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A METHOD FOR ADAPTING AN OPTICAL-ELECTRONIC CONVERTER TO A CHANGE IN ILLUMINATION IN A SYSTEM FOR OBSERVING DYNAMIC OBJECTS

[1]Abidova Gulmira Shuxratovna, [2]Djurabayeva Feruza Baxtiyarovna
Department of Electrical and Computer Engineering
Tashkent State Transport University, Uzbekistan[1], Department of Electrical and Computer Engineering
Tashkent State Transport University, Uzbekistan[2]
mir-miral@mail.ru[1]

ABSTRACT

Currently, in various sectors of the economy, in particular, in systems for diagnostics and quality control of products, production of products for the electronic industry, motion control systems for walking and transport robots, automated systems for medical diagnostics, metrology, in agriculture, video surveillance systems are widely used. such advantages as the possibility of remote monitoring at large distances between the system and the object, the absence of forces acting on the test object from the side of the transducer, high speed, the possibility of organizing multi-parameter control, wide variation in the resolution and measurement range, achieving high accuracy and stability of measurements. To implement this system, one of the tasks is to develop a method for adapting an optoelectronic converter to a change in illumination.

Key Words: Interference, Coherence, Interferometer, Video Surveillance.

INTRODUCTION

Of great importance in relation to the task of improving the quality of preliminary processing of video information, observing moving objects and carrying out optoelectronic measurements is the possibility of a quick response of an optoelectronic sensor to a change in illumination. In modern video cameras, matrix photosensitive devices with charge coupled are usually used as optical-electronic converters, therefore, it is necessary to adapt this type of device to a change in external illumination so that the useful parts of the video signal are within the working section of the energy characteristic.

METHOD AND CALCULATION

The energy characteristic of the CCD array photosensitive device is shown in Fig. 1, and the energy characteristic of an ideal (in terms of the value of the dynamic range) optoelectronic converter is shown in Fig. 2.

Let us introduce the following designations: $U_{work}=[U_{min}, U_{max}]$ - the working section of the energy characteristic of the matrix photosensitive device with a charge coupled, where U_{min} and U_{max} - the permissible range of the output signal, providing a given signal-to-noise ratio $K_{s/n}$, selected for a specific recognition problem; D_{ph} - dynamic range of the matrix photosensitive device with charge coupling; D - is the dynamic range of an ideal electro-optical sensor.

The difference in the magnitudes of the signals created by the object and the background at the output of a matrix photosensitive device with a charge coupled

$$\Delta U = \Delta E S_u K_y \frac{T_n}{T} = \frac{(\rho_0 - \rho_\phi)E}{\pi \times F^2} S_u K_y \frac{T_n}{T}, \qquad (1)$$

where E - is the total illumination of the object, S_u - is the integral sensitivity of the matrix CCD photosensitive device, Ku is the gain, T_n - is the passport exposure time, T - is the actual exposure time, F - is the lens aperture, ρ_0, ρ_b - are the reflection coefficients of the object and background, respectively.

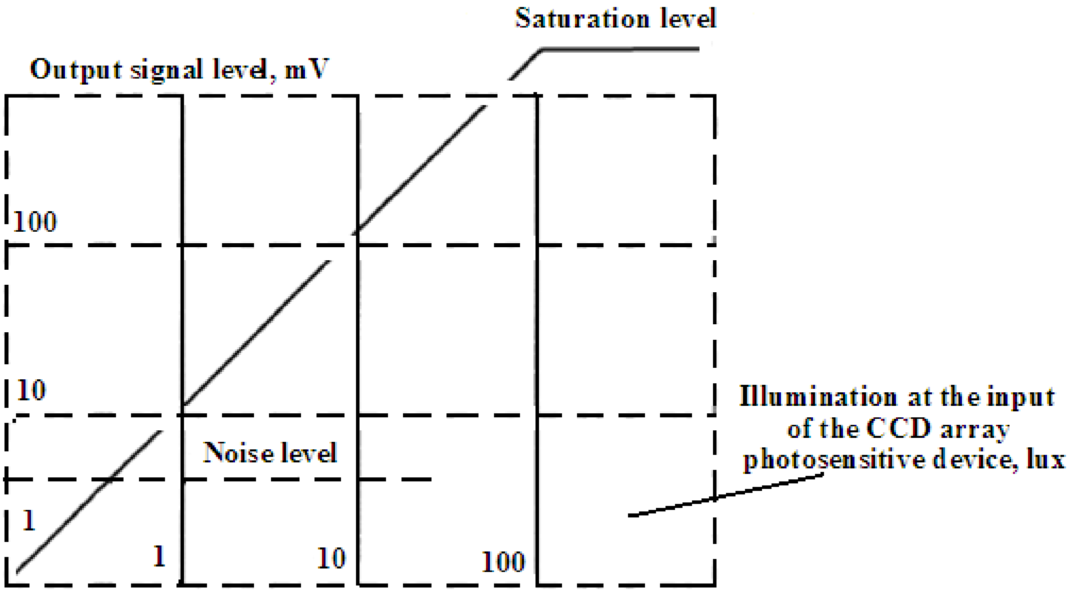

Figure 1. Energy characteristic of a matrix charge-coupled photosensitive device

Analyzing (1), it is possible to propose an accumulation mode capable of compensating for a part of the noise N_{st} and reconfiguring the operation of a matrix photosensitive device with a charge coupled so that the dynamic range D_{ph} shifts along the line of the energy characteristic of an ideal optoelectronic converter (fig.2).

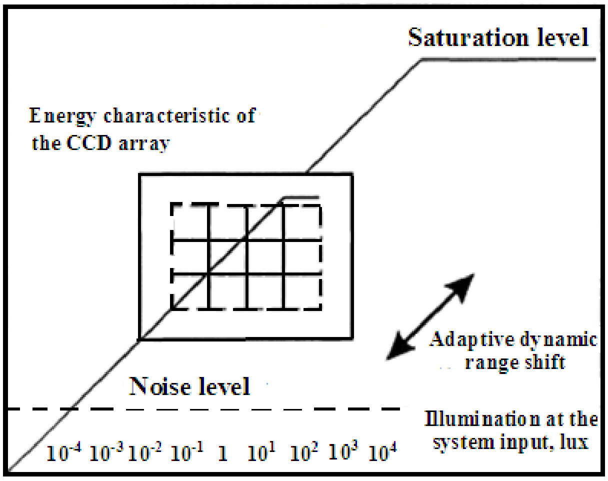

Figure 2. Energy characteristic of an ideal optoelectronic converter

These requirements are implemented by supplementing the optoelectronic sensor with an automatic exposure control unit [1]. Based on equation (1), analyzing the signal at the output of the CCD array photosensitive device and adjusting the parameter T, the amplitude of the video signal at the output of the CCD array photosensitive device is stabilized [1].

The amplitude of the video signal is controlled by changing the time of accumulation of the photo charge in the photosensitive section of the matrix photosensitive device with charge coupling. The accumulation time is associated with a pulse train of a certain frequency. The accumulation time is regulated by changing the frequency of this sequence (Fig. 3).

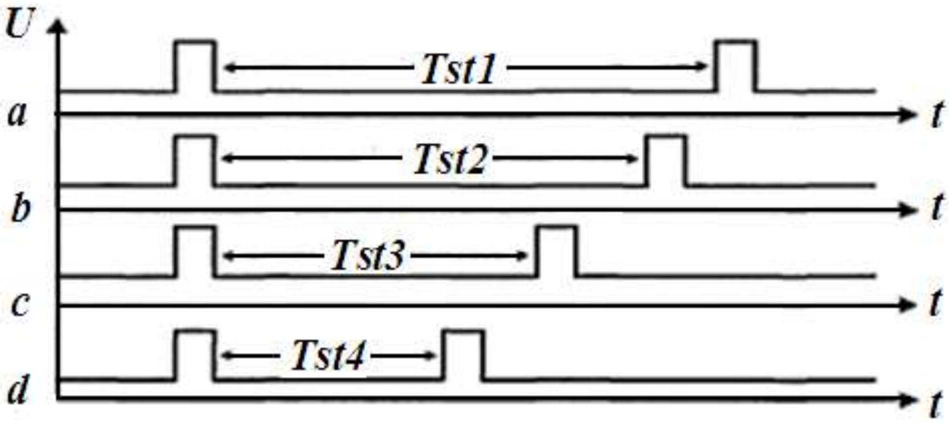

Figure 3. Sequence diagrams corresponding to different accumulation times

Let us estimate the extreme values of the accumulation time. Since the dynamic range is limited from above by the saturation level, and from below by the level of intrinsic noise, the minimum accumulation time t_{min} corresponds to the maximum illumination at the input of the optoelectronic sensor and depends on the physical characteristics of the matrix photosensitive device with a charge coupler, the construction of circuits that ensure the operation of the matrix photosensitive device with charge coupled, and from the construction of feedback circuits, the maximum accumulation time t_{max} corresponds to the minimum illumination at the input of the optoelectronic sensor and is limited by the level of intrinsic noise of the matrix photosensitive device with a charge coupler and the frequency of information readout from the output of the matrix photosensitive device with a charge coupler for further processing .

Thus, the adaptation of the matrix charge-coupled photosensitive device is carried out in accordance with the expression

$$t_{acc} = \begin{cases} t_{acc-l} + \Delta t, if U_{out} < U_{vol} \\ t_{acc-l} + \Delta t, if U_{out} > U_{vol} \end{cases}, \tag{2}$$

where $t_{acc\text{-}l}$ - previous value of accumulation time; Δt - accumulation time increment; U_{vol} - some voltage at which $K_{s/n}$→max, defined as:

$$U_{vol} = \frac{U_{\max} - U_{\min}}{2}.$$

The value of Δt is determined from the operating conditions of the device in the external environment and depends on the rate of change in the external illumination $\frac{\Delta E}{\Delta t}$ and the width of the working section U_{oper} of the energy characteristic of the matrix photosensitive device with charge coupling [2,3].

RESULT AND DISCUSSION

The adaptation of the optoelectronic converter in accordance with (2) is stable and the output signal of the matrix photosensitive device with a charge coupling U_{out} confidently enters the tracking mode U_{vol} at small values of Δt, when the ambient illumination changes homogeneously (for example, daily changes in illumination).

At large values of Δt, the operation of the algorithm becomes unstable due to large fluctuations in U_{out}. In addition, this algorithm is slow, that is, in one cycle of work, equal to the time it takes to get one frame, the correction is performed once. If the value of the output signal U_{vol} is significantly exceeded, the correction will be performed k times, i.e. to return U_{out} to the range U_{oper}, k frames will be skipped (k frames with low $K_{s/n}$ will be received), which is unacceptable for solving the problem of improving the quality of video information preprocessing and determining the parameters of object movement.

To eliminate these disadvantages, a modified adaptation method has been developed. The accumulation time $t_{acc} \in [t_{\min}, t_{\max}]$ is divided into N intervals. Each interval is assigned a voltage range in such $\Delta U_N \in [U_i, U_{i+1}], i = \overline{1, N+1}$ a way that when U_{out} and ΔU_N hit, the corresponding accumulation time is selected such that U_{out} falls into U_{oper}

$$t_{acc} = \begin{cases} t_1, U_{out} \in \Delta U_1 \\ t_2, U_{out} \in \Delta U_2 \\ \dots\dots\dots\dots\dots\dots \\ t_N, U_{out} \in \Delta U_N. \end{cases} \tag{4}$$

The matching of the accumulation time and the value of the output signal of the CCD array photosensitive device is performed at the stage of tuning or calibration of the optoelectronic sensor.

If however $U_{out} \in [U_{\min}, U_{\max}]$, the adaptation occurs in accordance with equation (3).

CONCLUSION

Based on the foregoing, according to the principle of operation of automatic exposure control, they are divided into two types: sequential and instant approach.

Automatic adjustment of the successive approximation exposure when the amplitude of the output video signal changes, generates a sequence of pulses to minimize the error in the deviation of the amplitude of the output video signal from the set value.

Automatic adjustment of the exposure of instant approximation when the amplitude of the output video signal changes, immediately forms a time sequence corresponding to the minimum error in the deviation of the amplitude of the output video signal from the set value.

In addition to adapting to changing conditions, the mode control means eliminate the influence of the technological scatter of the parameters of the matrix charge coupled photosensitive device [4].

REFERENCES

1. Gurtov V.A. Optoelektronika i volokonnaya optika: Uchebnoye posobiye. Petrozavodsk: Izd-vo PetrGU, 2005. - 239 s.
2. 2. Vinogradov, O.L. Matematicheskiy analiz / O.L. Vinogradov. - SPb.: BHV, 2017. - 752 c.
3. Shershnev, V.G. Matematicheskiy analiz: Uchebnoye posobiye /V.G. Shershnev. - M.: Infra-M, 2019. - 64 c.
4. Sukhanov I.I. Osnovy optiki. Teoriya izobrazheniya. Uchebnoye posobiye dlya bakalavriata i spetsialiteta.-Izdatel'stvo: Yurayt, 2020.111s.
5. Mirtoxirovna, A. M. (2020). THE SCIENTIFIC LEGACY OF ABU JA'FAR MUHAMMAD IBN JARIR IBN YAZID IBNKATHIR IBN GHALIB AT-TABARI AND THE IMPORTANCE OF TARIKH AR-RUSUL VAL-MULUK. Journal of Critical Reviews, 7(5), 923-925.
6. Mirtoxirovna, A. M. (2020). About copies, translations and editions of the work" tarikh ar-rusul val-muluk". ACADEMICIA: An International Multidisciplinary Research Journal, 10(4), 754-758.
7. Mirtoxirovna, A. M. (2020). About the persian translation of" tarikh ar-rusul val muluk". ACADEMICIA: An International Multidisciplinary Research Journal, 10(6), 416-419.
8. Irgashevich, D. A. (2019). Development of national network and corporate networks (in the case of Tas-IX network). International Journal of Human Computing Studies, 1(1), 1-5.
9. Dadamuhamedov, A. (2019). The role of information and communications technologies in pilgrimage tourism in Uzbekistan. The Light of Islam, 2019(1), 17.
10. Дадамухамедов, А. И. (2017). РАЗВИТИЕ НАЦИОНАЛЬНОЙ СЕТИ И КОРПОРАТИВНОЙ СЕТИ (НА ПРИМЕРЕ СЕТИ IX). Актуальные научные исследования в современном мире, (3-2), 133-137.
11. Irgashevich, D. A. (2020). Development of national network (tas-ix). ACADEMICIA: An International Multidisciplinary Research Journal, 10(5), 144-151.
12. Irgashevich, D. A. (2019, February). THE ROLE OF INNOVATIVE, INFORMATION AND COMMUNICATIONS TECHNOLOGIES IN PILGRIMAGE TOURISM IN UZBEKISTAN. In International Scientific and Practical Conference" Innovative ideas of modern youth in science and education" (pp. 262-265).
13. Dadamuhamedov, A. (2019). THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE DEVELOPMENT OF RELIGIOUS AND EDUCATIONAL PROGRAMS ON ISLAMIC SUBJECTS. The Light of Islam, 2019(4), 34.
14. IRGASHEVICH, D. A. (2020). METHODS OF USING CLOUD TECHNOLOGIES IN ISLAMIC EDUCATION INSTITUTIONS. METHODS, 7(5).
15. Ilkhomovich, S. E. (2020). The development of electronic trade and its role in general trade activities. ACADEMICIA: An International Multidisciplinary Research Journal, 10(3), 128-132.
16. Ablaqulovich, I. G., Salaxuddinovna, K. Z., Uytalovich, N. U., & Matlubovich, T. O. (2020). THE IMPACT OF THE ORGANIZATION OF A COTTON-TEXTILE CLUSTER ON THE SOCIO-

ECONOMIC DEVELOPMENT OF THE REGIONS. International Engineering Journal For Research & Development, 5(4), 5-5.