POINT ESTIMATION OF THE TRUE VALUE AND MEAN SQUARE DEVIATION OF THE MEASUREMENT

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Abstract. *This article covers in detail the issues of ensuring metrological dimensions at the required level in the process of production and repair of mechanical engineering parts, information about the types of measurements, means and rules for their use.*

Keywords: *Measurement, device, machine, deviation, deviation, metrology, object, function, distribution, interval.*

It is known in metrological practice that when estimating the true (searched) value of a measured quantity or finding a measurement result and finding its error according to a group of results of a series of measurements, the point (point) estimation method of the values of the distribution function of a random quantity is used. This method is based on solving a statistical problem, that is, a series of values from the results of n independent experiments based on a selection.

If the value is represented by a single number, it is called a point estimate. Any point estimate calculated on the basis of the data obtained from the experiment is a function of it, and therefore it depends on the distribution of the initial value of the random variable and the results of the experiment.

It must satisfy the three requirements of point evaluation: perfect, stable and efficient (effective)**.**

Perfect estimation means that the estimable values correspond to the characteristics of the estimator in terms of probability.

The measurement process and, of course, the measurement results are affected by many factors, which in some cases are difficult to take into account.Бу омилларни кўриб чиқишни It is necessary to start by understanding the concept of "measurement process" itself. "Measurement process" means the total amount of measurement data, devices and operations. In this case, the "element of the measurement process" should be understood as any individual factor affecting the measurement result (Fig. 1). Such factors include:

measuring object;
- measurement subject (operator);
- measurement method;
- measuring tool;
- measurement conditions.

The object of measurement has been sufficiently studied, and the formation of its model, its level of detail (in-depth study of the object of measurement) should be adequate for the intended purpose of measurement.

Figure 1.

Measurement of groove dimensions

For example, if "thread size should be measured". First, the object model is created and the shaft diameter is measured once so that the cross section of the shaft can be circular.

The operator also affects the measurement process, causing subjective error. Subjectivity of the operator depends on his qualification, psychophysiological condition, sanitary and hygienic conditions of work (measurement) and others.

Among the factors affecting the measurement result, the measurement method and measurement tools are also of great importance. It is necessary to choose both the measurement method and the measurement tool in accordance with the purpose of the measurement process and the conditions of its implementation.

It should be remembered that measuring instruments have only a specific error (instrumental component of measurement error) and can change the value of the object of measurement, that is, it can affect the measured quantity itself.

The measurement conditions affect all other elements of the measurement process - the measurement object, the measurement tool, and the operator himself.

Often, measurements of a quantity in different ways and using different measuring instruments give completely different results. Each of these options has its advantages and disadvantages, and the choice of the most optimal option (for a particular measurement problem) depends on the skill of the experimenter. Of course, in this case, there cannot be a specific ready-made solution and recommendation. However, there are some error reduction methods that can significantly reduce the individual components of the regular error.

Correlation function of random process and their properties.

The following laws are used to study the distribution of random quantities in metrology: normal (Gauss), uniform distribution law, Student, triangular (Simpson), xi-square (□2) (Pearson), Fisher's law, exponential law, etc.

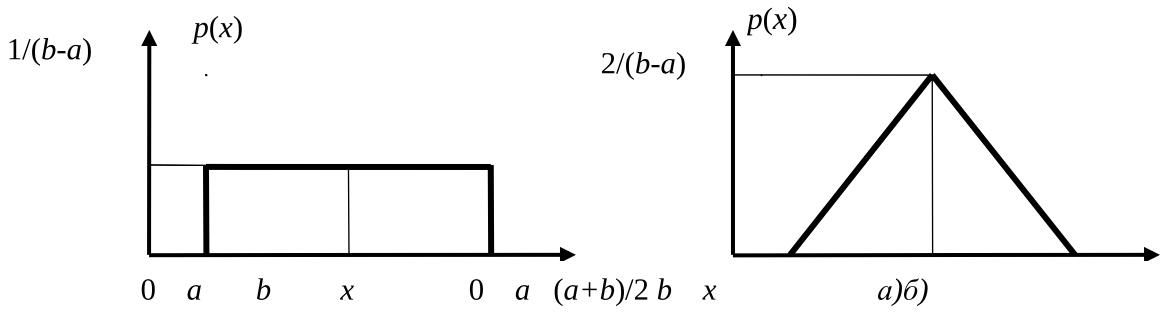
The normal distribution of random variables is often used in measurement techniques. The law of normal distribution of random errors, based on the theory of probability, is used when the results of measurements are affected by random factors. Random effects cause measurement results and errors to be distributed according to (almost) normal law.

The distribution curves according to the normal law for different values of the mean square changes are presented in Figure 2.

Triangular and uniform even distribution of random quantities are also found in metrological practice.

Figure 2.

Uniform (flat) (a) and triangular (b) distribution of random variable



If the random variable X assumes values in the interval from a to b with a constant probability density, such a distribution is called a uniform (flat) distribution, and this is characteristic of the display of most digital instruments (Fig. 2a).

The integral function F(t) of the normalized normal distribution is related to the Laplace function (probability integral) by the following expression.

$$L(t_p) = \frac{1}{\sqrt{2\pi}} \int_0^{t_p} e^{-\frac{1}{2}v^2} \cdot dV$$

$$F(t) = 0{,}5 + L(t_p).$$

This function does not differ from 1 for large values of t1 in the range outside the limit of values of t from -3.5 to +3.5.

XI is the squared X2 distribution - the sum of squares of the standard normal distribution of a random variable.

$$X_k^2 = \sum_{i=1}^{n} \left(\frac{x_i - m_x}{\sigma_x} \right)^2 = \frac{(n-1)S_x^2}{\sigma_x^2},$$

in this $K=н-1$ - number of degrees of freedom; $н$ - number of random variables. If x and $У$ are independent quantities, in this x - standard normally distributed quantity,

$У$ while - $К$ - with degrees of freedom x^2 - is a normally distributed random variable, then the random variable

$$T = x / \sqrt{\frac{У}{К}}$$

For different values, the Student's distribution is defined as the Student's fraction and is given in Table 1 (True value of K-size)

$$t_p = \frac{\bar{x} - m_x}{S_{\bar{x}}} = \frac{\bar{x} - Q}{S_{\bar{x}}} = \frac{\bar{x} - Q}{S_x}\sqrt{n}$$

of the magnitude measured using the Student's distribution or from Table B.1

$$\delta_p = t_p S_x$$

true value can be determined if its deviation (deviation) from the average arithmetic value does not exceed.

Fisher distribution. If X and $У$ – independent (unrelated) random variables

κ_1 and κ_2 – with degrees of freedom X^2 if distributed according to, then a random variable

$$F = \frac{x/k_1}{y/k_2},$$

ie *F* Fisher distribution κ_1 and κ_2 distributed by degrees of freedom.

The main characteristics of the laws of distribution of random numbers (variables), integral and differential functions of distribution are given in Table 1.

Table 1.

Characteristics of distribution laws of random variables

Distribution law	Distribution function	
	Differential	Integral
Normal (Gaussian)	$F(t_p) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{t_p} e^{-\frac{1}{2}t^2} dt$	$F(x) = \frac{1}{\sigma_x \sqrt{2\pi}} \int_{-\infty}^{x_0} e^{-\frac{(x-m_x)^2}{2\sigma_x^2}} dx$
Equally distributed (Uniform)	$p(x) = \begin{cases} 0; & -\infty < x < a \\ \frac{1}{b-a}; & a \le x \le b \\ 0; & b < x < +\infty \end{cases}$	$F(x) = \begin{cases} 0; & -\infty < x < a \\ \frac{x-a}{b-a}; & a \le x \le b \\ 1; & b < x < +\infty \end{cases}$
Triangle (The Simpsons)	$p(x) = \begin{cases} 0; & -\infty < x < a \\ \frac{4(x-a)}{(b-a)^2}; & a < x < \frac{a+b}{2} \\ \frac{4(b-x)}{(b-a)^2}; & \frac{a+b}{2} < x < b \\ 0; & b < x < +\infty \end{cases}$	$F(x) = \begin{cases} 0; & -\infty < x < a \\ \frac{2(x-a)^2}{(b-a)^2}; & a < x < \frac{a+b}{2} \\ \frac{2(b-x)^2}{(b-a)^2}; & \frac{a+b}{2} < x < b \\ 1; & b < x < +\infty \end{cases}$
Standardized (normal)	$p(t) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}t^2}$ *бунда m = (x – мₓ)/σ*	$F(t) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{t_p} e^{-\frac{1}{2}t^2} dt$
Exponential one-way (exponential)	$P(x) = \beta e^{-\beta x}$	$F(x) = 1 - e^{-\beta x}$

Example: The distribution of measured sizes of tractor wheel tires can be represented graphically (Figure 3). On the abscissa axis, the size intervals are plotted according to Table 2, and on the ordinate axis, the corresponding frequencies m or m/n are plotted. As a result of graphing, a step line 1 is obtained, which is called a distribution histogram. If we successively connect the points corresponding to the middle of each interval, a broken curve is formed, which is called the curve of the empirical distribution or the polygon of the distribution. With a large number of measured tire treads and a large number of size intervals, the broken empirical curve approximates a smooth curve in the form of a so-called distribution curve. It is recommended to divide the measured sizes into at least six intervals with a total number of measured tires of at least 50 units to construct a histogram distribution.

Under different conditions, the tire tread, the distribution of its actual dimensions, obeys different mathematical laws. Taking into account that the following laws are of great practical importance in the work of MTA, normal distribution (Gauss's law), equilateral triangle (Simpson's law), eccentricity (Rayleigh's law), probability laws and distribution functions that are part of these laws were taken as a basis.

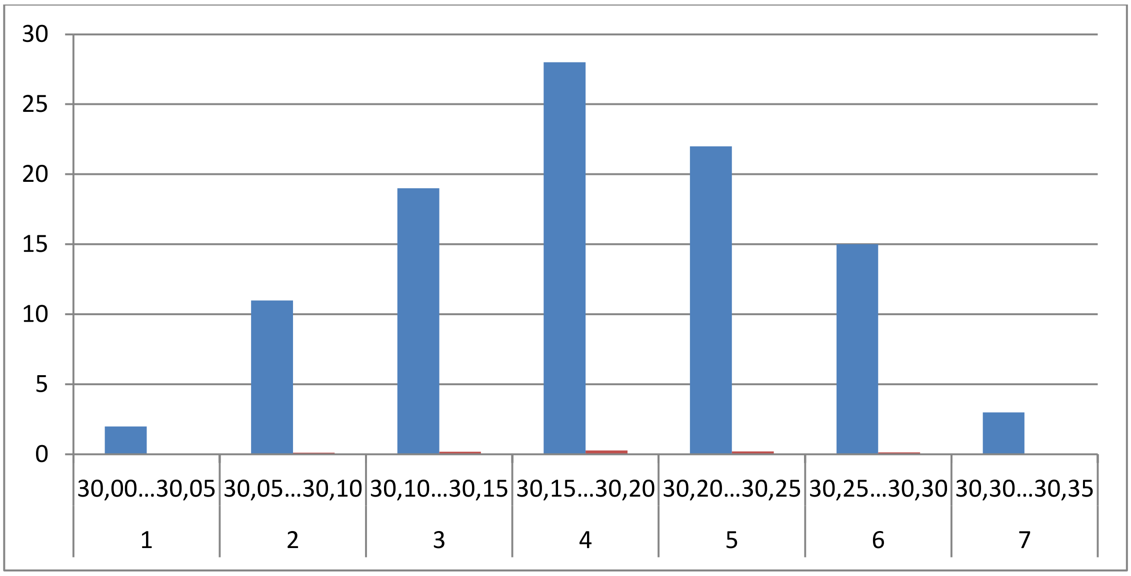
Table 2.

Distribution of deflection dimensions of tire tread pattern (9.5-42 Ya-183). MMTP "Kokumboy" and "Hudayberdiyev" in Kosonsoy district

T/r	Interval, mm	Frequency m	Frequency m/n
1	30,00…30,05	2	0,02
2	30,05…30,10	11	0,11
3	30,10…30,15	19	0,19
4	30,15…30,20	28	0,28
5	30,20…30,25	22	0,22
6	30,25…30,30	15	0,15
7	30,30…30,35	3	0,03
	Itogo	n = Σ m=100	Σ m/n = 1

Figure 3.

Distribution of deflection dimensions of tire tread pattern (9.5-42 Ya-183) "Kokumboy" and "Hudayberdiyev" MMTP of Kosonsoy district



Conclusion

Using the laws of probability allows you to find optimal options for the size of research results.

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