Augmented Reality to Aid Color Blindness

Brief Background

Color blindness (or color vision deficiency) is the decreased ability to see color or differences in color. A genetic deficiency, color blindness is incurable and can make some activities difficult as well as prohibit certain professions such as that of a pilot, train driver, or armed forces. Affecting about 8% of males and 0.5% of females, the science behind color blindness is well known. There are three types: Protanopia, Deuteranopia, and Tritanopia, with deuteranopia being the most common. [2, 3]

Apple recently introduced ARKit with iOS 11. ARKit is “a new framework that allows you to easily create unparalleled augmented reality experiences for iPhone and iPad” that works by allowing applications to blend “digital objects and information with the environment…freeing them to interact with the real world in entirely new ways.” By affecting how someone sees and experiences the world, Apple’s ARKit enables developers to create augmented reality experiences that drastically change how a user interacts with the color of the objects around him, opening the door to new and unique transformations to the experience of color blind people. [1]

Statement of Achievement

For my final project, I would like to use the Swift programming language and take advantage of ARKit to create an iOS application that uses augmented reality to help color blind people.

iOS Application Specifications

1. “Color Tagging” – a feature that allows you to mark and label the colors of objects seen through your camera in real-time

2. “Color Filtering” – a feature that applies a filter to a marked color/object, altering the color to “counteract” the deficiency to appear more like what a non-color blind person would see

3. “Color Discrimination” – a feature that transforms commonly confused colors into easily discriminable colors

4. Simple user profile that either determines through standardized tests or is given a user’s color vision deficiency type

5. Provide simple color prediction given a user’s profile – e.g. given user X’s type, upon tagging color A, the application predicts what color the user sees contrasted to the actual color

\[^1\text{excluding monochromacy, where the person can see no color at all}\]
Roadmap of Progress

1. *Playground and Research* (expected period: 1st week). In this phase I will both learn the ins-and-outs of Swift’s ARKit as well as color science, specifically in relation to color blindness.

   (a) Grasp capabilities and features of Swift’s ARKit
   (b) Use online tutorials, documentation, and resources to create playground augmented reality applications
   (c) Research color science behind computer graphics and how displays can affect color
   (d) Understand how to effectively transform colors, particularly commonly confused colors into color blind friendly colors
   (e) Take advantage of and learn from other (human) resources in this space (e.g. Professor Zucker)

2. *Application Mockup* (expected period: 2nd week). Here I will outline and design the necessary components of the app.

   (a) Diagram data models, relationships, and application flow
   (b) Design user interface, storyboard layout, and controls

3. *Initial Implementation* (expected period: 2nd to 5th weeks). Next I will implement the application’s skeleton, user profile, and features on a still image (rather than real-time).

   (a) Realize skeleton user interface and navigation system to enable application flow
   (b) Create user profile with color vision deficiency type
   (c) Implement color tagging, filtering, and discrimination features on a still image (i.e. from the camera library)

4. *Real-time Implementation* (expected period: 6th to 9th weeks). Finally, I will convert from still images to real-time images using ARKit.

   (a) Implement color tagging, filtering, and discrimination features in augmented reality in real-time
   (b) Move from applying transformations upon not moving for some time in order to more easily resemble a still image, to real-time augmented reality
   (c) Allow the user to “save” tags or spaces to return to at later times

5. *Testing and Experimenting*. Throughout the project I will test and experiment the application with other color blind subjects.

   (a) Perform varying degrees of experiments – e.g. from using monochromatic images, to those with subtle changes in shading
   (b) Incorporate feedback on how application can be improved into future design decisions
   (c) Understand real-world limitations of real-time color transformations
Expected Challenges

Although I recognize that the most difficult challenges are those that you do not expect, there are two features that I believe will prove the most difficult. The first is being able to consistently, effectively, and accurately apply a transformative color filter that makes commonly confused colors easier to distinguish and appear more like what a non-color blind person would see. This feature will not only take an immensely deep knowledge of color science and how various forms and degrees of color blindness affect graphics, but also an equally strong understanding of how to negate these effects.

The second will be moving from the still image to real-time augmented reality. It is one thing to perform these tags and transformations on a single, still image and an entirely other to apply them to real-time vision. This will require an in-depth look into ARKit and its documentation and capabilities.

Deliverables

1. iOS Color Blindness Aid Application (as described in iOS Application Specifications)
2. Swift source code and design outline
3. Brief documentation and tutorial of application’s features
4. Screenshots and video of application in action
5. Final Project Report

Stretch Goals

A stretch goal for my project is to incorporate advanced color prediction for a user given their color deficiency type. This would involve preemptively knowing what color they think they are seeing, and adjusting the actual color immediately. This feature would also take into account existing active filters.

A second stretch goal is to allow for color object outlining. That is, display firm, clear boundaries over the colors of the objects displayed in order to make differentiation and distinction between various colors easier. This is a stretch goal because I do not believe it has very many practical use cases, as these distinctions are not particularly common.

A final stretch goal is to incorporate a sharing aspect of augmented reality “rooms”. Simply a fancy add-on that would not affect the core of the application, this sharing feature would allow users to record and save rooms they have tagged and filtered and then share them with other users, allowing them too to experience the same room.
References

