Colors - One: Perceptually Based Color Photo Editing

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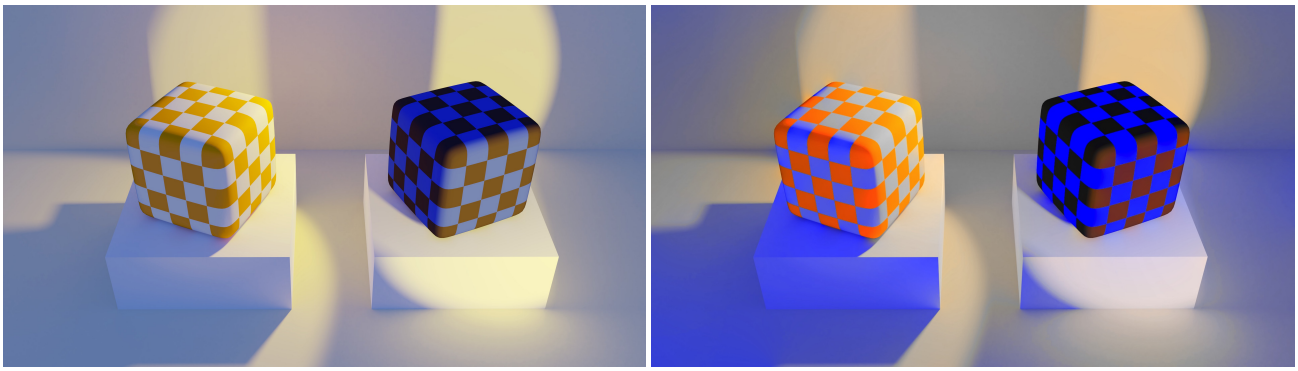

Figure 1: Perceptually based color editing, in a nutshell. The pair of cubes in the left image have physically identical front faces, but appear yellow/white and blue/brown, respectively. The pair of cubes in the right image have been edited with the 'Colors - One' app to selectively enhance the perceived colors, rather than the pixel colors, resulting in the stunning appearance of neon orange and blue colors, respectively.

ABSTRACT

We introduce 'Colors - One', a perceptually based color photo editing app built for the Apple ecosystem. The app's core algorithm augments standard Poisson image editing methods to allow the prediction and editing of perceived image color, rather than pixel color. Users can isolate 16 unique hues and edit the contrast color of each hue individually. The resulting photo edits are striking and provide new insights into the nature of perceptual color representations.

CCS CONCEPTS

• **Human-centered computing** → **User models**.

KEYWORDS

color, photo, perception, editing, app

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1 INTRODUCTION

The creation and deployment of perceptually based user models is a critical ingredient for the development of next generation computing technologies. Here we present a perceptually based color photo editing app, called 'Colors - One', for the Apple ecosystem.

The app is grounded in research from human color vision science, computational neuroscience and computer graphics: It embeds standard Poisson image editing technology within a novel color processing pipeline that is designed to mimic key aspects of human color perception. In this manner, the app allows users to edit perceived photo color–that is, color that is dependent on the surrounding context–rather than pixel color (Fig. 1). The editing of perceived color opens up an entirely new vista of artistic color photo editing opportunities for users.

2 MODELS

The underlying user model can be split into two (2) models: The hue representation model and the spatial representation model. The hue representation model transforms RGB image data into 16 partially overlapping hue-tuned filter channels (plus a grayscale channel) using a double-angle cosine mapping function that models the hue-tuning curves of color-sensitive neurons in the visual cortex [Bohon et al. 2016].

The spatial representation transforms the hue channel data using standard Fourier-based [Morel et al. 2010] Poisson editing [Perez et al. 2003] techniques to generate context-sensitive representations of hue. A scalar parameter assigned to each hue channel–controlled by a slider in the user interface–adjusts the spatial integration by transforming the gradient magnitude data [Fattal et al. 2002] in each hue channel according to a power function. This power function

effectively replaces the threshold operation in classical Retinex theory [Land 1977]. Thus, rather than thresholding the gradient magnitude map, we allow the user to flexibly adjust the exponent of a power function.

The exponent of the power function determines the relative contributions of smaller versus larger gradient magnitudes. The fascinating aspect of this transformation is that, by setting the power exponent to favor larger gradient magnitudes, the app effectively models many color illusions, such as the neon color spreading, the Watercolor effect, and the Craik-Cornsweet-O'Brien illusion. This property also allows users to create stunning neon and translucent color effects by minimising gradient shading cues associated with diffusely reflecting surfaces. The app thus operates both as a model of human color perception and a tool for editing perceived colors. Together, the hue and spatial representations in the app allow the user to selectively edit and adjust the perceived color in each hue channel to create artistic color palettes and effects.

3 RESULTS

When the user selects a photo or image in the app (JPEG, PNG, Raw and ProRaw formats are all supported), the app will automatically create representations of all 16 hues plus the grayscale representation (Fig. 2). When the user taps the palette icon in the navigation bar, the app selects the most salient hue channels in the image and presents a palette of selectable hue brushes. The photo is initially presented in grayscale, in order to allow users to add desired hues to their image.

The user taps each paint brush once to add the hue to the image. A second tap removes the hue. When the hue has been selected and added to the image, the adjustable slider mentioned above appears in the interface to allow for editing of the contrast color for the selected hue. Moving the slider to the right enhances the contrast color, whereas moving the slider to the left weakens the contrast color. The user can also tap the wand icon in the navigation bar, which automatically combines and enhances all hues using a default internal configuration.

4 DISCUSSION

The 'Colors - One' combines hue and spatial representations to provide users with a novel and powerful suite of tools to edit photo color. The app represents the culmination of more than a decade of research, planning, prototyping and production deployment. It is available for iPhone, iPad and Mac users in the Apple ecosystem. We envisage adding new features to the app in order to enhance user interactions and to process video files.

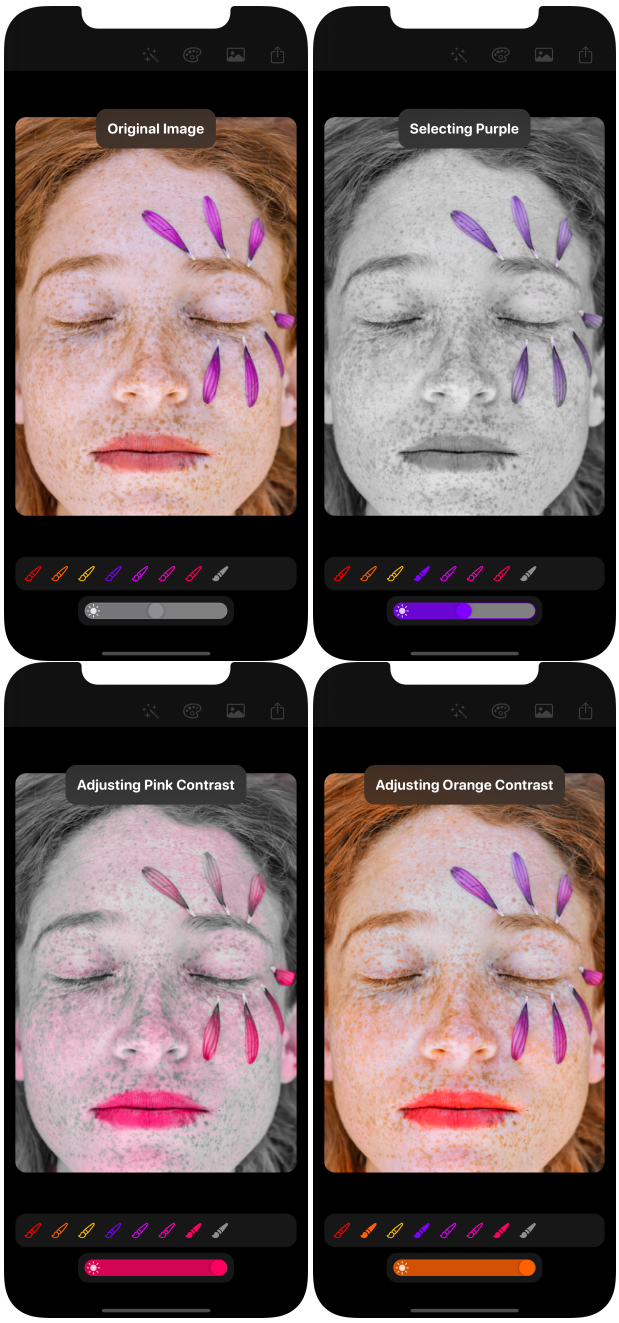

Figure 2: Screenshots showing how the app can be used to select, adjust and combine hue.

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In memory of Eric L. Schwartz, mentor and friend.

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