The Optimal Meaning of Average Gradient for Photographic Films In Hybrid Photographic Systems with Digital Image Processing

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Abstract

The main object of this research was the definition of optimal meaning degree of development for photographic films for getting the best characteristics of tone reproduction.

The database of tone reproduction parameters of the photographic systems with digital image processing was created on the basis of construction of objective tone reproduction curve and calibration curves.

Subsequent scanning negative image was applied. The cameras (Canon F1, Nikon F4, Pentax MZ-6, Pentax MZ-7), the films Kodak T-Max 100, 400, Ilford 100 and the developer D-76 were used in our experiments.

The standard gray scale was used as test-object for taking photos. The films were developed up to various average gradient values in the interval 0.55 -0.90 for the definition of optimum development degree.

According to the technique, developed by us (the "Mirror" program), the curves of objective tone reproduction have been constructed for all shooting and processing specified conditions.

At the same time the image quality was visually estimated up on shooting objects (picture, portrait, landscape etc).

The submitted results convincingly confirm necessity of an establishment of different degrees of development for black-and-white still-picture films and movie films. The analysis of objective tone reproduction curves allows to make conclusion, that the optimum meaning of average gradient for photographic films should be in an interval 0.80-0.85.

Experimental

Now in connection with a wide circulation of hybrid photographic systems a problem of quality of images received in these systems gets a special urgency. First of all it is connected with that point that criteria of an evaluation of quality for silver halide photos and for the image in the electronic form are various. It complicates the control and does not allow to take into account the influence of each stage on quality of the image.

One of the most important parameters of quality of the photographic image is tone reproduction. In tone reproduction two basic directions develop:

- An estimation of an objective tone reproduction phase
- An estimation of a subjective tone reproduction phase

In our work for an estimation of an objective tone reproduction phase in hybrid systems we offered to use Mees` method which had well proved it is useless for silver halide processes, and had also allowed to take into account all the factors determining tone reproduction character.

For practical realization of this method we had been developed the program "Mirror". This program is intended for construction of a curve of objective tone reproduction and for a choice of optimum conditions of carrying out of the process with digital image processing. It works on the basis of a tone reproduction parameters database on which recalculation of shooting object into its photographic image is made.

The basic problem arising at adaptation of Mees` method to hybrid photographic systems is a necessity of the translation of characteristics of the image at an electronic stage into optical density, i.e. the translation of brightnesses RGB into means of optical densities.

To decide this problem we used a densitometric calibrations method. Curves were approximated by sedate function with factor of correlation close to 0,95 (fig.1). On a basis of calibration curves the program "Mirror" allows to make measurement of optical density of the image. Also it is possible to enter optical density into the program manually. The image from which it is necessary to receive a reproduction is scanned and further is loaded

into the program. Looking through a database and observing of change of the image it is possible to choose optimum conditions of carrying out of the process with digital image processing.

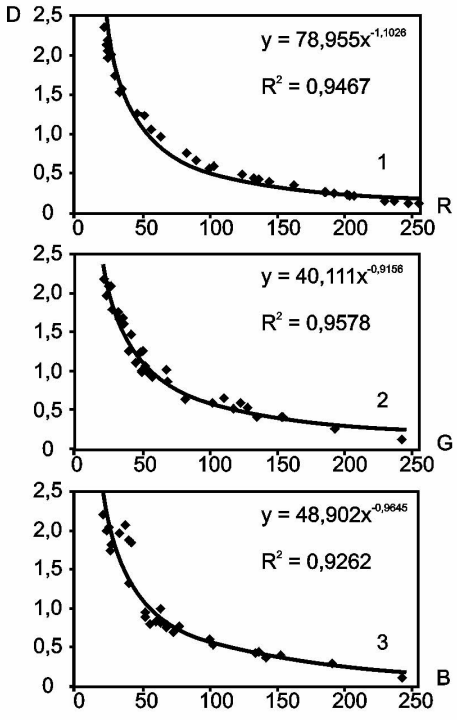

Figure 1. Calibration curves for converting RGB values into optical densities: 1-behind red filter, 2-behind green filter, 3behind blue filter.

With the help of the program "Mirror" we have carried out comparative research of various types of hybrid photographic systems.

The comparative estimation of tone reproduction curves for hybrid processes has shown, that the best characteristics of the image from the tone reproduction point of view are received in system with scanning a negative, and the worst in shooting by the digital camera. In all cases study of details in shadows get worse and growth of optical density in highlights are observed. At a visual estimation growth of contrast in halftones in comparison with the images received in silver halide process, is marked that leads to deterioration of subjective quality.

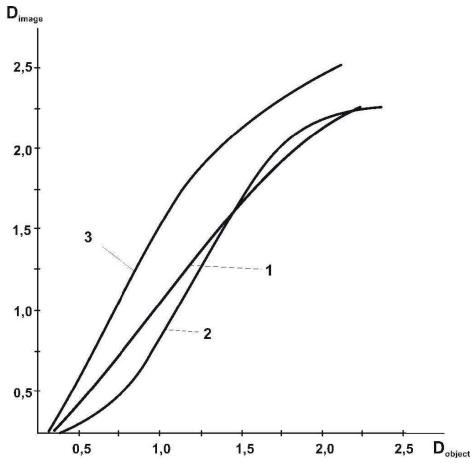

Figure 2. Tone reproduction curves in hybrid photographic systems: 1-silver halide process, 2-system with scanning a negative, 3-shooting by the digital camera.

For hybrid system with scanning of a negative a research of influence of a developing degree of a photographic material on tone reproduction is made. Optimum results from the point of view of tone reproduction are received at values of an average gradient 0,8-0,85. In this case the general gradient of a tone reproduction curve is in an interval 0,9-1,05, and a gradient in halftones 1,1-1,25. (fig. 3) The best values of the relation of the general gradient of a tone reproduction curve to a gradient of halftones also turn out at value of an average gradient 0,8-0,85.(fig. 4)

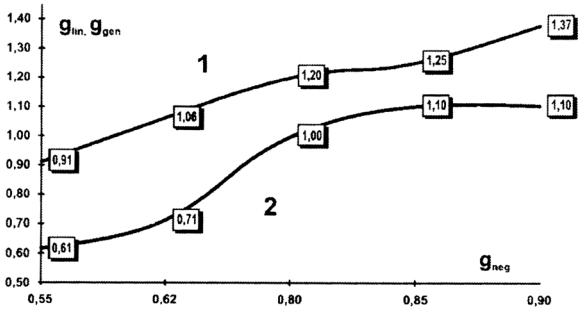

Figure 3.General gradient and gradient of the linear part of tone reproduction curve versus development degree of negative photographic film: 1-gradient of a rectilinear site, 2-general gradient of tone-reproduction curve.

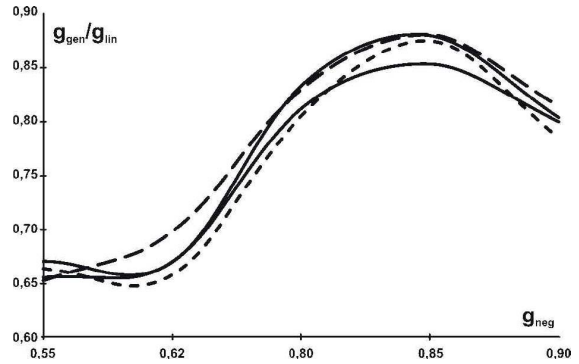

Figure 4. Relation of general gradient of the tone-reproduction curve to the gradient in half-tones versus mean gradient of negative photographic film: Nikon F4, Zenit 12, Zenit 11, Canon F1.

For an estimation of a subjective tone reproduction phase in hybrid systems check of the hypothesis Bartleson– Breneman`s is carried out. The interrelation of the factor of correlation of linearity of model and an index of subjective quality is established. The best values of an index of subjective quality have photographic prints at which proportional transfer subjective luminosities in relation to referent white is observed.

Results of an estimation of a subjective tone reproduction phase for hybrid photographic systems testify that the highest characteristics have the images received in system with scanning of a negative, and the worst in shooting by the digital camera.

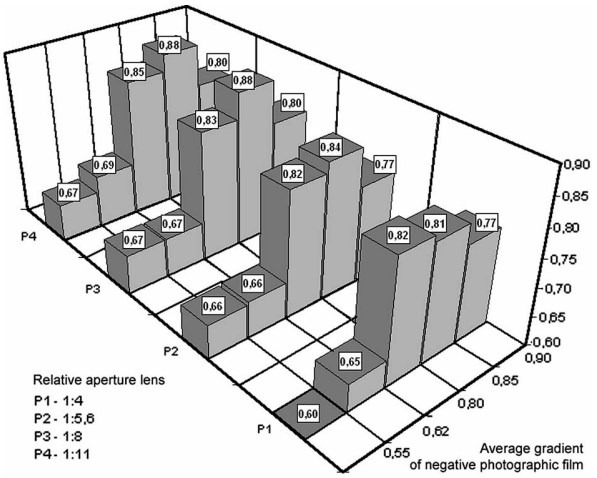

Figure 5. Relation of general gradient of the tone-reproduction curve to the gradient in half-tones versus values of the relative aperture lens and average gradient of negative photographic film

For automation of tone reproduction quality assurance in hybrid systems it is necessary establishment of optimum values of optical density for priority brightness details of shooting object. Such work has been carried out for a series of portrait images. It is established, that from the point of view of subjective tone reproduction quality, density of the person on a positive should there are in an interval 0,3-0,5, density grey in an interval 0,45-0,65 and a linear scale relative highlights.

The optimum sizes establishment of optical density for all priority brightness details on the photographic positive image allows to predict subjective quality and to optimize conditions of carrying out of the through photographic process with digital image processing.

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Biography

Elena Konstantinova received her B.C. degree in chemical sciences from the Institute of Cinema engineers at Leningrad in 1985 and a Ph.D. in technical sciences from the St.-Petersburg's state university of moving picture and television.

Since 1985 she has worked at cathedra of photography of St.-Petersburg's state

Her work has primarily focused on the university of moving picture and television as a lecturer.problems of tone and color reproduction in silver halide photography and digital photographic systems. She is a member of the IS&T.