

# The Application of the Digital Image Processing Technology in Printing of Package

Wanyou Tang<sup>1</sup>, Zhiguo Yu<sup>2</sup>

Tianjin University of Science & Technology TUST Tianjin China

E-mail:yuzhiguo282@163.com

**Abstract:** use digital image processing technology to locate the position of the image of the printing package captured by CCD (Charge Coupled Device) camera and make partition of image; make RGB convert to Lab through Difference algorithm of three-dimensional Lookup table; use VC++ programming to calculate the quantity of ink for each ink zone.

**Keywords:** digital image processing technology; color space conversion; VC++ programming

With the improvement of people's material civilization, spiritual civilization is rapidly improved. For the print quality, people do not just need the information but also need beauty. The company makes the package of product be Good-looking in order to be content with customer. Thus the printing industry must improve the quality of the printing products. This can enhance their market competitiveness.

Because the traditional printing quality detection system can not meet the requirement of products, we should develop the online detection system. This paper uses digital image processing technology to analyze the products, and control ink supply.

## 1. The principle of online detection system

The basic principles of the detection system of printed materials is that a defect-free standard print image can be captured by CCD (Charge Coupled Device) cameras, and then the detected image is captured on line, compare the standard image to the detected image, find the differences and adjust the press. Figure 1 is Process flow chart. [1-2]

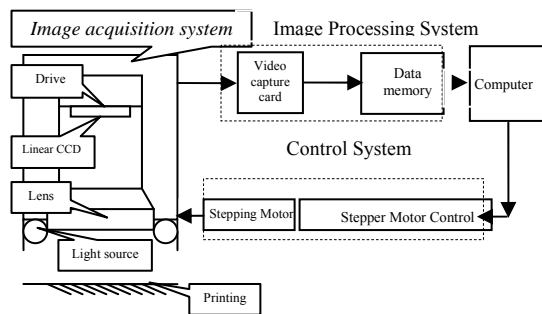


Figure 1. Flow chart.

## 2. Image Acquisition System

Image acquisition system is composed with CCD, lens, light source, video capture card and computer. The image scanned by CCD camera is stored in RGB. By digi-

tal image processing, firstly locate position of image, and then make partition of image according to the press requirements. This can make the standard image correspond to the detected image

### 2.1. Position Locating of Image

Position Locating is the registration of the standard image and detected image, and adjust the produced differences, make the relative position consistency, thus facilitate other operations of the subsequent tests. In general, the position differences between the standard image and tested image are the horizontal or vertical deviation and the deviation of two rotating

#### 2.1.1. The horizontal and vertical deviation [3-4]

Horizontal or vertical deviation can be resolved by the image translation. Image translation is to move all the points of image in accordance with the specified value.

Choose a point  $(x_0, y_0)$  of the original image, the value of horizontal motion is  $t_x$ , the value of vertical motion is  $t_y$ , then the translation point  $(x_0, y_0)$  will become  $(x_1, y_1)$ .

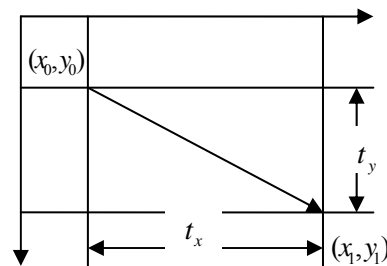


Figure 2. Translation of point in the image

According to figure 2, the translation formula is:

$$\begin{cases} x_1 = x_0 + t_x \\ y_1 = y_0 + t_y \end{cases} \quad (1)$$

$(x_0, y_0)$  -point coordinates before the translation;

$(x_1, y_1)$  -point coordinates after the translation;

$t_x$  -the value of horizontal motion;

$t_y$  -the value of vertical motion;

The translation formula can be shown by the matrix:

$$\begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x_0 \\ y_0 \\ 1 \end{bmatrix} \quad (2)$$

**2.1.2. The rotation deviation [5-6]**

The rotation deviation can be resolved by rotating the image according to the rotation angle of the image.

Figure 3 show that  $(\alpha-\theta)$  is the rotation angle from  $(x_0, y_0)$  to  $(x_1, y_1)$

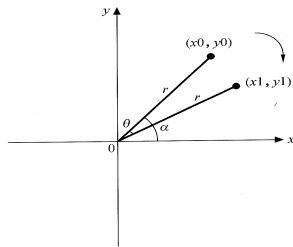


Figure 3. Rotation of point in the image

The rotation formula is

$$\begin{cases} x_0 = r \cos(\alpha) \\ y_0 = r \sin(\alpha) \end{cases} \quad \text{Before rotation} \quad (3)$$

$$\begin{cases} x_1 = r \cos(\alpha - \theta) \\ y_1 = r \sin(\alpha - \theta) \end{cases} \quad \text{After rotation} \quad (4)$$

$(x_0, y_0)$ -point coordinates before the translation;

$(x_1, y_1)$ -point coordinates after the translation;

$\alpha$ --the rotation angle of  $(x_0, y_0)$ ;

$(\alpha-\theta)$  -the rotation angle of  $(x_1, y_1)$ ;

**2.2. Partition of Image**

The printing press controls the ink supply by ink zone. Different printing presses have different zone. In general, the size of ink zone is 32.5cm. In order to adjust ink of the print, we should do partition of captured image.

Assuming ink zone size of the press is  $W$ , resolution of captured image is  $r$ , the number of pixels of ink zone in the width is  $S$ .  $r$  is related to CCD resolution. Then  $S$  can be calculated according to the formula:

$$S = \frac{W \cdot r}{25.4} \quad (5)$$

In the detection system, use VC++ Programming and digital image processing to realize the function.

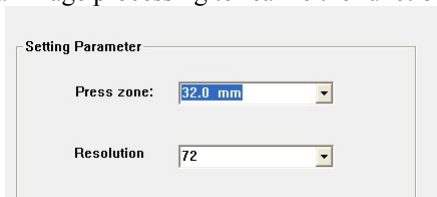


Figure 4. Image parameter

**3. Image Processing System**

The image captured by CCD is stored in RGB, but the three values have certain relevance. If directly used this values, the results are not what we get. Thus, we should make RGB space to convert Lab space that is not relevance to the equipment. This paper chooses a new color space conversion technology.

**3.1. Difference algorithm of three-dimensional Lookup table (3D-LUT) [7-8]**

Difference algorithm of three-dimensional lookup table is a relatively new color space conversion technology. The entire color space is cut up grids, the standard color space data corresponded to each grid are recorded in a reference table. By looking for the corresponding and calculation, achieve the coordinate transformation of color space. RGB space is first uniformly divided into  $N \times N \times N$  small cubes, and then measured the Lab of all the nodes, produced the lookup table from RGB to Lab, RGB of non-nodes is calculated with the interpolation method of values around nodes. This paper chooses the cubic interpolation, because of the smaller deviation.

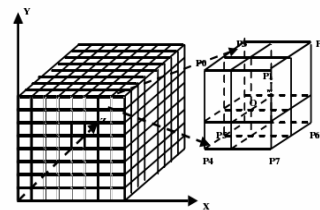


Figure 5. Theorem of 3D-LUT

Figure 4 is the schematic diagram of cubic interpolation. It is a three dimensional table that the L axis, a axis and b axis are uniformly divided into eight deciles. The memory of the grid is the output exact value. L a b is expressed by the point Q in three dimensional coordinate. Assumed the peak of a unit cube are from  $P_0$  to  $P_7$ . The output value is set to  $O_{P_0}, O_{P_1}, \dots O_{P_7}$ . The unit cube is divided by the perpendicular plane of Q and Lab axis. Then, we get eight cubes. The peaks is expressed  $H_i$ , and the volume is expressed  $V_i$ . That,  $Q_{out}$  is calculated by the formula:

$$Q_{out} = \left\{ \sum_{i=0}^7 O_{pi} \cdot V_{7-i} \right\} / VI, \quad VI = \sum_{I=0}^7 V_I \quad (6)$$

**3.2. The ink calculation**

This paper uses coated and uncoated paper, uncoated paper, Toyo Ink, as well as printability device, X-Rite 418 densitometer, spectrophotometer, scanner and so on. Analysis the relation of ink film thickness and Lab On the same paper, find the monochrome pixel. This can make RGB of captured image transform to CMYK of the press.

Establish the databases that Lab of different ink

thickness is put into. Figure 6 is the tables in the databases.

paper and ink	L	a	b	sekuaidensity
金东和东洋	0	0	0	6
金东和东洋	0	0	0	7
金东和东洋	0	0	0	8
金东和东洋	45.31	-06	3.34	9
金东和东洋	42.2	02	3.41	1
金东和东洋	40.57	04	3.52	1.1
金东和东洋	38.13	12	3.32	1.2
金东和东洋	36.95	.2	3.01	1.3
金东和东洋	35.02	.28	2.72	1.4
金东和东洋	33.16	.39	2.58	1.5
金东和东洋	31.31	.54	2	1.6
金东和东洋	29.03	.83	1.25	1.7
金东和东洋	29.25	.73	1.16	1.8
金东和东洋	30.28	.58	1	1.9

Figure 6.databases

If the difference from the values of the ink zone monochrome pixel to database is smaller the threshold that we has use in experiments, the density of the database is ink supply of zone.

The code is that calculate the ink supply:

```

_variant_ tVL,va,vb,vsekuaidensity;
while(!m_pRecordset->adoEOF)
{
    vL=m_pRecordset->GetCollect("L");
    tL=vL.dblVal;
    va=m_pRecordset->GetCollect("a");
    ta=va.dblVal;
    vb=m_pRecordset->GetCollect("b");
    tb=vb.dblVal;
    if(f11>0)
    {
        tCL[k]=CL/f11;
        tCa[k]=Ca/f11;
        tCb[k]=Cb/f11;
        if(fabs(tCL[k]-tL)<3||abs(tCa[k]-ta)<3||abs(tCb[k]-tb)<3)//||abs(tCa[k]-ta)<1||abs(tCb[k]-tb)<1
        {
            vsekuaidensity=m_pRecordset->GetCollect("sekuaidensity");
            DC=vsekuaidensity.dblVal;
        }
    }
}

```

}  
Figure 7 is an example:

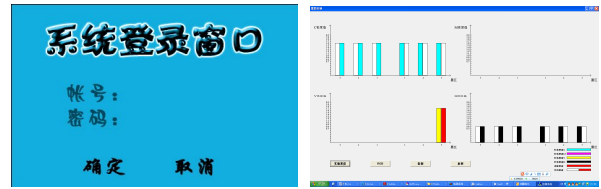


Figure 7.Translation of point in the image

#### 4. Conclusion

The detection system use digital image processing technology to control the ink supply. It has basically completed, but has some faults. That should request we constantly improve. I think that with the continuous development of image processing technology, the role in the detection system will become more and more important.

#### References

- [1] H.Kalviainen, P.Saarinen, P.Salmela, etc. Visual inspection on paper by machine vision [J].Proceedings of SPIE, 2003, 5267 : 321-332
- [2] R. Kennet, Casteman, Digital Image Processing[C].New York, Prentice Hall, 1988, 112-120
- [3] YU Songyu,Zhou Yuanhua, Zhang Rui. Digital image processing technology[M]. Shanghai : Shanghai jiaotong university press, 2007,5-15.
- [4] Guo Wenqiang, Hou Yongya. Digital image processing technology[M]. Xian: Xidian university press,2009,5-15.
- [5] ZhangYuJin. Image processing and analysis[M].Beijing: Tsinghua university press,2000,22-37.
- [6] Rafael C. Gonzalez, Richard E. Woods. Digital Image Processing Using MATLAB[M].Beijing : Publish House Of Electronics Industry,2005,8-27.
- [7] Huang Qingmei, Zhao Dazun. Color gamut mapping of color duplication[J]. Lighting engineering, 2002,13(1):19-26.
- [8] Huan Hui etc. Using look-up table search matching calibration methods CRT[J].2000(1):35-36.