



Color Imaging Workflow Primitives: Executive Summary

Ann McCarthy Xerox Innovation Group The term "color fidelity" refers to the successful interoperability of color data, from image creation to output across multiple targets, such that color reproduction quality consistent with the user's intent can be achieved

Interoperability among system color components, necessary for color fidelity, is both color-workflow and market-segment dependent

No limited defined set of workflows can be prescribed that will be sufficient for all cases

Rather, the approach is to define a small set of workflow primitives, i.e., workflow building blocks, that can be assembled in a variety of ways, and when aggregated, can be used to describe all workflows in standard terms

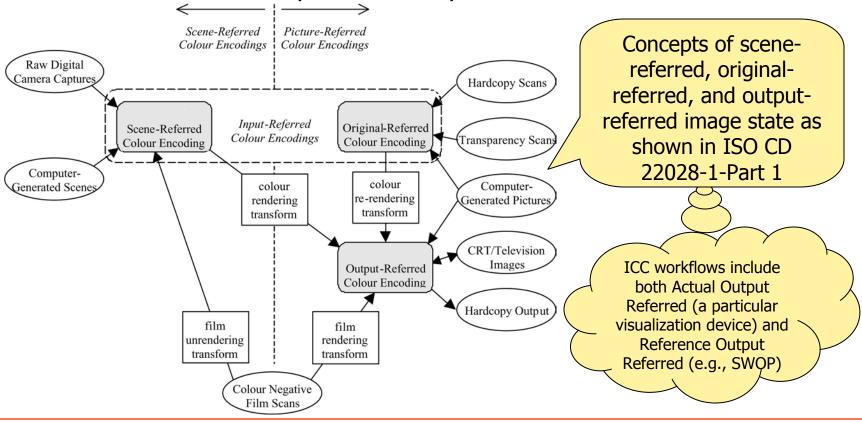
Color Control (ICC) Architecture

- Device calibration Color Calibration
 - Alters the color response of a device to return it to a known state
- Capture and visualization characterization Color Characterization
 - Describes the color response of an input or output condition
- Profile creation
 Color Aim Implementation
 - Encodes a characterization and a color aim for use in a transform
- Image color encoding Color Source Specification
 - Unrendered (e.g., capture a scene) vs. color-rendered (targeted)
- - Profiles can be embedded with an image or document, or can be transmitted as separate files
- Profile use Color Transformation
 - Profiles are applied in pairs to transform an image from a current encoding (the source) to another encoding (the destination)
- Visualization the human element Color Aim Expectation
 - What does the human expect?

Definitions 4

Image state

 The degree to which image data has been constrained or purposed to a particular visualization mechanism, as compared to the degree to which the image data has been retained unaltered with respect to its capture condition



- 'Scene-Referred image data' (SR)
 - Image data that unambiguously encodes the spectral reflectances of the scene (including scene-capture tristimulus encodings)
- 'Original-Referred image data' (OR)
 - Image data that unambiguously encodes a computer-generated or hardcopy original
- 'Reference-Output-Referred image data' (ROR)
 - Output-referred image data that is color-rendered to a standardized output (i.e., an output that is defined through an ideal specification - a precise, arbitrary, output definition that may or may not be realizable)
- 'Actual-Output-Referred image data' (AOR)
 - Output-referred image data that is color-rendered to a specific, particular, realizable device, e.g., encoding the intended color appearance of an image as it is to be printed
- Four fundamental image processing operations
 - Correction operations: 'Corrections' are operations that are required based on device limitations or anomalies
 - Appearance operations: perform input to output environment specific adaptation operations
 - Preference operations: deal with intentional alterations of appearance to increase the aesthetic value of an image and may be image and visualization specific
 - Gamut mapping operations: map the co-ordinates of the elements of a source image to the co-ordinates of the corresponding elements of a destination image, compensating for differences in the source and output color gamut volume and shape

Scene reflectances, Original images

Fundamental Imaging Operation:

1. Device correction

Key Color Fidelity Requirements:

- 1. Process control stability
- 2. Transform proprietary device-dependent raw capture data to a device-independent representation

Image State Impact:

 Initialize image state based on capture conditions

Image System Domain:

- 1. Proprietary methods
- 2. Standard output format

Scenereferred, Originalreferred Capturereferred, Outputreferred

Fundamental Imaging Operations:

- Gamut mapping and appearance operations
- 2. Preference operation

Key Color Fidelity Requirements:

- 1. Process characterization
- 2. Transform a source device-independent representation to a destination device-independent representation

Image State Impact:

1. Change or 'nest' image state based on color-render condition

Image System Domain:

- 1. Standard format interface
- 2. Standard media-relative colorimetric methods
- 3. Proprietary perceptual methods

Applied rendering, Virtual rendering

Capturereferred, Outputreferred

Fundamental Imaging Operation:

- 1. Preference operation Key Color Fidelity Requirements:
 - 1. Proprietary methods estimate expected visualization conditions
 - Transform an initial representation into an 'expected visualization' preferred representation

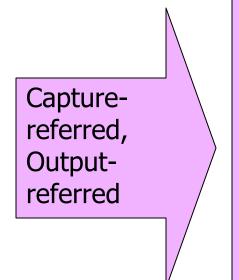
Image State Impact:

- 1. Persist image state
- 2. Same-state appearance changes are encoded in image or metadata

Image System Domain:

- 1. Standard format interface
- 2. Proprietary methods

Capturereferred, Outputreferred



Fundamental Imaging Operation:

1. None

Key Color Fidelity Requirements:

- 1. Job control and format persistence and control
- Proprietary methods incorporate expected visualization conditions
- Combine images and objects for an expected visualization

Image State Impact:

- 1. Persist image state
- 2. Format images and metadata in PDL and job protocol containers

Image System Domain:

- 1. Standard format interface
- 2. Proprietary methods

Formatted for display,
Formatted for further use

Formatted for display, Job control defined

Fundamental Imaging Operation:

1. Device correction

Key Color Fidelity Requirements:

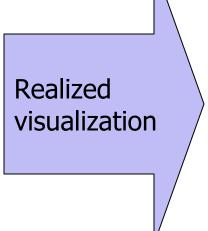
- 1. Process control stability
- Proprietary device specific visualization optimization
- 3. Transform a deviceindependent visualization encoding into a devicedependent realized visualization

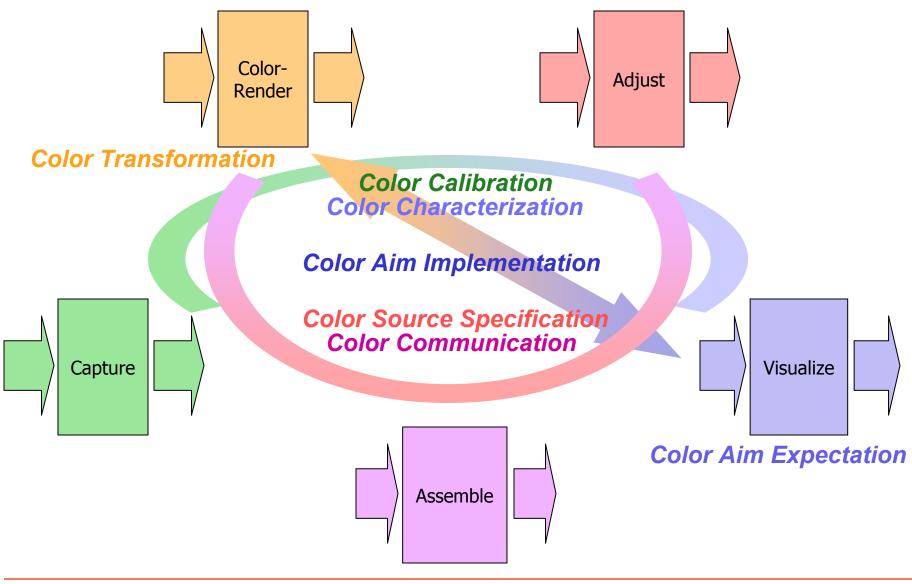
Image State Impact:

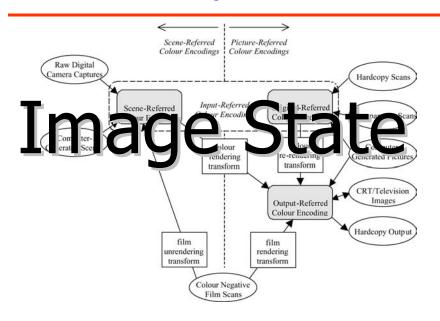
1. Final proprietary devicemapped image state

Image System Domain:

- 1. Standard input interface
- 2. Proprietary methods









Color Transformation

Color Calibration
Color Aim Implementation
Architecture

Color Aim Expectation

