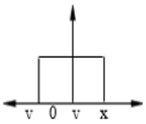
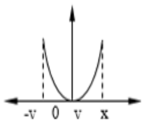
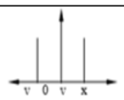
rangefinder block error; errors caused by the reflector or the reflective object surface.

Error distribution functions

Table №1

Types of errors	Distribution of potential errors h (x)	Appearance of the distribution curve	$k_i = \frac{V_i}{\sigma}$	P_c
Errors caused by noise, temperature fluctuations, vibration of the illuminator	Normal distribution		3	0,997
Target correction and counting, friction, quantization errors	Flat, equal dimensional distribution		$\sqrt{3}$	1
Errors that occur due to sinusoidal correction eccentricity and other in the supply frequency	Arcsinusoidal distribution		1.41	1
Errors due to hysteresis	Discrete distribution		-	1

The resulting errors can generally be written as the sum of permanent systematic errors, variable systematic errors, and random errors [2].

$$\Delta_{\sum} = \sum_{i=1}^{n} \Delta_{si} \pm \sqrt{\sum_{i=1}^{m} \Delta_{si}^{2} + \sum_{i=1}^{p} k_i^2 \sigma_i^2} ,$$

here $\Delta_{si} - i$ is a permanent systematic errors of the angle measuring device; n – is a number of permanent systematic organizers; Δ_{si} – is the finite value of the i^{th} defined distribution function; m – is a number of variable systematic constituents; σ_i - is a standard deviation of the random *i-th* constituent errors of the instruments;*p*- is a number of random organizers; k_i – is a coefficient taking into account the transition from the standard random errors deviation to the finite error V_i [2].

Conclusion: A permanent systematic error remains constant when measured with a specific electronic total station (when the mutual state of some of its parts recorded) and can in most cases be detected by special studies and corrected (eliminated) by making appropriate corrections to the measurement results.

The variable systematic constitutive error varies with each new measurement, and the value varies over a certain range over a given deterministic relationship. The random constitutive errors of an electronic total station of an independent errors set.

The error of geodetic instruments is determined by calculating the maximum and probability effects of measurement errors. The preparation of some tools details is done by calculating the dimensional chains to obtain the parameters and checks. Such calculation examples can be found in the literature [3, 4].

In order to provide metrological support for all electronic total station types' inspection, it is necessary to develop a comprehensive program for angle and distance measuring blocks inspection in the reference geodetic network in field conditions.

Literature:

1. Mirzaev A. A., Rakhmatilloeva K. Prohibition of angular and distance measurement errors of electronic taximeters, which are widely used in Uzbekistan. International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 08, 2020 ISSN: 1475-7192., p.1742-1746.
2. Karsunskaya M.M. «Experience in the use of automated systems for determining the metrological characteristics of geodetic instruments». Collection of materials of the industry seminar for specialists from the metrological service of Roskartografiya «Metrological support for topographic, geodetic and cartographic production», Nizhny Novgorod, June 13-16 2000, p. 109-117.
3. High-precision angular measurements /Anikst D.A., Konstantinovich K.M., I. V. Meskin and etc.; Edited by Yakushenkov Yu.G., M.: Mechanical Engineering, 1987. – p.480.
4. Zakharov A.I. Reference book on geodetic instruments. M., Nedra, 1989 314p.