Mathematical modelling of optical density on the example of producing rasterized films

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Introduction

Modern production of printing forms is characterized by a high degree of digitization. However, there are examples of using photographic films to perform various tasks. The quality of printing products is determined by the factors that lead to the information changes in reproduction. The factors are associated with the reproduction technological conditions and the nature of the elements that make the information, the manufacture of rasterized printing plates and the printing process in the presence of various effects. Therefore, to improve the quality of the finished products at each stage of the technological chain of the manufacturing process of printed matter, it is necessary to monitor and evaluate certain parameters. Each technological stage is performed on a specific equipment, the less we have the control checks of the parameters, the harder it is to detect various influences, distortions, the waste origin, and it is difficult to optimize certain processes [1, 2, 11]. One of the most important and complicated process is the process of making films and preparing for direct recording on a plate, changing the size of raster elements in the process of reproduction, increasing (dot gain) of the raster elements area of the image when manufacturing the plates (copying), on the imprint at the contact area of the plate or offset canvas with the paper. The dot gain of the ink layer during the printing process is significant and could be 10-20%

Problem Description

Work is to improve the existing formulas to determine the gradation characteristics of raster plates, to develop a simulator to calculate and analyse their properties at different effects.

Methods

The analysis of the optical density properties of the plate has been carried out under the condition that the plate substance is homogeneous on the whole surface, and transmittance coefficient changes. Therefore, the researches of the film optical density at a nonlinear transmittance coefficient are of considerable practical interest. A block diagram has been worked out with the simulator in the package of Simulink, that on the basis of the expression calculates and defines the characteristics of the plate optical density for nonlinear transmittance coefficient (Figure 1)

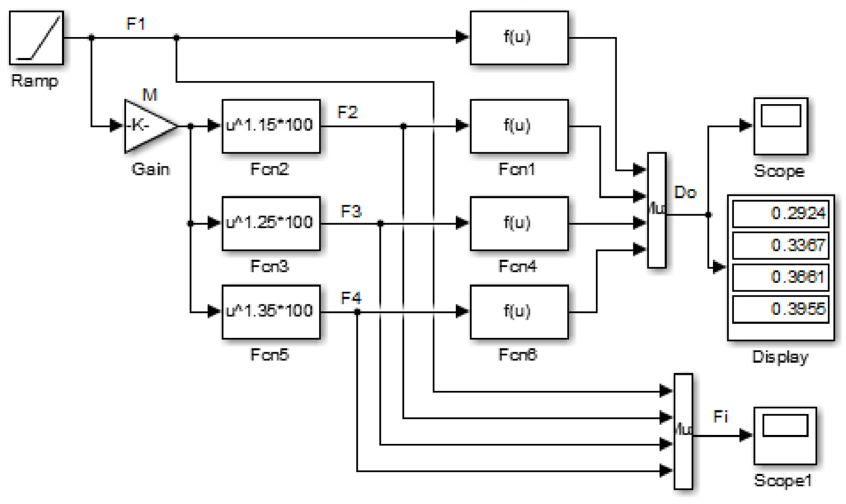

Figure 1

A block diagram of the simulator to define characteristics of the plate optical density for nonlinear transmittance coefficient

Results

The Ramp block generates the linearly increasing F0 light flux, that is scaled by the Gain block. In the first row of math functions blocks Fcn, there are programs that form rated nonlinear coefficients of reduction by the expression T=Uv, which, after de normalizing, turn into nonlinear light fluxes of F2, F3, F4, that are visualized by the Scope1 block and simultaneously supplied to the output of the second row of math functions blocks Fcn, that calculate films optical density for nonlinear transmittance coefficients, visualized by the Scope block. More sufficient data of separate blocks parameters are shown in Figure4. The results of simulation of nonlinear light fluxes are shown in Figure 2

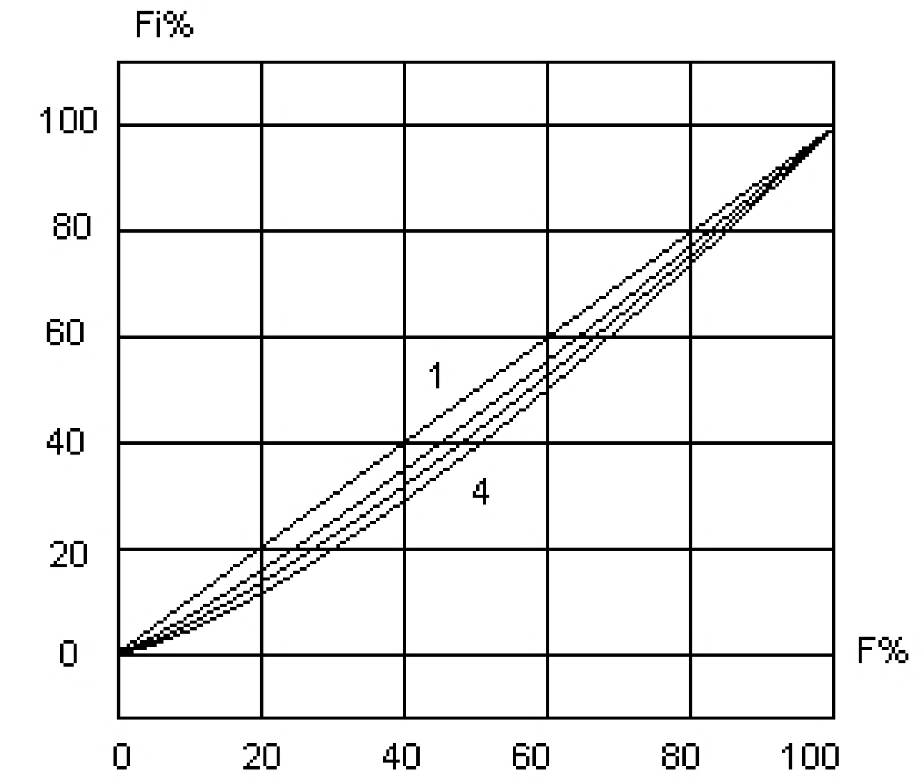

Figure 2

Parameters of nonlinear light fluxes

Slight deviation of light fluxes from linearity (5,2; 8,20; 11,0%) considerably shifts the parameters of the film optical densities to the right. It is offered to assess the influence of non-linearity of transmittance coefficient on the optical density by the maximal deviation in the parameter from the first one (E=Di-D0). The results of simulation of the deviation of the film optical density from the nominal one for different light fluxes are shown in Figure 3

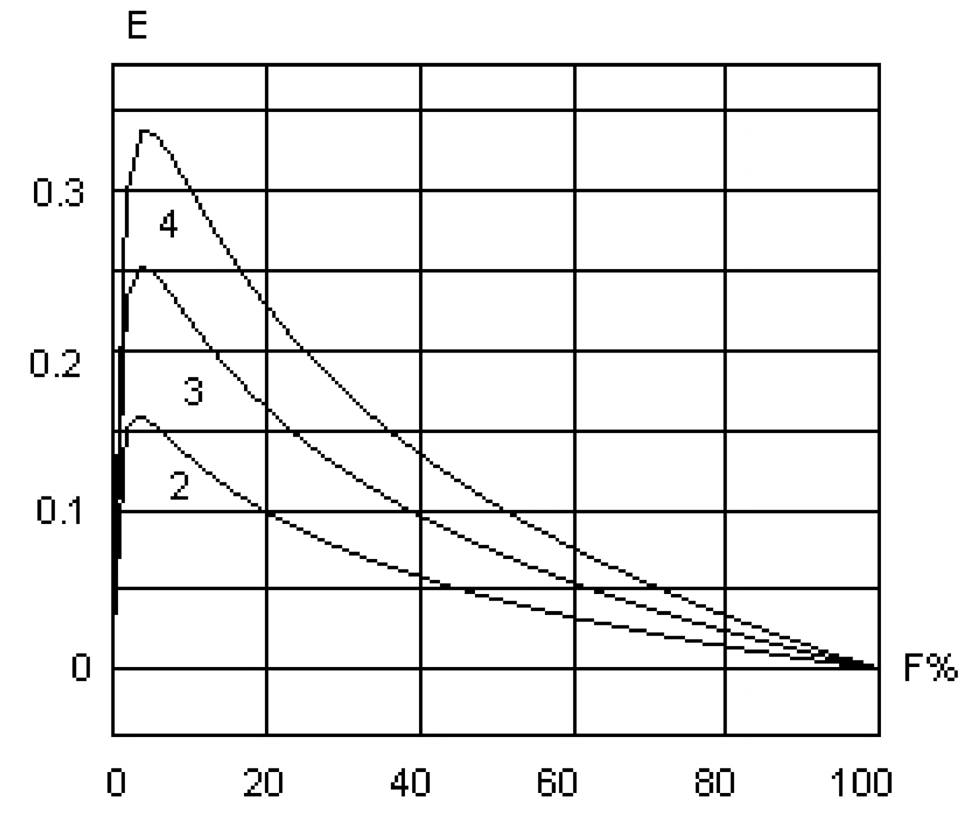

Figure 3

Deviation of the photo-film optical density from the nominal one for light fluxes variation

Discussion / Conclusion

A mathematical model of optical density of rasterized films has been improved, which has significantly increased the calculation accuracy of the optical density, especially at low intensities of the light flux of 0-5%. The results of the simulation have been presented in the form of graphs of the optical densities characteristics for various parameters and their properties have been analysed.
The block diagram of the simulator Simulink in the Matlab package has been worked out, which provides an opportunity to calculate and design a family of the optical densities characteristics for various parameters, analyses, and practical application. The results of the simulation of the linear reduction influence of the light flux intensity in the form of a set of the optical densities characteristics of a photo-film have been presented and it has been found out that even double reduction of a flux has little effect on the optical density, the finite deviation of the optical density is 0,219 at tolerance of 0,15 units. Thus, plate optical density is quite insensitive to the linear changes of the flux intensity.
The influence of the nonlinearity of the transmittance coefficient has been studied, caused by distortions of the geometric dimensions of raster elements (expanding) in the reproduction process of the plate contamination production, as well as copying from a photo-film or direct record on a plate. It has been found out that slight deviation of the transmittance coefficient, with its maximal values of 5,2; 8,2; 11,0%, causes significant deviation of the optical density on small fluxes (F = 5-10%), their maximum values are 0.34, 0.25 and 0.16 units at tolerance of not more than 0.15 units, so the expanding (the increase of the area of the raster elements) must be taken into account while raster plate production, which is often ignored. To control the expansion of a photo-film, it is possible to use a densitometer by measuring the density of the controlled scale instead of the area.
The obtained results of the research can be used for preparing images for screening, as well as for photo-films production and control.

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