Printing quality control automation

O V Trapeznikova

Omsk State Technical University, 11, Mira av., Omsk, 644050, Russia

E-mail: ol-trapeznikova@yandex.ru

Abstract. One of the most important problems in the concept of standardizing the process of offset printing is the control the quality rating of printing and its automation. To solve the problem, a software has been developed taking into account the specifics of printing system components and the behavior in printing process. In order to characterize the distribution of ink layer on the printed substrate the so-called deviation of the ink layer thickness on the sheet from nominal surface is suggested. The geometric data construction the surface projections of the color gamut bodies allows to visualize the color reproduction gamut of printing systems in brightness ranges and specific color sectors, that provides a qualitative comparison of the system by the reproduction of individual colors in a varying ranges of brightness.

Key words: the distribution of ink layer, accuracy, software

1. Introduction

The quality ratings of multicolor image obtained by the methods of offset printing can be determined by the optimal matching of main components of printing system. Among the priority quality ratings of printed sheet the factor characterizing the distribution of ink layer on the printed substrate is chosen. The distribution of ink layer on the sheet has a significant effect on changes in optical density, color gamut, and other factors.

The surface characteristics of a printed material are also included in the number of estimated prior factors of substrates. Increasing the accuracy of the result of measuring the above-mentioned factors due to the development of modern high-precision methods and software is up-to-date.

2. Statement of the problem

The earlier grapho-analytical method for determining the ink layer on the sheet is based on an analysis of the characteristics of ink transfer from the plate to paper and the equation of ink balance in a contact with paper during the printing process [1] does not give a complete objective estimation for a number of reasons. From the scientific and practical point of view, the investigations by [2-4] are interesting but they illuminate the problem solving only by qualitative methods. When solving such problems, it is necessary to overcome significant mathematical difficulties.

Despite the printing process is preceded by the stages of prepress process and time on the printing press makeready, the process of offset printing today is sufficiently automated to produce a high quality circulation. Nevertheless, the improvement of existing methods of estimation and the development of new approaches in solving this problem is of both scientific and practical interest. To achieve this goal, the methods of calculus mathematics and mathematical analysis elements are applied.

3. Results and Discussion

Taking into account that the stock of paper is wide enough, and its characteristics are of an advertising nature, the existing methods of evaluating the quality rating of printing do not provide the required
accuracy and the adequacy of estimation. Standard MedienStandart Druck 2008 classifies papers both by surface type and by color parameters, however, the ISO 12647-2:2004 limits the types of model papers that causes difficulties in assessment of the quality of color reproduction. Taking into account that the printed substrates have a natural surface microrelief making the distribution of ink film on the sheet along its thickness irregular, an algorithm for its evaluation has been developed [5]. For the software development the high-level programming languages Visual C# and .NET Framework 4.0 were used; and the software environment of Microsoft Visual Studio 2010 was served. The functional of a program is removed under the tabs created with the TabControl component. To display the result of the program run an element of the StringB uilder class is formed into which the final result is written. To build the plots (sections) the standard component, i.e. Chart is used. To reduce the miscalculations the program provides an error control module. A fragment of program module for calculating the paper surface characteristics is represented on Fig. 1.

// Coordinate output on the screen
//========================================================
private void openFileBackgroundWorker_RunWorkerCompleted(object sender, RunWorkerCompletedEventArgs e)
{
    xNach.Text = Convert.ToString(nwx);
    yNach.Text = Convert.ToString(nwy);
    zNach.Text = Convert.ToString(nwz);
    zmax.Text = Convert.ToString(z_max);
    profil.Text = Convert.ToString(zn_profil);
    nachStep.Text = Convert.ToString(Math.Abs(Math.Round(h, 3)));
    znachN.Text = Convert.ToString(N);
    nachStep.Text = Convert.ToString(Math.Abs(Math.Round(h, 3)));
}
//========================================================
// Calculation of Fourier polynomial elements
//========================================================
// A number of Fourier polynomial elements is set by user.
//========================================================
private void countbackgroundWorker_DoWork(object sender, DoWorkEventArgs e)
{
    int N1;
    int N2 = 0;
    int N3 = 0;
    int N4 = 0;
    int N5 = 0;
    int main_inch = 0, ich = 0, ich2 = 0, ich3 = 0, ich4 = 0, ich5 = 0;
    double fsin, yk, ts, fin, argsin, a, TempPopravka;
    double y0N, yN1, yN2;

    Figure 1. A fragment of program module for calculating the paper surface characteristics

    A fragment of program module for calculating the ink perception of a paper is represented in Fig. 2.

    // Ink perception computing
//========================================================
private void GetKraska_Click(object sender, EventArgs e)
{
    double kraska_got = 0;
    double kraska_1 = 0;
    double kraska_2 = 0;
    kraska_1 = 0;
    for (int lep = 0; lep != zn_profil; lep++)
    {
        kraska_2 = 0;
        for (int lep2 = 1; lep2 > i - 1; lep2 = 2 * lep2 + 1)
        {
            kraska_2 = kraska_2 + (cof_b[lep, lep2] / lep2);
        }
        kraska_1 = kraska_1 + kraska_2;
        kraska_got = (0.00015 * (zn_profil * z_max * ((2 / Math.PI) * kraska_1))) / 1000;
    }
    MessageBox21.Text = Convert.ToString(kraska_got);
}
private void tabControl1_SelectedIndexChanged(object sender, EventArgs e)
{
    if (tabControl1.SelectedIndex == 5)
if (cof_b == null)
{
    tabControl1.SelectedIndex=1;
    MessageBox.Show("Произведите расчеты");

Figure 2. A fragment of program module for calculating the ink perception of a paper

The irregularity of the ink layer surface on printed substrate is described by the sum of two independent functions that take into account macrogeometric deviations (nonplanarity, areas with a greater or lesser ink layer thickness) and a stochastic microgeometric component (reflects the surface roughness of the ink layer on the substrate being printed).

In the case, the macrogeometric deviation was defined as the distance from some point of the real surface to the ideally flat abutting surface, i.e. up to the plane, in accordance with the principle of abutting surfaces for measuring the macrogeometric deviations.

The algorithm for estimating the color reproduction quality of the system is offered in Fig. 3.

Figure 3. Simplified algorithm for estimating the color reproduction of a printing system
For the automation of the calculation process of the color gamut body volume, a software was developed. Computing the color gamut of the reproduction system is carried out using the Qhull (Quickhull) algorithm. The functions of plotting and calculating the body of color gamut are realized with the help of developed software [5]. The program fragment presented shows the construction of distributing the color samples in three projections on the L * a * b * graph using the scatter3 function.

```
figure ('Color', [0.5 0.5 0.5]); axes ('Color', [0. 8 0.8 0.8]);
camproj('perspective'); view(-44,17); grid on; xlabel('a*'); ylabel('b*'); zlabel('L*'); hold on;
scatter3(a, b, L, 200, [sR sG sB ],'filled'); hold off.
```

Practical realization of another part of printout is putted out in the construction of wire-frame model of a color gamut body surface.

```
[C,V] = convhulln([a b L]);
for i = 1:size(C,1);
j = C(i,[1 2 3 1]); patch (X(j,1), X(j,2), X(j,3), [0 8 0.8 0.8]);
end;
view(3), axis vis3d; axis([-100 100 -100 100 0 100]);
grid on; xlabel('a*'); ylabel('b*'); zlabel('L*'); hold on;
rotate3d on; camproj('perspective'); view(-44,17); figure(gcf).
```

The geometric representation of the data of color gamut body surfaces projections allows visualizing the color gamut of printing systems color reproduction by the brightness ranges and separate color sectors, and lets to compare systems qualitatively for the reproduction of certain colors in a particular range of brightness. As an example, the construction of the projections of color gamut body surfaces was carried out in highlights (brightness value – L = 80), midtones (brightness value – L = 50) and shadows (brightness value – L = 20). A cross-section of color gamut body surfaces was made. Section of L = 20 is a mixture of solid colors with white – muting by the color of printed material; proportional reduction of both colors. Section of L = 50 is the line of solid (most saturated) colors formed by the main ink sets and their binary mixtures in different quantitative ratios. Section of L = 80 is a mixture of solid colors with black – muting the binary ink mixture by black; proportional increase in the relative amount of black. The projections of color gamut body surfaces are shown in Fig. 4.

**Figure 4.** Projective representation of geometrical model of reproduced colors for the system of reproduction in highlights (L = 80) and shadows (L = 20) (1 – L = 80, 2 – L = 50, 3 – L = 20)

This approach allows predicting the garbling (deviation) in color reproduction of separate colors in the number of reproduced tints of compared systems, for example, in highlights (graphs 1 of Fig. 3).
4. Resume

Thus, for the optimal selection of the components in ink-and-paper system ensuring the quality of multicolour image in accordance with the requirements of international standard ISO 12647-2: 2004, it is suggested to control the quality rating of paper, ink coating in accordance with the proposed methodology by stages, i.e. by carrying out the burst of controlled systems on a number of independent subsystems (separate quality ratings). The process should be guided by the exercise control on the deviation principle. Thus, the distribution of ink layer on the printed substrate is proposed to characterize by so-called the deviation of the ink layer thickness on the sheet from the nominal surface.

Quality control on each stage in the "ink-and-paper" system is an integral part of a developed automated system for control and the prediction of a multicolor image quality. A distinctive feature of this approach is the possibility of mutual coordination of subsystems and optimization the management process as a whole, that provides the scientific novelty of the task solution.

References

[1] Korzhev V A and Shepitinovsky G V 1978 Researches in Pulp and Paper Technology. Proceedings of CRIP (Moscow) 15 p 92-99
[2] Koivula H, Preston J S, Heard P J and Toivakka M 2008 Colloids and Surfaces A: Physicochemical and Engineering Aspects 317 (1-3) p 557-567
[3] Ozaki, Y and Kimura M 2000 Appita J. (3) 216-219
[4] Varepo L G, Nagornova I V and Trapeznikova O V 2015 Proc. Eng. 113 357-36
[5] Varepo L G and Trapeznikova O V 2014 A software for the estimating the color reproduction of printing system Certif. of registr. the computer program No 2014619696 from 19.09.2014. (Moscow).FIPS