

## CHAPTER 3

### PROGRAM DEVELOPING TECHNIQUE

#### TO CREATE THE MONITOR PROFILE

The color mixing in all devices is defined by the RGB color space, which is not the device independent color. Therefore, the results from each device are the high different values. For this reason, the Color Management System (CMS) has started to be developed to adjust high accuracy device efficiency.

Profile is a tool, which can increase device efficiency because it can transform the color values in the device dependent color space into the device independent color values, XYZ tristimulus values. Therefore, each space can all the same comprehend.

This chapter described the monitor profile creation. We can transform the input data into the output data by through profile. Typically, characterization is a process to define relationship between input signal and output signal of an unknown model as shown in Figure3-1. For this research, an unknown model is the monitor profile.

A color technologist is matching a standard, engineering a color system, or developing a color-management system, the key component is an understanding of the relationship between the coloration process and the resulting color.

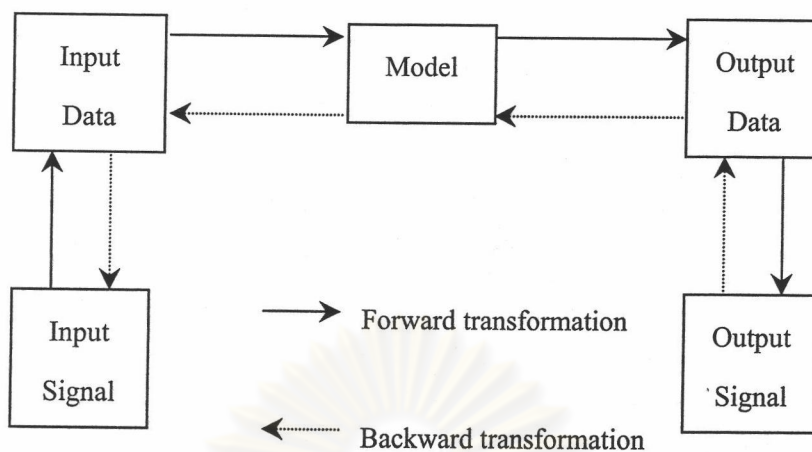
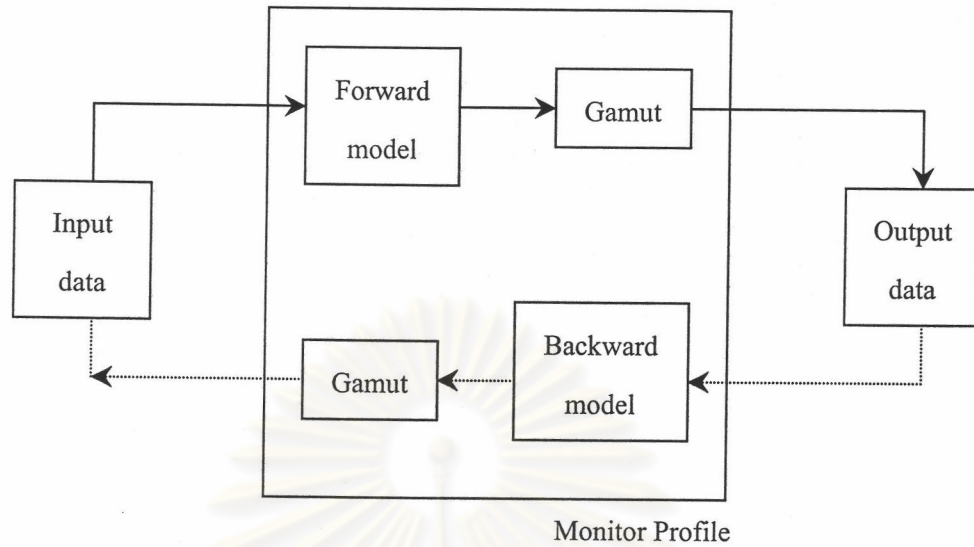


Figure 3-1 The schematic diagram of typical relationship between input and output signal.

### 3.1 Structure of Monitor Profile

The structure of monitor profile consists of forward and backward transformation.

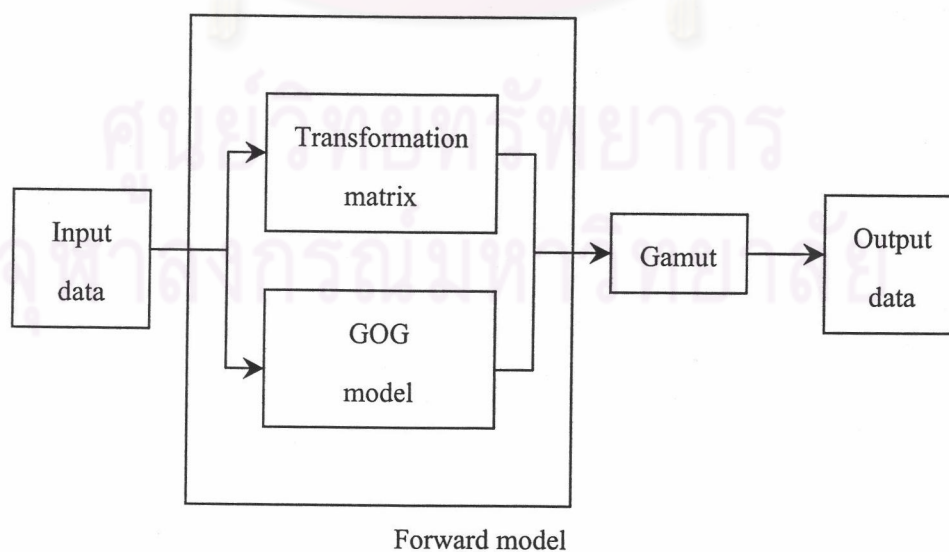
Forward transformation is the transformation of input data (dependent color space) into output data (independent color space) by through forward model. And Backward transformation is the transformation of output data into input data by through inverse model. Both of these transformation as shown in Figure 3-2.



**Figure 3-2** The schematic diagram of transformation between input data and output data

A color on the monitor is divided into two parts; colorant, and luminance. Therefore, the creation of monitor profile must consider both of these parts.

In case of Forward model, we can transform input data into output data by through the transformation matrix and Gain Offset and Gamma (GOG) model as shown in Figure 3-3.



**Figure 3-3** The schematic diagram of Forward model

In case of Backward model, we can transform output data into input data by through the inverse transformation matrix and inverse GOG model as shown in Figure 3-4.

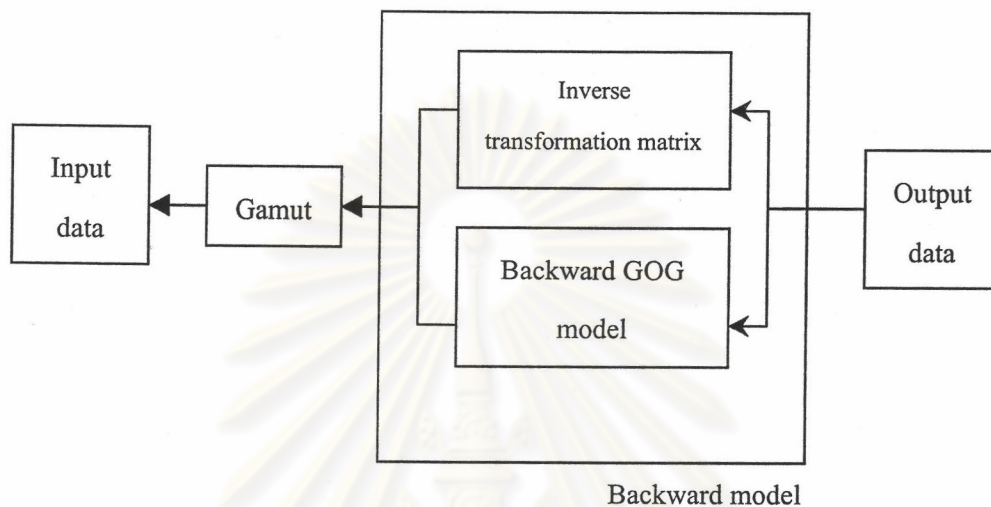


Figure 3-4 The schematic diagram of Backward model

### 3.2 Calculation to Created the Monitor Profile

The structure of monitor profile consists of the transformation matrix, inverse transformation matrix, GOG model, and inverse GOG model. Therefore, we must consider these components.

Both of the transformation and inverse transformation matrix were calculated from the data in colorant part:  $x_{r,g,b}$ ,  $y_{r,g,b}$ , and  $L_{r,g,b,max}$  as follows:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} X_{r,\max} & X_{g,\max} & X_{b,\max} \\ Y_{r,\max} & Y_{g,\max} & Y_{b,\max} \\ Z_{r,\max} & Z_{g,\max} & Z_{b,\max} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}. \quad (3.1)$$

where

$$\begin{bmatrix} X_{r,\max} & X_{g,\max} & X_{b,\max} \\ Y_{r,\max} & Y_{g,\max} & Y_{b,\max} \\ Z_{r,\max} & Z_{g,\max} & Z_{b,\max} \end{bmatrix} = \begin{bmatrix} (X_{r,\max}/Y_{r,\max}) & (X_{g,\max}/Y_{g,\max}) & (X_{b,\max}/Y_{b,\max}) \\ 1 & 1 & 1 \\ (Z_{r,\max}/Y_{r,\max}) & (Z_{g,\max}/Y_{g,\max}) & (Z_{b,\max}/Y_{b,\max}) \end{bmatrix} \begin{bmatrix} L_{r,\max} & 0 & 0 \\ 0 & L_{g,\max} & 0 \\ 0 & 0 & L_{b,\max} \end{bmatrix} \quad (3.2)$$

where  $X_{r,g,b,\max}$  : the tristimulus value of  $X$  of the maximum red, green, and blue respectively.

$Y_{r,g,b,\max}$  : the tristimulus value of  $Y$  of the maximum red, green, and blue respectively.

$Z_{r,g,b,\max}$  : the tristimulus value of  $Z$  of the maximum red, green, and blue respectively.

$x_{r,g,b,\max}$  : the chromaticity of  $x$  of the maximum red, green, and blue respectively.

$y_{r,g,b,\max}$  : the chromaticity of  $y$  of the maximum red, green, and blue respectively.

$z_{r,g,b,\max}$  : the chromaticity of  $z$  of the maximum red, green, and blue respectively.

$L_{r,g,b,\max}$  : the luminance of the maximum red, green, and blue respectively.

$R$  : the red scalar.

$G$  : the green scalar.

$B$  : the blue scalar.

Since, CRT color monitors produce an image with the lights emitted by red, green, and blue phosphor. The quality of the image depends on the nonlinear relationship between the amount

of emitted light and DAC count applied to RGB channels. The tradition CRT techniques have been summarized by Berns and can be described as the gain-offset-gamma (GOG) model to characterize this nonlinear relationship[34] as follows:

$$\frac{L_{\lambda,p}}{L_{\lambda,p,\max}} = \left[ k_{g,p} \left( d_p / (2^n - 1) \right) + k_{o,p} \right]^{\gamma_p} \quad (3.3)$$

or

$$\frac{X_r}{X_{r,\max}} = \frac{Y_r}{Y_{r,\max}} = \frac{Z_r}{Z_{r,\max}} = \left[ k_{g,r} \left( d_r / (255) \right) + k_{o,r} \right]^{\gamma_r} = R \quad (3.4)$$

$$\frac{X_g}{X_{g,\max}} = \frac{Y_g}{Y_{g,\max}} = \frac{Z_g}{Z_{g,\max}} = \left[ k_{g,g} \left( d_g / (255) \right) + k_{o,g} \right]^{\gamma_g} = G \quad (3.5)$$

$$\frac{X_b}{X_{b,\max}} = \frac{Y_b}{Y_{b,\max}} = \frac{Z_b}{Z_{b,\max}} = \left[ k_{g,b} \left( d_b / (255) \right) + k_{o,b} \right]^{\gamma_b} = B \quad (3.6)$$

where

$L_{\lambda,p,\max}$  : a channel's maximum spectral radiance.

$k_{g,p}$  : the monitor gain term.

$k_{o,p}$  : the monitor offset term.

$\gamma_p$  : the monitor gamma term.

$X_r, Y_r, Z_r$  : the tristimulus value of the typical red channel.

$X_g, Y_g, Z_g$  : the tristimulus value of the typical green channel.

$X_b, Y_b, Z_b$  : the tristimulus value of the typical blue channel.

The monitor gain, offset, and gamma terms were calculated from the data in luminance part. These data are the gray scale data, which were divided into 16 levels (minimum at 0 and maximum at 240).



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