Color Tone

Interacting with colors by touch to produce sound

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Abstract

This paper explores the use of touch gestures to interact with colors on a screen by producing sound based on hue, saturation and value of a pixel. By touching a pre-defined or custom image, the user could generate sounds based on a fixed mapping of color to note. A speech mode also announces the color at the touch-point, thus making it not only an interesting instrument, but also a tool for the visually impaired.

Keywords

Touch gestures, hue, saturation, value, sound

Introduction

The relationship between color and sound has been studied over the years and is of continued interest. This is because there are many similarities in the nature and our understanding of both light and sound. Both are essentially results of vibrations [1], and both are often complex waves composed of different frequencies. Just like different sources of light produce different colors, different instruments produce different sounds, even if someone plays the same note with two different instruments, known as Timbre (or color) [2].

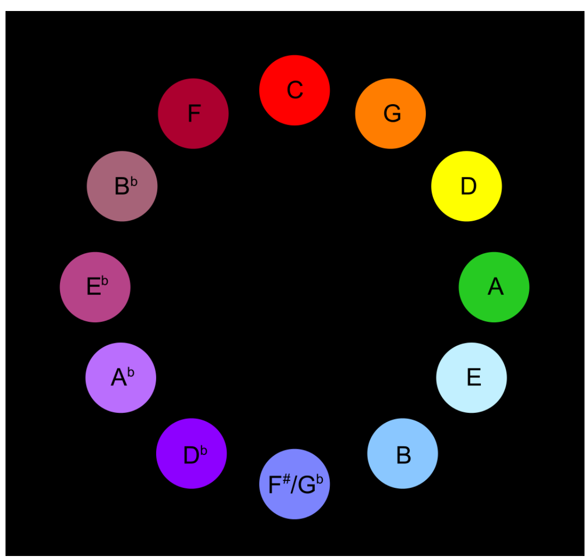

Figure 1: Keys arranged in a circle of fifths in order to show the spectral relationship.

Chromesthesia, a form of synesthesia which is an involuntary joining of sensory information [3], leads to an involuntary perception of color on hearing a sound [4]. There is no consensus on the color that represents specific frequencies of sounds, as every person with chromesthesia may perceive different colors for a sound. However, Alexander Scriabin, an influential composer and pianist, invented *clavier à lumières* (keyboard with lights), a musical instrument that used colors to specify notes. This invention was ascribed to Scriabin being a synesthetic [5], but some argue that it was also due to the influence of theosophy [6]. The color system he devised was based on the circle of fifths, which did not conform with the claims of other synthetics about color-sound relationship [5]. However, it is a relationship that was used in one of his work Prometheus: Poem of Fire [7], and thus forms a good basis for mapping colors to sound in this project *(Figure 1)*.

Color is often one of the components used to visualize sound, especially in music. It is also used in music education to facilitate learning. Essentially, color has been used to represent sound in a visual medium. In contrast, the representation of colors as sounds is not as ubiquitous. Most applications that convert image to sound associate hue to different properties of sound like timbre [8] or different musical instruments [9], while some map patterns to sounds [10]. Of particular interest is the software tool described in the paper "Color Sonification for the Visually Impaired", which scans each pixel on the screen from left to right, top to bottom, and generates sound based on hue, saturation and value (HSV model) of each pixel's color [11]. Such a representation could be overwhelming as the target user receives the sound of each pixel, although they have the ability to control the scanning rate, and consequently the resolution. These projects either output an overall representation of the image through sound or give a sequential representation through a series of sounds. The user does not get to interact with the colors.

Compared to these previous works, this project enables the user to interact with the colors using touch gestures. The user can touch the colors displayed on a touch-enabled device, and the application produces a synthesized note based on the hue, saturation and value of that specific pixel. This amount of control and interaction empowers the user to seek specific details in the whole picture, and not accumulate the information into an average. A similar practical application was developed for Neil Harbisson *(Figure 2)*, a person born with a rare visual condition called achromatopsia, which is total color blindness [12]. He uses a sensor attached to his skull to convert colors in front of him to sounds. He interacts with the colors by moving his head and the sensor along with it, giving him control over what details he can focus on. However, such a sensor still *'sees'* a large area and thus may not provide accurate conversion of color to sound. However, it does help him live an enhanced life, making him the first cyborg in the world [13].

This project, not only explores the use of mapping color to sound as an interaction medium to produce music, it also aims to provide color information to the color blind or the visually impaired.

Figure 2: Neil Harbisson

Color Tone

Color Tone is a JavaScript application that runs in a modern browser and uses the WebAudio API for sound synthesis. It consists of a web-page with a full-page Canvas element that renders a pre-defined or user-selected image. Touching the image triggers *touchstart*, dragging triggers *touchmove*, and lifting the fingertip triggers *touchend.* These events are used to start and stop the sound synthesis. The Touch API also provides the X and Y coordinates of each touch point (each fingertip) which is used to get the color of that specific pixel of the image. However, this pixel's color is defined in terms of RGBA color model. In agreement with previous works, HSV provides a better mapping of color to sound than RGB. Hence, RGB is converted to HSV using a third-party library called ColorJS.

The hue, saturation and value of each pixel are mapped to a specific note and scale, based on the Scriabin circle described in *Figure 1*. This mapping can be visualized as piano keys, with the colors having lower saturation and lower value mapped to the lower scales, the saturated colors on the mid scales and the desaturated colors with high value mapped to higher scales. In terms of colors mapped on a 88-key keyboard, the keys to the left represent shades of the hues, the middle keys represent saturated hues and the ones on the right being tints of hues.

The note thus determined based on the HSV of each pixel, is played for an interval of half a note. Each new touch or movement of touch triggers new sounds based on the pixel's color. It supports up to 10 simultaneous fingertips, but the limitations of Web Audio API and unoptimized code leads to choppy sound for more than 4 fingertips simultaneously. It can also be used by two or more users simultaneously. Based on the feedback received from some of the test users, a colored ring is shown around each touchpoint as well as the label of the specific specific note that gets triggered.

Figure 3: Color Tone application displaying a color wheel
with multi-touch detection and visual feedback

It also features a secondary "Speak" mode to announce the colors based on the touch-points. It uses Name that Color JavaScript library by Chirag Mehta, that takes a Hex code of a color and gives back the name of a color based on closest match. It then uses ResponsiveVoice JavaScript library to invoke the text-to-speech engine of the touchscreen device and announce the name of the color. This simple addition to the application makes it, not only an interesting midi player, but could also help the color blind and visually impaired, to detect colors in pictures.

Using the device's camera or photo gallery, the user can use a custom image for producing sound. This makes it a dynamic midi player, where each image would lead to different set of notes and compositions. Since black and white colors are not mapped to any sound, this option could lead to a bad user experience, if the user choses a grayscale photo.

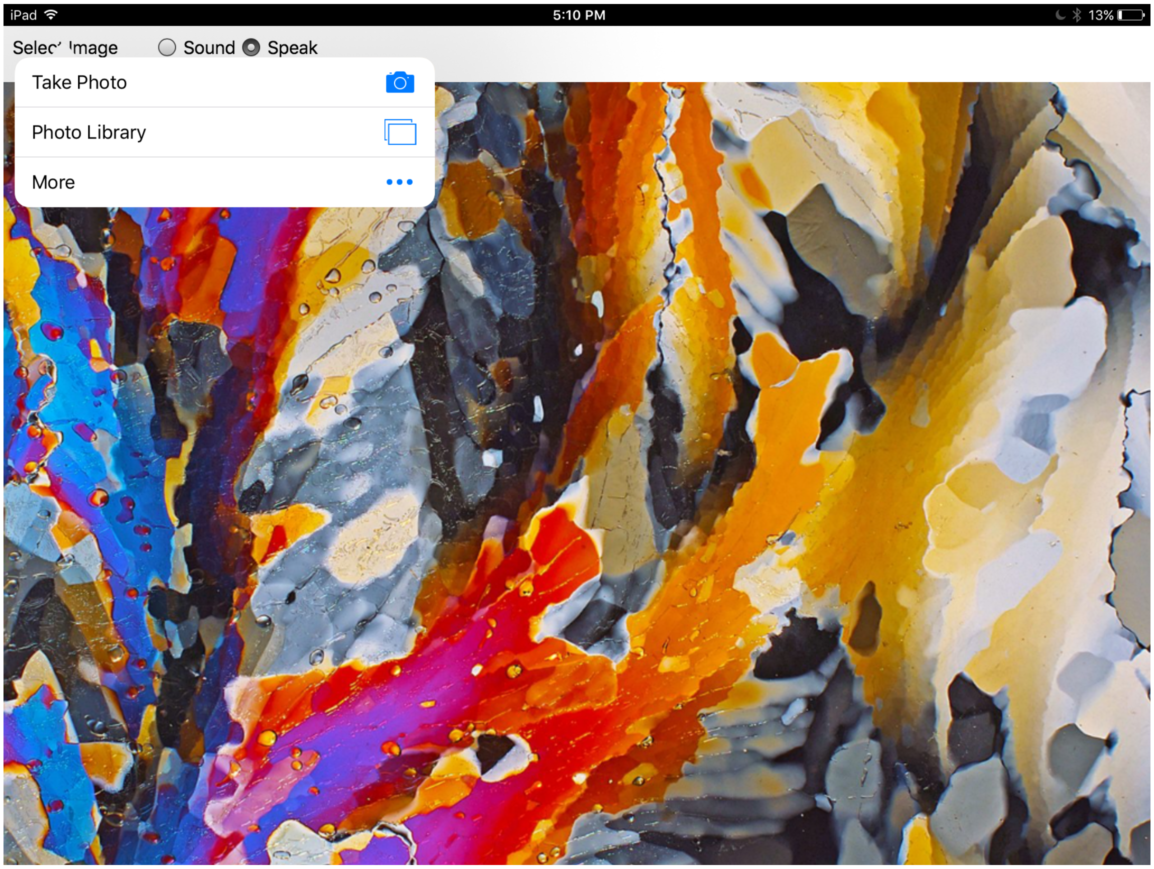

Figure 4: User can click a new photo or select one from the photo library

Result, Reflection and Future

Touching colors makes for an interesting interaction, and an abstraction with many possibilities. Apart from producing sound, it can also be used to edit sounds. One could apply the paradigms of a graphic editor to perform operations on sound, like painting over a picture to add sound, erasing colors to erase specific sounds, replace colors to change sounds, adding filter effects, etc. Additionally, by providing different haptic feedback for different colors, one could feel colors. However, current touch devices do not have the ability to provide localized haptic feedback, and there is no Web API to trigger vibrations.

While designing for the touch interface *(specifically the iPad Air)*, it was assumed that the touch device had good palm rejection algorithms, that would reject spurious touches. It was expected to detect fingertip touches and gestures like tap, drag, pinch and spread. However, it sensed palm touches during user testing. This was an unexpected development [14], which could have potentially been used for an interesting interaction.

Some users suggested the use of better sound synthesis, while others suggested mapping different instruments to different colors. The web browser as a platform also has its shortcomings. In future, this could be implemented as a native application on iOS and Android platforms and could use

SuperCollider engine for sound synthesis. As a native application, it would also have access to enough processing power for a user to be able to touch a live video and use its colors for sound synthesis. Additionally, an 88-key keyboard can be displayed on the interface as an additional point of interaction, where on touching each colored key, the corresponding color on the picture could be highlighted apart from the sound synthesis.

Conclusion

There have been previous attempts at using colors to produce sound, but this project takes this further by having the user interact with the colors. Not only does it make for an interesting and unpredictable musical instrument, but also makes us more aware of colors around us and how they may be connected to our other senses. This project also makes for a useful tool to read colors for the visually impaired or the color blind. Taking cue from Neil Harbisson's sensor, such a technique could enable us to not only hear visible light, but with the right camera, also hear infra-red and ultra-violet light. Taken further, one could potentially feel color with the right haptic feedback. This project is just a glimpse into the various possibilities that interacting with color provides.

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