Creating a simple ICC profile for a CMYK printer using LCMS library

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1 Introduction

Color consistency across various devices, such as monitors, printers, and cameras, is crucial in industries where accurate color reproduction is essential. International Color Consortium (ICC) profiles are used to manage this consistency by defining how colors should appear on different devices.

The provided C code is specifically designed to generate a CMYK ICC profile, which is commonly used for printers. This profile is generated using the Little CMS (lcms) library, an open-source color management system. The lcms library facilitates the creation, manipulation, and application of ICC profiles, allowing for accurate color transformations across different devices.

The code accomplishes several key tasks:

- It defines the color space for a CMYK device and sets up the Profile Connection Space (PCS), which is used for color transformations.
- It generates transformation pipelines using look-up tables (LUTs) to convert between the CMYK color space and the PCS, ensuring consistent color output.
- It sets important metadata such as the profile description, manufacturer, and copyright, making the profile identifiable and legally protected.
- It uses simplified random data for the 'AToB0' and 'BToA0' tags to represent color transformations. This random data is used for simplicity in the absence of real color measurement data.

This document explains the tags and headers used in the ICC profile generated by the code, providing insights into their purposes and how they contribute to the overall functionality of the profile.

1.1 Little CMS (lcms) Library

Little CMS (lcms) is an open-source color management library that facilitates the creation, manipulation, and application of ICC profiles. It provides a wide

range of functions to handle color conversions and profile generation, making it a popular choice for developers working with color management in software applications.

The lcms library is designed to be lightweight and efficient, enabling the integration of color management functionalities into applications with minimal overhead. It supports all standard ICC profile features, including various color spaces, tone reproduction curves (TRCs), and look-up tables (LUTs). The library is highly customizable, allowing developers to create profiles tailored to specific devices and use cases.

2 ICC Profile Headers

The ICC profile header contains essential metadata about the profile, which helps color management systems understand how to use the profile. Here are the key headers used in the profile:

2.1 Profile Version

The profile version indicates the version of the ICC specification that the profile adheres to. This helps in ensuring compatibility with color management systems that support different versions of the ICC standard.

2.2 Profile Device Class

The **Device Class** header defines the type of device the profile is intended for. In the case of the provided code, the device class is set to **cmsSigOutputClass**, which indicates that the profile is for an output device, such as a printer. This information is critical for the color management system to apply the profile correctly.

2.3 Color Space

The **Color Space** header specifies the color space of the device that the profile represents. In this context, the color space is set to CMYK (Cyan, Magenta, Yellow, and Black), which is typically used for printers. This header ensures that the color data interpreted by the profile corresponds to the appropriate color model.

2.4 Profile Connection Space (PCS)

The **Profile Connection Space** (PCS) is a device-independent color space used as an intermediary in color transformations. In the provided profile, the PCS is set to the **CIELAB** color space, which is commonly used in ICC profiles due to its perceptual uniformity. The PCS allows color data from different devices to be translated into a common format before being converted to another device's color space.

2.5 Manufacturer Signature

The **Manufacturer Signature** header identifies the entity that created the profile. In the provided code, the manufacturer is set to "SD" (using the signature ‘’S’ — (’D’ ¡¡ 8) — (’ ’ ¡¡ 16) — (’ ’ ¡¡ 24)‘), which signifies that the profile was created by an entity identified by these initials. This information can be used for quality control and tracking the source of the profile.

3 ICC Profile Tags

Tags in an ICC profile are used to store various types of data, such as color transformation information, metadata, and more. Below are the key tags used in the CMYK profile and their purposes:

3.1 Media White Point (cmsSigMediaWhitePointTag)

The **Media White Point** tag defines the reference white point for the profile, typically using the D50 illuminant in the CIEXYZ color space. This tag is crucial because it establishes the baseline for color interpretation, ensuring that all colors are relative to this white point. In the provided profile, the white point is set to D50, which is the standard white point used in ICC profiles.

3.2 Copyright (cmsSigCopyrightTag)

The **Copyright** tag contains information about the ownership and usage rights of the profile. In the provided code, the copyright is set to "Shankhya Debnath", indicating the creator of the profile. This tag helps in protecting the intellectual property associated with the profile and provides legal information about its usage.

3.3 Profile Description (cmsSigProfileDescriptionTag)

The **Profile Description** tag provides a human-readable description of the profile. In the example code, the description is set to "A simple CMYK printer profile". This tag helps users and applications understand the purpose of the profile, making it easier to select the appropriate profile for a given task.

3.4 AToB0 (cmsSigAToB0Tag)

The **AToB0** tag contains a look-up table (LUT) that maps device color space values (CMYK) to the Profile Connection Space (PCS), typically CIELAB. In this code, random data is used to populate the LUT for simplicity in the absence of real color measurement data. This transformation is essential for converting device-specific colors to a device-independent format, allowing for accurate color reproduction across different devices. The AToB0 LUT is typically used when

converting colors from the device color space to the PCS during printing or other output processes.

3.5 BToA0 (cmsSigBToA0Tag)

The **BToA0** tag is the inverse of the AToB0 tag, providing a LUT that maps PCS values back to the device color space (CMYK). Similar to the AToB0 tag, random data is used in this code for the LUT to keep the example simple in the absence of real data. This tag is used when converting colors from a device-independent format (such as CIELAB) back to the device-specific format (CMYK), ensuring that colors are reproduced accurately according to the device's capabilities.

3.6 Gamut Tag (cmsSigGamutTag)

The **Gamut** tag defines the color gamut of the device, which is the range of colors that the device can produce. This information is crucial for color management, as it allows the system to handle colors that fall outside the device's capabilities by performing gamut mapping. In the provided code, the gamut is represented by a CLUT (Color Look-Up Table) that maps PCS values to the device's gamut, ensuring that out-of-gamut colors are appropriately handled.

3.7 Viewing Conditions Description (cmsSigViewingCondDescTag)

The **Viewing Conditions Description** tag provides a description of the viewing conditions under which the profile is intended to be used. This typically includes information about the ambient light, the surround, and the illuminant. In the provided profile, this tag is set to "D50", indicating that the profile is intended for use under D50 lighting conditions, which is standard for color-critical tasks.