ACES Working Group Proposal

Proposal submitter | Proposal submission date

Matthias Scharfenberg & Carol Payne | 10/31/19

Description of the problem or question(s) the Working Group will be investigating

Users of ACES are experiencing problems with clipping of colors and the resulting artifacts (loss of texture, intensification of color fringes). This clipping occurs at two stages in the pipeline.

1. Conversion from camera raw RGB or from the manufacturer's encoding space into ACES AP0
2. Conversion from ACES AP0 into the working color space ACES AP1

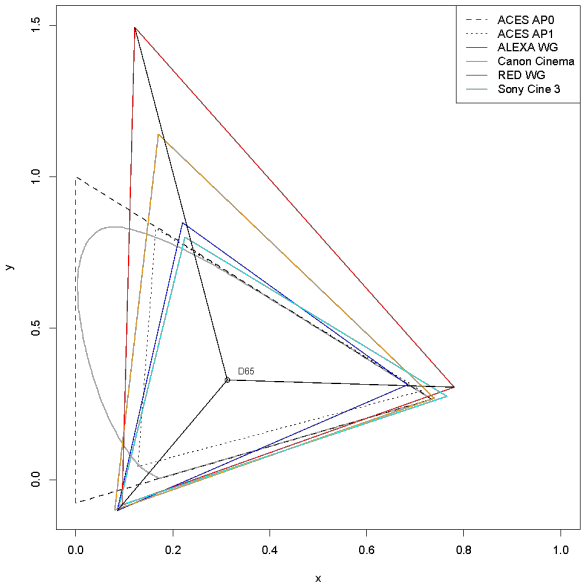
To alleviate the issues either the definitions of the color spaces needs to be changed (e.g. the working color space needs to be as large or larger than the encoding color space) or new transforms need to be developed that avoid clipping (or that do not result in negative RGB values which are clipped in a second step). We believe that the second option is most viable/likely, as a working space larger than the encoding space will be fraught with problems similar to those experienced when trying to use AP0 as a working color space. We also believe that cameras and their associated encoding primaries will continue to change and adapt, so a solution should be vendor encoding agnostic and be compatible with future developments.

The scope of work for the working group is as follows:

- Propose transforms between color spaces that avoid or reduce color clipping. Solutions for this may include:
    - Proposing a suitable color encoding space for digital motion-picture cameras.
    - Proposing a suitable working color space.
    - Propose a suitable gamut mapping/compression algorithm that performs well with wide gamut, high dynamic range, scene referred content that is robust and invertible.

Additional Information

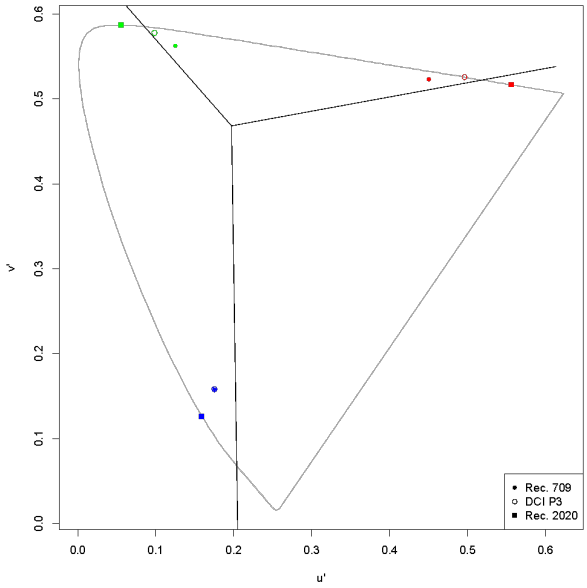
The figure on the left shows the color encoding spaces of four different camera manufacturers compared to ACES AP0 and AP1. All camera color encoding spaces extend the ACES color spaces in two or even three directions.
Converting from the camera color encoding space into one of the ACES color spaces may thus result in negative RGB values, which cause color clipping in many transforms.
Among the reasons why a manufacturer chooses a color encoding space with primaries outside of the spectral locus are color analysis errors (see Holm 2006), virtual RGB values created by demosaicing and filtering, and considerations for the working color space.
In the DI-style post production the color encoding space in combination with a non-linear transform (Alexa LogC, Canon C-Log, Red LOG3G10, Sony S-Log3) becomes a working color space because images are creatively manipulated in this encoding before they are rendered for display. The selection of the primary colors impacts the response when non-linear transforms (curves) are applied to the RGB channels.



We note that the blue primaries of the four camera color encoding spaces are close together and that the green primaries are all close to the line extending from the D65 white point. One could assume that feedback from creative

users caused this convergence. Here is an article where Art Adams discusses the selection of the primaries for the Sony Cine 3 gamut: https://www.provideocoalition.com/camera-not-color-gamut/
Preliminary tests at ARRI also show that a green primary with low x-values “feels less right” to a colorist. The workgroup will investigate the significance of these assumptions and whether it should inform the choice of primaries for a proposed working colorspace.

This second figure shows the same axis as in the previous figure translated into the UCS Diagram. Added are the positions of the primaries of the commonly used output color spaces.



Existing gamut compression transforms generally employ color appearance models that are defined for a display-referred domain, while a proposed algorithm will have to function with images in a scene-referred state. There are two separate parts to any gamut compression operation - the use of an appropriate color appearance model, and then the algorithm itself. The group will need to investigate existing methods in both areas.
The group will also investigate a recommendation for when to apply any gamut compression step and whether it should be invertible.

Proposed Working Group deliverable(s)

- Documentation detailing the group’s research and findings around gamut recommendations, based on real-world and CG content.
- New proposed gamut standards (if changing)
- New recommendation for a gamut mapping algorithm (if applicable)

List of Proponents

Netflix, Industrial Light and Magic, Arri

Anticipated core Working Group contributors

ACES Rep - Rod Bogart
Scott Dyer - LA
Joseph Goldstone - LA
Harald Brendel - Germany
Daniele Siragusano - Germany
Sean Cooper - London
Chris Clark - LA
Thomas Mansencal - New Zealand

Anticipated Working Group lifecycle

More than 6 months

ACES Leadership Use

☒ Approved
☐ Not approved
☐ Proposal modifications required

Review date
01/12/2020

Assigned Working Group Name
ACES Gamut Mapping Working Group

Assigned Working Group Lead
Matthias Scharfenberg & Carol Payne

Supervising Technical Advisory Committee
☒ Architecture ☐ Implementation

Anticipated Academy resources required
Staff administrative and technical support, modeling tools (Matlab, Python, etc.), Science and Technology Council Imaging Lab and Stella Stage for testing

Notes
This refined proposal is based on an earlier proposal submitted by Harald Brendel of Arri