RESEARCH OF THE BACKGROUND INFLUENCE ON THE ELECTRO-OPTIC TRANSFORMERS RESOLUTION

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The research refers to electro-optic appliances which work at different levels of background brightness [1, 2, 5].

The research objective is to define the influence of the background brightness upon the resolution of the different types of electro-optic transformers, types B-1, B-3, П-3 and П-4.

A trial has been made to study if there is a correlation between the illumination of the background, the brightness of the test object and the number of scintillations on electro – optic transformer screen.

Keywords: background influence, resolution, electro – optic transformer

The examination of a pair of quantities is not enough to determine the real correlation between them. It is necessary also to examine the partly correlation between them. Kendal and Stewart make the following comment: if the correlation between two quantities decreases when another fixed accidental quantity is fixed, this means that their mutual relation originates partly from the influence of this quantity. If the partly correlation equals to zero, or if it is a very small value, this means that their mutual relation is completely dependent on this effect. Therefore, we can judge about the way the examined accidental quantities are mutually related by the change of the particular correlation coefficient in comparison with the casual correlation coefficient.

An experiment is carried out and the number of scintillations of an electro-optic transformer is examined at defined object brightness and emitted illumination of the site by means of appliances and methods about impartial assessment of the electronic and optic appliance characteristics. The calculated values are presented by analogue-digital transformer with a digital indicator and printing output.

It is supposed that the examined quantities have three-dimensional normal distribution. The acceptance of a zero hypothesis means that there is not a reason to consider that the particular correlation coefficient is substantially different from zero, i.e. the linear relation between the brightness of the test object and the illumination of the site (the background) does not exist. The acceptance of the alternative hypothesis is a proof about the existence of linear statistic relation.

Of special interest is the fact that there is a strong relation between the brightness of the test object, the number of the scintillations and especially between the illumination of the background and the number of the scintillations.

The resolution is examined at three levels of background brightness when the contrast is zero and this is done by means of an appliance for objective evaluation of the electro-optic transformers characteristics. [3,4].

I level:

$N_1(B_1)$ - Maximum resolution of electro-optic transformer (EOT) when the brightness of the test object is optimal for the observer.

II level:

$N_2(B_2)$ - Normal resolution of EOT when the background brightness is 2,6.10 cd/m^2.

III level:

$N_3(B_3)$ Normal resolution of EOT when the background brightness is 0,024 cd/m^2.

Table 1

Electro-optic transformer	EOT of B-1				EOT of B-3				EOT of П-1				EOT of П-4				$\overline{X}_{0e}$
	j			$\overline{X}_{1e}$	j			$\overline{X}_{2e}$	j			$\overline{X}_{3e}$	j			$\overline{X}_{4e}$	
	1	2	3		1	2	3		1	2	3		1	2	3		
$N_1(B_1)$	35	33	34	34	36	37	38	37	27	28	29	28	29	30	28	29	32
$N_2(B_2)$	32	30	31	31	33	33	33	33	25	23	24	24	25	27	26	26	28,5
$N_3(B_3)$	25	27	16	26	28	29	30	29	22	23	21	22	23	23	23	23	25
X_{i0}	33,33				33,6				24,66				26				28,5

The registered values $N_1(B_1)$, $N_2(B_2)$ and $N_3(B_3)$ for the existing types of EOT, are represented in Table 1.

The problem is solved by usage of two-factor dispersion analysis.

The basic equation of the dispersion analysis with the two factors – the examined EOTs and the levels of background brightness B has the following mode: [1]:

(1) $$Q = Q_{EOT} + Q_B + Q_{EOT.B} + Q_R$$

Where:
- Q – total quadrants sum;
- Q_{EOT} – quadrants sum of the EOTs;
- Q_B – quadrants sum of the background brightness levels
- $Q_{EOT.B}$ – quadrants sum between the variants of interaction of the EOTs and background brightness;
- Q_R – remainder quadrants sum.

The number of the degrees of freedom of these quadrants sums is as follows:

(2) $$\sqrt{\ } = N - 1 = nkq - 1 = 3.4.3 - 1 = 35$$

Where:
- n – number of experiments;
- k – number of the examined EOTs;
- q – number of the examined background brightness.

(3) $$\sqrt{_{EOP.B}} = k - 1 = 4 - 1 = 3\,;$$

(4) $$\sqrt{_{B}} = q - 1 = 3 - 1 = 2\,;$$

(5) $$\sqrt{_{EOP.B}} = (k-1)(q-1) = 6;$$

(6) $$\sqrt{_{R}} = kq(n-1) = 24 .$$

Evaluation of the dispersion is received by dividing the quadrants sums Q, Q_{EOT}, Q_B, $Q_{EOT.B}$ and Q_R to the corresponding degrees: $\sqrt{\ }$, $\sqrt{_{EOP.B}}$, $\sqrt{_{B}}$, $\sqrt{_{EOP.B}}$ and $\sqrt{_{R}}$. The received values are represented in Table 2.

In order to check the correctness of the null hypotheses H_0, separately about the type of the EOTs and the influence of the background brightness upon the resolution, the dispersion correlations are calculated:

(7) $$F' = \frac{s_{EOT}^2}{S^2} = 256{,}1$$

(8) $$F'' = \frac{s_B^2}{S_R^{\ 2}} = 88{,}5$$

(9) $$F''' = \frac{s_{EOT.B}^2}{S_R} = 161{,}5$$

The table values of the disperse relation (F) accordingly for 5 % and 1 % levels of significance α at number of degrees of freedom $\sqrt{_{EOT}} = 3$, $\sqrt{_{B}} = 2$ and $\sqrt{_{R}} = 24$ are:

For $\alpha = 0{,}05$ and for $\alpha = 0{,}01$

(10) $$F_T' = \frac{\sqrt{_{EOT}}}{\sqrt{_{R}}} = 3{,}01 \qquad F_T' = 4{,}72;$$

(11) $$F_T'' = \frac{\sqrt{_{B}}}{\sqrt{_{R}}} = 3{,}40; \qquad F_T'' = 5{,}61;$$

(12) $$F_T''' = \frac{\sqrt{_{EOT.B}}}{\sqrt{_{R}}} = 2{,}51; \qquad F_T''' = 3{,}67 .$$

Table 2

Quadrants sum	Degrees of freedom	Dispersion Evaluation
$Q = \sum_{i=1}^{k}\sum_{l=1}^{q}\sum_{j=1}\left(\overline{X}_{ilj} - x\right)^2 = 1604{,}09$	$\sqrt{\ } = 35$	$s^2 = \frac{Q}{\sqrt{\ }} = 45{,}8$
$Q_{EOT} = nq\sum_{i=1}^{k} (\overline{x_{i0}} - \overline{x})^2 = 638{,}37$	$\sqrt{_{EOT}} = 3$	$S_{EOT}^{\ 2} = \frac{Q_{EOT}}{\sqrt{_{EOT}}} = 212{,}8$
$Q_B = nk\sum_{l=1}^{q} (\overline{x_{l0}} - \overline{x})^2 = 147$	$\sqrt{_{B}} = 2$	$S_B^{\ 2} = \frac{Q_B}{\sqrt{_{B}}} = 73{,}5$
$Q_{EOT.B} = n\sum_{i=1}^{k}\sum_{l=1}^{q} (\overline{x_{jl}} - \overline{x_{i0}} - \overline{x_{l0}} + x)^2 = 798{,}72$	$\sqrt{_{EOT.B}} = 6$	$S_{EOT.B}^{\ 2} = \frac{Q_{EOT.B}}{\sqrt{_{EOT.B}}} = 133{,}12$
$Q_R = \sum_{i=1}^{k}\sum_{l=1}^{q}\sum_{j=1}^{n} (x_{ilj} - x_{il})^2 = 20$	$\sqrt{_{R}} = 24$	$S_R^{\ 2} = \frac{Q_R}{\sqrt{_{R}}} = 0{,}83$

A dispersion analysis has been carried out and it showed that the brightness of the background affects the corresponding resolution in different ways according to the type of electro-optic appliance.

The following conclusions can be drawn from the carried research:

1. The null hypothesis that the resolution of the type EOT is not influenced by the background brightness cannot be accepted, because $F' >> F'_T$, $F'' >> F''_T$ and $F''' >> F'''_T$ on both influence levels, i.e. the background brightness has a significant influence upon the resolution of the examined EOTs.
2. The carried out dispersion analysis shows that the background brightness influences the different types of EOTs upon the corresponding resolution. When the background brightness is low, the best results of the visually observed distant objects will be registered by EOTs B-3 and B-1, and when observation is at dusk – the EOTs B-3, П-4 and B-1 will be used. The combination of the types of EOPs with the experiment conditions will be a prerequisite for creation of optimal conditions for discovery and identifying of objects in conditions of different background brightness influence, when prognosticating the probability through calculated resolution of the examined EOTs.

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