Medical Color Matching (MCM)

Overview

Codonics Medical Color Matching™ (MCM)™ is an advanced image processing feature that adjusts printed output colors to more accurately match CRT monitors. This process corrects differences in hue, saturation, and intensity between the printer and the CRT. Users can easily determine the best match for their screen using the automatic MCM Bracketing feature which is built into the printer. MCM settings may be specified on printer default and user-specific basis, both across the network and through the printer's front panel.

Although Medical Color Matching was designed as a solution for medical imaging, MCM is also useful in many monitor matching situations.

How Colors Are Produced

Achieving a match between the computer screen (CRT) and printed output has long been a challenge to makers of hardcopy output devices. The reason for the difficulty lies in the physics of color, how it is created by output devices, lighting conditions, and how it is perceived by the human eye.

An image that is displayed on a CRT is composed of combinations of three primary component colors: red, green, and blue. Each primary imparts light of a different wavelength, or color, to the system. A wide array of colors can be created by adding these primaries together in various amounts. This is known as an "additive" process.

Printed output is different in that it creates color by filtering out specific colors from the white light that hits the paper. This is known as a "subtractive" process. By combining the three subtractive primary colors (cyan, magenta, and yellow) in various amounts, a large range of colors can be reproduced.

The Challenge of Color Matching

The difference between the additive and subtractive modes of color generation makes producing a visual match between the screen and the printer hardcopy difficult. Primarily, the screen is able to impart energy to the color system, while the print can only take energy away. Because of this, CRTs typically can produce brighter and more vivid colors, with more dynamic range, than the best hardcopy devices.

Secondly, because hardcopy processes are subtractive, they depend on the outside world to provide a light source. Typi-

cally, this light is the ambient light of the room, provided by fluorescent or tungsten lighting. Because light sources vary dramatically in terms of the wavelengths of light they emit, the perceived color or overall cast of a print will differ with changes from one light source to another and even as the print is moved from room to room.

Codonics Medical Color Matching (MCM)

Despite these difficulties, the problem of CRT-to-printer color matching is not insurmountable. An advanced set of algorithms has been developed that transforms images between the CRT and printer color spaces so that printer output more closely matches the screen. No special calibration of the monitor is required, and no processing need be done to the images being displayed. This is an important benefit that Codonics' MCM has over other color matching schemes.

The Printer is Changed, Not the Monitor

Traditional schemes, such as Pantone™ and TruMatch™ require the screen and printer to be calibrated to some industry standard. This means that images must be manipulated before being viewed on the monitor. With MCM, this is not the case. The printer output is adjusted to match the monitor, so that users will see on the screen what they have always seen and will have no uncertainty about the integrity of their screen image. This can be especially important in certain disciplines including medicine, forensics, and microscopy. In addition, because all MCM processing is performed on the printer, making use of the built-in RISC workstation, the user's imaging equipment is free to perform more important tasks.

For medical users, MCM technology pays particularly close attention to "medical blues", producing images for the medical market that traditional approaches can not accomplish.

How to Use MCM

The printer supports 18 color matching settings. These settings are based on different monitor types and lighting conditions, and each setting is assigned a unique MCM ID number.

To use Medical Color Matching, the user must first decide which MCM ID provides the best match for their particular monitor and lighting conditions. This is done using the MCM Bracketing feature. Then the user need only tell the

CODONICS

Page 1: Darker Prints

0	**1**	**2**	↑ Min Adj
3	**4**	**5**	Blue/Magenta
6	**7**	**8**	↓ Max Adj

Min Adj ◄— **Green/Yellow** —► Max Adj

Page 2: Lighter Prints

9	**10**	**11**	↑ Min Adj
12	**13**	**14**	Blue/Magenta
15	**16**	**17**	↓ Max Adj

Min Adj ◄— **Green/Yellow** —► Max Adj
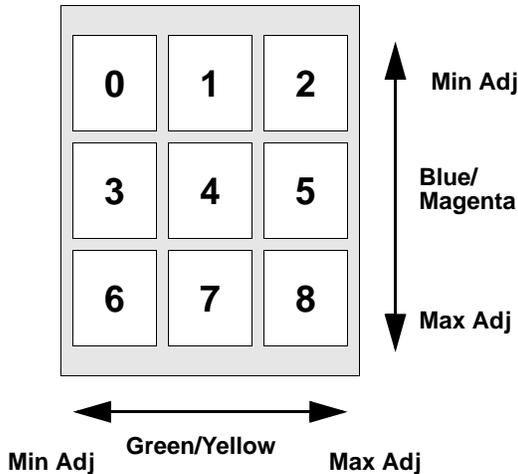
printer which ID to use. These tasks are discussed in detail in the sections that follow. Once this is done, the desired color matching will be applied to all images printed by that user. Note that MCM is applied in conjunction with all other image processing settings, such as TCR, gamma correction, scaling and antialiasing. These will all be applied the same as before. Two processing options, TCR and gamma correction, are completely or partially superseded by MCM. Users who choose to enable MCM should consider it their primary color correction. TCR should primarily be used for fine-tuning image lightness once the MCM ID is selected. Gamma correction should be used with care, as it can cause slight changes in color balance.

Users who are comfortable with their TCR and gamma settings can continue using these as they always have simply by turning MCM off (by selecting MCM ID 0). This is the default setting when the printer ships from the factory.

MCM works with VMF, FMF, Gamma-TCR Bracketing, and Gamma-Contrast Bracketing the same as the other image corrections such as gamma, contrast, and TCR.

Step 1: Choosing the MCM ID

The MCM ID is chosen using the MCM Bracketing feature. This feature allows users to compare the different MCM settings to find the MCM ID that produces the best match with their monitor. To produce an MCM Bracketing print, send an image to the MCM Bracketing Device on the printer (Logical Device 8) using FTP or LPR.

An image sent to the MCM Bracketing Device will have each of the MCM corrections applied to it, producing as many copies of the image as there are MCM ID numbers. The resulting copies are then arranged nine on a page to produce two pages of printed output. This is shown in the following
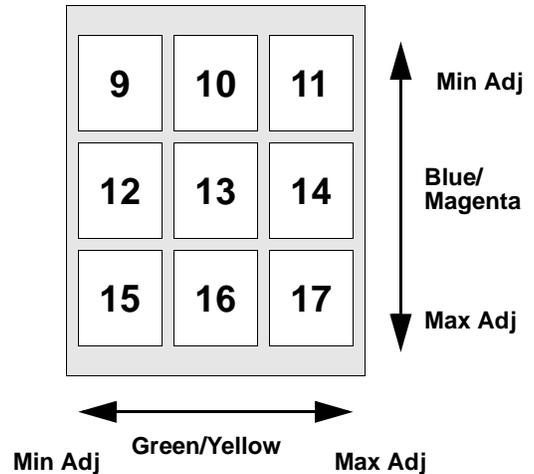
figures. In the figures, each small box represents a copy of the image with a unique MCM ID applied to it. The MCM ID number is denoted inside each box. Note that ID 0 turns MCM off.

To choose the proper ID, the user should compare the Bracketing prints to the same image displayed on the CRT monitor in question and determine which of the corrections produces the best match for that monitor.

Guidelines

The following guidelines help users make best use of the MCM Bracketing feature.

1. All default color corrections (except for the existing MCM setting) are applied to the MCM Bracketing images. This property is useful when users want to see the effect of TCR or other corrections on the range of MCM values.
    ◆ When making their INITIAL MCM Bracketing prints, users should turn off their default color corrections by setting gamma = 1.0, contrast = 0, and TCR = 0.
    ◆ **Once the closest MCM ID is chosen, further lightening of the image can be achieved by increasing the TCR setting.**
    ◆ To see the effect of various processing features such as TCR or gamma, turn them on and create additional bracketing prints. Gamma correction should be used with care, since it can affect the color balance of the image.

2. The image in the upper-left corner of page 1 (MCM ID 0) has no MCM correction applied. By default, choosing MCM ID 0 turns MCM off. The farther an image is located from this corner of the bracketing print, the greater the amount of correction.

3. The difference between Pages 1 and 2 is overall image intensity (overall lightness and darkness).

   ◆ For darker colors, use an MCM ID from page 1.
   ◆ For lighter colors, use an MCM ID from page 2.

4. The transition from the top to the bottom of each page varies the effect of MCM on the blue/magenta region of the spectrum. Colors in this region are some of the most challenging for dye diffusion printers to reproduce faithfully.

   ◆ The top row of each page has no blue/magenta correction.
   ◆ The bottom row of each page has maximum blue/magenta correction.

5. The transition from the left to the right of each page varies the effect of MCM on the green/yellow region of the spectrum.

   ◆ The left column has no green/yellow correction.
   ◆ The right column has maximum green/yellow correction.

The images chosen for bracketing should be representative of ones that will normally be used on the printer and should contain a wide range of colors. **The differences between adjustments are subtle and may not be obvious in images with narrow color ranges.**

Step 2: Setting MCM on the Printer

MCM can be enabled on the printer in two ways. First, the printer default MCM ID can be set through the printer's front panel. Second, users can store their personal MCM preference on the printer so that the printer default setting will not apply to them.

Setting Printer Default MCM ID

Setting the MCM ID through the printer's front panel specifies the **printer default value**. This value is used for any users who have not stored a personal settings file on the printer. This value is entered into the printer as follows:

Use the following front panel key sequences to select the MCM ID. When an **<Up-arrow>** or **<Down-arrow>** is indicated, press the key repeatedly until the correct response is showing on the LCD. Start from the READY display.

Use Key	Until LCD Displays
<Setup>	SETUP: NETWORK
<Down-arrow>	SETUP: IMAGE

Use Key	Until LCD Displays
<Setup>	IMAGE: TCR
<Down-arrow>	IMAGE: MCM
<Setup>	*The LCD will display the current MCM ID.*

To change the MCM ID, use the following front panel commands:

Use Key	Until LCD Displays
<Up-arrow> *or* **<Down-arrow>**	*Until the desired MCM ID is shown on the LCD.*

Once the desired MCM ID is displayed, exit from the setup menu and return to the READY *state as follows:*

Use Key	Until LCD Displays
<Setup>	IMAGE: MCM
<Down-arrow>	IMAGE: EXIT
<Setup>	READY

The front panel menu hierarchy just described is summarized below:

   READY → IMAGE → MCM → *default_ID*

Where *default_ID* is one of the MCM ID numbers shown on the MCM Bracketing print.

Setting Personal MCM Preference

Users may store a file on the printer specifying their personal image processing preferences. The file must be a plain text file. To specify the scaling method, first create a file with the following text:

   MCM *id*

Where **id** is one of the MCM ID numbers shown on the MCM Bracketing prints. Then, send the text file to Logical Device 0 of the printer using the FTP or LPR programs. The user must be logged-in under his/her own username for LPR and must use their own username and binary transfer mode when using FTP.

Note: The text file is stored on the printer and is referred to any time that user makes a print. **If the user previously stored a personal settings file on the printer, this will overwrite the original.** Therefore, all other personal preferences should be included in this file, as well. An invalid file sent to Logical Device 0 will clear any existing file which would return all settings to factory defaults.

CODONICS

Changes to MCM as of Release 1.4

NP-1600 Operating Software Release 1.4 contains new MCM ID numbers that have been changed from previous releases. The new MCM ID numbers range from 1 through 17. Old MCM ID numbers which ranged from 1 through 12, have been mapped to numbers 201 through 212 in Release 1.4 and later. Thus, a user that was accustomed to MCM ID 10 in previous releases can get the same results with Operating Software Release 1.4 and later by choosing MCM ID 210.

Querying Printer Status

The printer default MCM ID can be determined by querying the front panel as described in the previous section. The printer default and user-specific settings can also be determined using the **root** login from a Telnet session and running the **stat** command. Users that are familiar with Telnet can log into the printer as follows:

1. Telnet to printer's **hostname** or **IP Address**
2. Login as **root**
3. Run **stat** **username** command.

This command displays a page of useful information about the printer status. All of the image processing options for both **root** (printer default settings) and the specific **username** are displayed.

Get it all with just one call
1-800-444-1198

CODONICS
We bring the future into focus