Paint-like Compositing Based on RYB Color Model

Junichi Sugita*
Tokyo Healthcare University

Tokiichiro Takahashi†
Tokyo Denki University / UEI Research

(a) $\alpha$-compositing ($\alpha = 0.6$)

Figure 1: Paint-like compositing based on RYB color model.

1 Introduction

Many people have been familiar with subtractive color model based on pigment color compositing since their early childhood. However, the RGB color space is not comprehensible for children due to additive color compositing. In the RGB color space, the resulting mixture color is often different from colors viewer expected. CMYK is a well-known subtractive color space, but its three primary colors are not familiar. Kubelka-Munk model (KM model in short) simulates pigment compositing as well as paint-like appearance by physically-based simulation. However, it is difficult to use KM model because of many simulation parameters.

In order to realize easy to use for paint-like compositing, we present two color compositing methods based on an RYB color model. The RYB color model proposed by Johannes Itten [1973] is widely used in art education, where red, yellow and blue are defined as subtractive primaries. Gossett and Chen [2004] proposed a conversion method from RGB color space to RYB color space based on tri-linear interpolation among three primaries. However, this conversion method is irreversible, i.e., conversion equations between RGB and RYB color models have not been proposed yet.

In this paper, we formulate mathematical and bi-directional conversion equations between RGB and RYB color spaces. We also propose simple color compositing methods to represent lower and highly scattering pigments compositing.

2 RYB Color Model and Compositing

We derive conversion equations between RGB, $(R_{RGB}, G_{RGB}, B_{RGB})$, and RYB, $(R_{RYB}, Y_{RYB}, B_{RYB})$, color spaces. Note that $0 \leq R_{RGB}, G_{RGB}, B_{RGB}, R_{RYB}, Y_{RYB}, B_{RYB} \leq 1$.

2.1 RGB to RYB Conversion

We introduce two sets of variables, $(r_{RGB}, g_{RGB}, b_{RGB})$, and $(r_{RYB}, y_{RYB}, b_{RYB})$, which are calculated by the following equations.

$$
(\tau_{RGB} = \tau_{RGB} - \min(\tau_{RGB}, \tau_{GBG}))
$$

$$
\frac{\tau_{RYB}}{\tau_{YRB}} = \min(\tau_{RGB}, \tau_{GBG})
$$

Here, $i_w = \min(R_{RGB}, G_{RGB}, B_{RGB})$ is a white component in RGB color space. These variables are normalized as

$$
\frac{\tau_{RYB} - \tau_{GBG}}{\tau_{RYB} + \tau_{GBG}} = \frac{\tau_{RYB} - \tau_{GBG}}{\tau_{RYB} + \tau_{GBG}}
$$

2.2 RYB to RGB Conversion

A black component $I_0 = \min(R_{RYB}, Y_{RYB}, B_{RYB})$ is subtracted from each component $R_{RGB}, Y_{RGB}, B_{RGB}$ in RGB color space:

$$
(R_{RGB}, Y_{RGB}, B_{RGB}) = (R_{RYB}, Y_{RYB}, B_{RYB}) - (I_0, I_0, I_0)
$$

Three variables, $(\tau_{RGB}, \tau_{GBG}, \tau_{GBG})$, are obtained as follows:

$$
\tau_{GR} = \tau_{GR} + \tau_{GR} - \min(\tau_{GR}, \tau_{GR})
$$

$$
\tau_{GBG} = 2(\tau_{GR} - \min(\tau_{GR}, \tau_{GR}))
$$

These variables are normalized as

$$
\frac{\tau_{RGB} - \tau_{GRG}}{\tau_{RGB} + \tau_{GRG}} = \frac{\tau_{RGB} - \tau_{GRG}}{\tau_{RGB} + \tau_{GRG}}
$$

Finally, by adding a white component, $I_0 = \min(R_{RGB}, G_{RGB}, B_{RGB})$, $(R_{RYB}, Y_{RYB}, B_{RYB})$ in RYB color space are obtained by the following equations.

$$
(R_{RYB} - B_{RYB} - B_{RYB}) = (R_{RGB} - \max(R_{RGB}, G_{RGB}, B_{RGB})) + (I_0, I_0, I_0)
$$

$\ast$[sugita, toki]@crl.jp

References
