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A Kind of Digital Intelligent System for the Ink Hue Analysis

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ABSTRACT

This paper introduces a kind of new ink hue analysis system (HAS) based on the model-distinguishing technology and briefly casts light on the principle of the analysis. Also, it stresses the hardware structure, the software designing methods and programming procedure of the HAS as well as its interface. And the simulation result of the experiment data was given. The study shows that this kind of system can help to improve the color arrangements and managements of ink. The accuracy has reached ±0.5% compared with high precision density meter.

Keywords: Ink, Hue Analysis, Model Distinguishing, VB.NET.

1. INTRODUCTION

At present the arrangements of ink color are still made by hand in the printing industry. According to the client's sample color (standard color), the operator can't get the desirable color until he mixes several colored inks many times with his experience. Completely depending on a personal identification and judgment of color arrangements, that method makes every operator or factory/ company have his own way of getting the ink he needs so that there is not correct or objective standard of testing his work. Therefore, the accuracy and repeatability of this kind of manual operation can't be guaranteed so much so that it will easily result in the conflicts between the operator and client. Moreover, it will waste a great deal of ink and printed matter, which is not beneficial to modern massive production[1-3].

So far little research is conducted on the computer-aided ink blend instead of the manual operation. The domestic research mainly concentrates on how to blend the ink to improve the quality of the printed pictures [4,5] while the foreign research focuses on the spectrum analysis of all kinds of colors [6], so the research on ink digital management is rated as zero. Even if in some document [7] the concept of the color management system is raised, no concrete way is given to dealing with it. Therefore, it's necessary to study a new digital ink hue analysis system representing the self-reliant intellectual property.

2. THE PRINCIPLE OF THE HUE ANALYSIS

The hue analysis is based on the principle of three basic colors of light, because either the sense of color or the sense of sight is caused by varying intensities and wave lengths of light of objects. Experiments prove that in Nature virtually all the colors can be got by mixing those three basic col-

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ors in different proportions. Decomposing a color and then making it reappear with the three-basic-color principle by which finally are realized all the colors in the visual sense, is the basic method of displaying and expressing color pictures.

A color model is an abstract mathematical model describing the way colors can be represented as tuple of numbers, typically as three or four values or color components (e.g. RGB and CMYK are color models). However, a color model with no associated mapping function to an absolute color space is a more or less arbitrary color system with little connection to the requirements of any given application.

The description of color space is the application of the three-basic-color principle. CIE (National Lighting Commission) Stipulates that as a method of expressing color space, RGB stands for these three basic colors red (R), green (G) and blue (B) whose wave lengths are respectively 700.0nm, 546.1nm and 435.8nm.

Most people have heard that a wide range of colors can be created by the primary colors red, blue, and yellow, if working with paints. Those colors then define a color space. We can specify the amount of red color as the X axis, the amount of blue as the Y axis, and the amount of yellow as the Z axis, giving us a three-dimensional space, wherein every possible color has a unique position.

However, this is not the only color space. For instance, when colors are displayed on a computer monitor, they are usually defined in the RGB color space. This is another way of making the same colors. Red, green and blue can be considered as the X, Y, and Z axes. Another way of making the same colors is to use their hue (X axis), their saturation (Y axis) and their brightness (Z axis). This is called the HSV color space. There are many more color spaces. Many can be represented as three-dimensional (X,Y,Z) values in this way, but some have more, or fewer dimensions, and some cannot be represented in this way at all.

RGB uses additive color mixing, because it describes what kind of light needs to be emitted to produce a given color. Light is added together to create form from out of the darkness. RGB stores individual values for red, green and blue. RGBA is RGB with an additional channel, alpha, to indicate transparency. Common color spaces based on the RGB model include sRGB, Adobe RGB and Adobe Wide Gamut RGB as shown in Fig. 1.

CMYK uses subtractive color mixing used in the printing process, because it describes what kind of inks need to be applied so the light reflected from the substrate and through the inks produces a given color. One starts with a white substrate(canvas, page, etc), and uses ink to subtract color from white to create an image. CMYK stores ink values for cyan, magenta, yellow and black. There are many CMYK color-spaces for different sets of inks, substrates, and press characteristics (which change the dot gain or transfer function for each ink and thus change the appearance) as shown in Fig. 2.

HSV (hue, saturation, value), also known as HSB (hue, saturation, brightness) is often used by artists because it is often more natural to think about a color in terms of hue and saturation than in terms of additive or subtractive color components. HSV is a transformation of an RGB color space, and its components and colorimetry are relative to the RGB color space from which it was derived.

Of the multimedia computer technology, RGB is the most often used. Because the color computer screen needs inputting RGB which can turn into any color on the screen in their different proportions, the signal input to the screen of the hue analysis system must be transformed into RGB first[9].

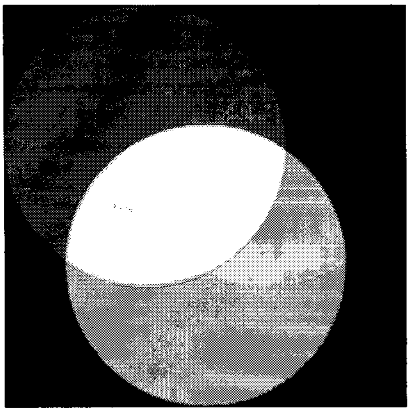

Fig. 1. Additive color mixing.

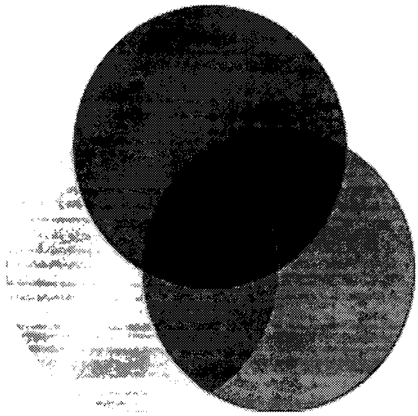

Fig. 2. Subtractive color mixing.

3. THE STRUCTURE OF THE HARDWARE OF THE SYSTEM

The composition principle of the ink hue analysis system is shown as Fig. 3. The system is made up of the steady, direct - current light source, a hi-speed CCD camera and the computer system.

In a special ink sampling box is installed a hi-speed camera with a charge coupled device (CCD) which is made from semiconductor of high light sensitivity and can turn light into electricity. When the surface of the CCD is shone, every light sensitive unit will conduct electricity to the equipment.

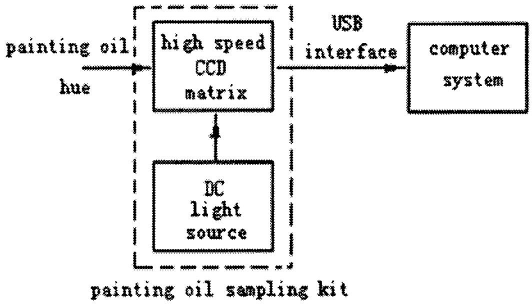

Fig. 3. The principle diagram of the system structure.

All the signals produced by all the light sensitive units together make up a complete picture. The CCD camera speedily takes photos of the ink colors and sends the electrical signals of the photos through joint USB to the computer which, next, can analysis and process the data. Here, the steady light source with direct currents is very important because it can provide the standard light source for CCD. In order to satisfy the demands of the system for the intensity of light and the quality of color display, the black light-absorbing material is attached to the interior sides of the box to guarantee no light reflection.

To obtain a high quality picture, a DC power is provided which is at least 800LX, 98% light transmission The halogen lamps from a triangle around the camera to ensure the light inside the box shines evenly.

In addition, in the box is fit the standard color codes referring to the standard basic colors like red, green, and blue to calibrate the degree of color display and ensure the stability and reliability of the data of the system. At the bottom of the box is also fixed a special device for collecting samples. The temperature-controlling circuit inside to box can ensure there is constant temperature at any time. The above mentioned equipment guarantees the amount of the ink really used is virtually the some as that on the computer screen.

4. DESIGN OF THE SYSTEM SOFTWARE

The computer system conducts the data analysis of the collected ink pictures. It's critical to get the amount of RGB from the ink picture. The structure of the system software is NET popular nowadays. The program has been written by VB.NET which is one of the most popular program languages. The software interface can be used easily and friendly. After the program is started by means of the screen and keyboard of the computer, we can use the system for our learning and training through the dialogue between Man and machine. The software program employs model distinguishing technology and includes the training section and the judgement one function shown as Fig. 4.

The training section includes picture handling, characteristic extraction and studying and training while the judgement one also covers picture handling characteristic extraction and consulting table and displaying.

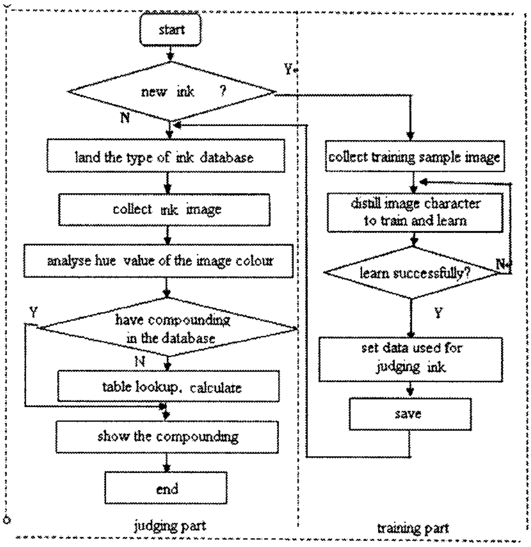

Fig. 4. The flow block diagram of the software program.

5. THE INTERFACE DISPLAY

The interface is mainly made up of three sections, ie, examination, sample and data store. Examination aims at analyzing the characteristics of the collected hue images, picking up the amounts of R, G and B and giving the specified place the ink rate. For example, if R=12, G=89, B=43, the ink rate will be yellow at 62.5 and blue at 37.5.The show date can be stored into Data Store Section as historical data (sample color). In the Sample Section, the data from the Data Store can be found and shown the same as that has the same amount of color in Examination Section (shown in Fig. 5).

6. EXPERIMENT DATA ANALYSIS

6.1 The Simulation Curve

The computer use RGB hue space to describe the different color, however, the painting samples are often mixed through the CMYK hue space. So when the signal has been entered into the computer, the color's change is obvious. How to compensate the energy is the key factor that our system can work accurately whether or not. We collected many data from the experiment, and simulated the curve through MATLAB 6.5 in order to find whether the system can redisplay the true color of the sample.

We processed six group data which we collected from the standard card (used as a criterion in the painting field) that we can see they have regular change in our naked eyes. Input the command:

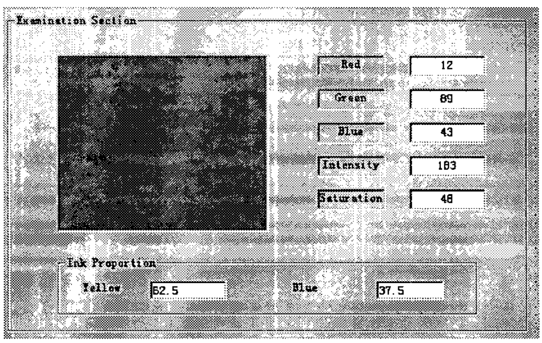

Fig. 5. Examination section.

plot3 ([255 232 37],[255 230 57],[255 228 78],
[255 183 35],[255 157 31],[255 149 17],
[255 158 33],[255 144 15],[255 121 6], //
the sample of blue and pink
[255 88 144],[255 44 86],[255 107 175],
[255 92 154],[255 55 141],[255 85 172],
[255 85 172],[255 69 155],[255 82 177],
'r-*'),grid,box // the sample of yellow and green

Fig. 6 is the simulation's result. There are two curves, the upper is the sample of blue and pink, the other one is the sample of yellow and green. It is obvious that the result is similar with the HIS theory model(shown in Fig. 7). And it is proved that our method is feasible.

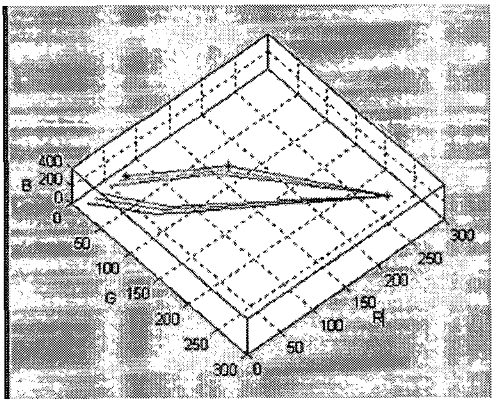

Fig. 6. the simulation curve.

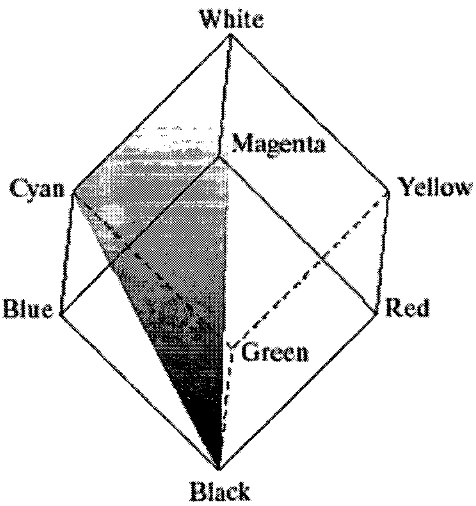

Fig. 7. HIS theory model.

6.2 The Collection of The ink proportion

The standard card provides 14 basic colors, for example, yellow, white, pink, orange, green, black, etc. Each color can be mixed by these basic colors.

Whether there are relationship between the value of RGB and the ink proportion is the key point. So we compared 2 groups data which was chose stochasticly. The input commands of the MATLAB 6.5 are following:

plot3([0 55 111],[0 75 130],[0 97 129],'r-*'),grid, box//sample one

plot3([0 23.5 76.5],[0 35 65],[0 47.5 52.5],'r-*'), grid,box//sample two

plot3([0 98 121],[0 99 106],[0 87 81],'r-*'),grid, box//the ink proportion for sample one

plot3([0 43.5 56.5],[0 50 50],[0 48.5 51.5],'r-*'), grid, box// the ink proportion for sample two

Fig. 8 and Fig. 9 are the RGB simulation results

Fig. 10 and Fig. 11 are the corresponding ink proportion simulation results.

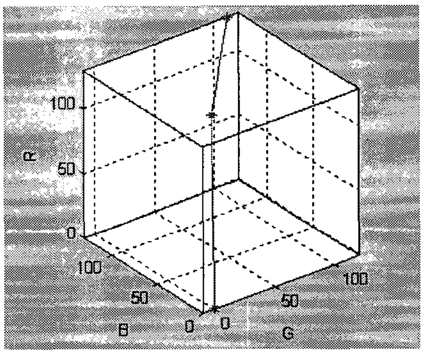

Fig. 8. The first sample.

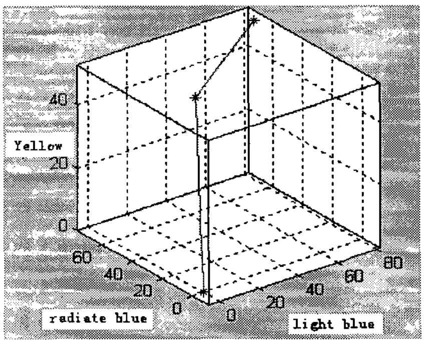

Fig. 9. The ink proportion for the first sample.

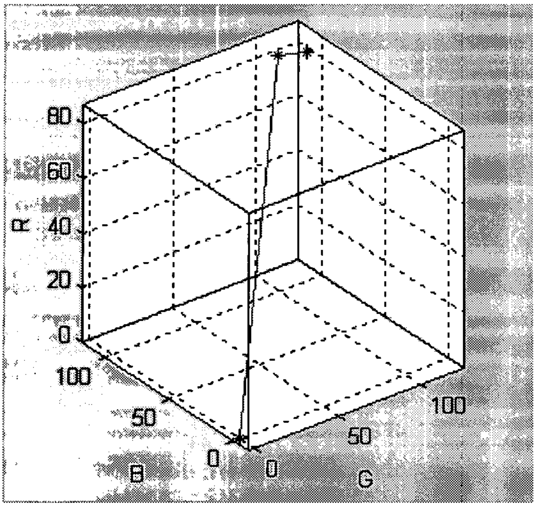

Fig. 10. The second sample.

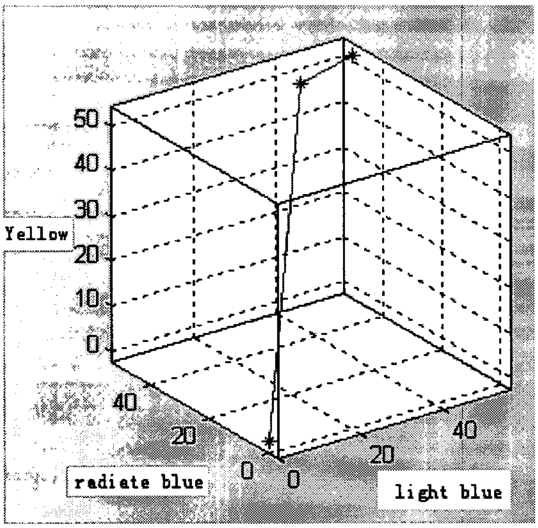

Fig. 11. The ink proportion for the second sample.

It is obvious that the curve of the ink proportion's result is similar with the one of the RGB . It is proved that there are some relations between them. Usually the Besyel curve is used to describe the value of the RGB. Also, through the simulation result, we found it is impossible to create an equation to describe the relation between the RGB and the corresponding ink proportion. So the method of selecting 3D table is more feasible. The key of the system is how to enlarge the amount of data in the database and make our data are more accurate.

7. CONCLUSION

A great deal of collection, analysis and contrast of the color that the ink color given by the intelligent analysis system is almost the same as waned in our naked eyes, even the differences of colors are limited within 0.5% under the examination of the precise light decomposition and density instrument.

At present, this kind of system has been used in some printing house and it improves the color arrangement and management of the ink.

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