Eyes: Iris Sonification and Interactive Biometric Art

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ABSTRACT

"Eyes" is an interactive biometric data art that transforms human's Iris data into musical sound and 3D animated image. The idea is to allow the audience to explore their own identities through unique visual and sound generated by their iris patterns based on iris recognition and image processing techniques. Selected iris images are printed in 3D sculptures, and it replays the sound and animated images on the sculptures. This research-based artwork has an experimental system generating distinct sounds for each different iris data using visual features such as colors, patterns, brightness and size of the iris. It has potentials to lead the new way of interpreting complicated dataset with the audiovisual output. Moreover, aesthetically beautiful, mesmerizing and uncanny valley-effected artwork can create personalized art experience and multimodal interaction. Multi-sensory interpretations of this data art can lead a new opportunity to reveal users' narratives and create their own "sonic signature."

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KEYWORDS

Iris; iris sonification; sound synthesis; biometric data; digital art; interactive art; interactive biometric data art

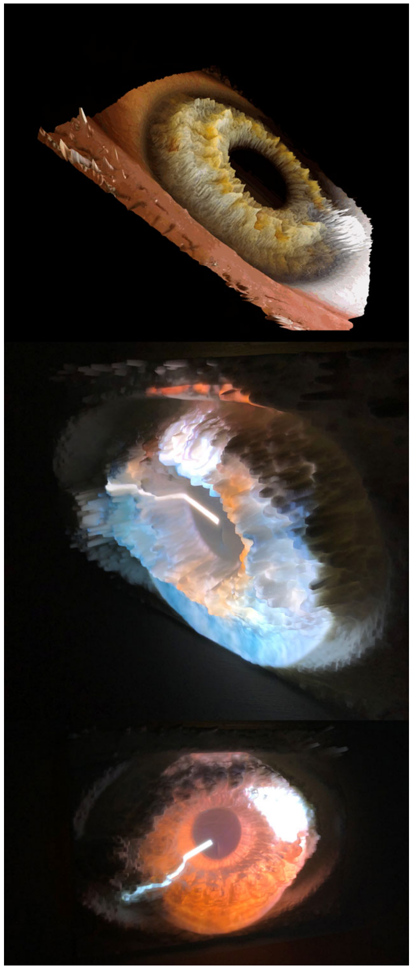

Figure 1: Eyes: Iris Sonification.

1. BACKGROUND

The iris is one of the unique biometric patterns on the human body. Due to its unique, stable and complex patterns, iris recognition has been commonly used in security and identification system in these days. Using mathematical pattern-recognition techniques, it is possible to extract unique visual patterns and colors of the iris and use them to recognize each person's identity and apply to the security system. Data obtained from the iris is a fascinating one that can be both visualized and sonified. I believe that sonification can serve as an effective technique to read the complex patterns as the audience can listen and perceive spatial pattern instantly in the sonic input. In an artist's perspective, sonification can also allow the audience to have more immersive and dynamic artistic experience along with visual outcome. Therefore, iris sonification can have unique personalized art experience to the audience and enhance the readability of the intricate patterns.

"Eyes" (as shown in figure 1) is a series of biometric data sonification and data-driven artworks that I started in 2012. The first biometric data used for the series was fingerprints. [1] Fingerprint sonification was created by scanning fingerprint data in multiple directions, extracted the minutiae, and mapped to sound using various sound synthesis. Users were able to control the playback of the sound and animations on the screen. While the iris recognition has rarely been used in the fields of sonic arts/sonification, it has been applied in several interactive visual artworks as an essential technique. [2][3][4] However, there was no direct sound output or sonification driven from the iris data yet in the artworks, which can be found in this artwork. Biometrics are a part of the systems being developed to produce seamless and "natural" human-computer connections and interactions with others. The uniqueness of iris has been chosen to explore the meaning of biometric data, digital identities and entities, and our inability to conceal ourselves and powerless in the face of this empirical self.

2. DESIGN

In this installation, audience members can capture their iris images with a customized USB web camera as Figure 2 shows. They can observe personalized audiovisual outcome based on their captured and manipulated iris data. A three-dimensional converted image is projected on a wall, and it starts playing sound once the image is animated. Extracted visual features of the iris data determine the timbre and melody of the sound. The audience can also observe 3D printed sculptures (as shown in Figure 1) next to the interactive art installation. Selected distinct iris data is selected and printed in 3D form, and it includes projected images over the sculptures that loop iris image along with audio based on the iris image data. The 3D printed sculptures represent unique dominant colors from previous participants (blue, green, brown, yellow, dark brown, black) thus the audience can compare their iris image with others and discover similarities and distinctiveness.

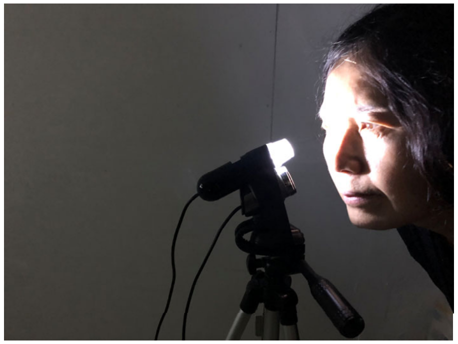

Figure 2: A customized camera captures an iris image of an audience member in the installation.

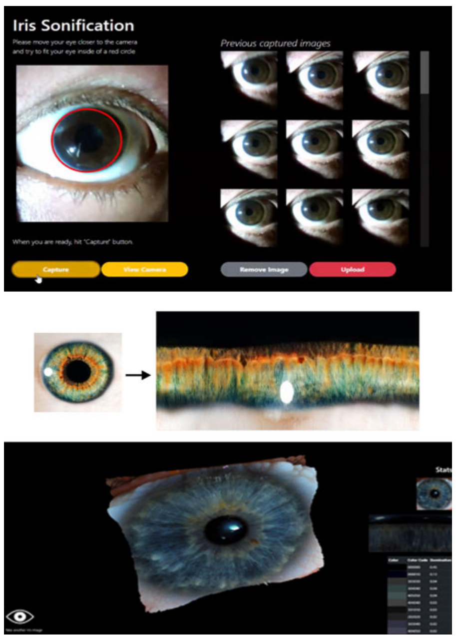

Figure 3: Capturing process (top), Normalization process (middle) and A screenshot image of the final screen (bottom) showing a 3D iris image and extracted dominant colors.

3. TECHNICAL DETAILS

The process of the iris recognition in this artwork includes several key steps to analyze the complicated patterns of the iris data, extract significant visual features and compare with other iris data. To extract the iris region, we detected pupil and iris circle. We used Hough transform for detecting both the circles [5]. The key steps of the iris recognition are segmentation, normalization, and feature encoding. Image processing techniques are employed to extract the unique iris pattern from a digitized image of the eye such as dominant colors, patterns, mean brightness and overall size of the iris region. Figure 3 shows the process of normalization and transformed image in Cartesian co-ordinates.

The originally captured iris data is a two-dimensional image, however, in order to increase more engaging visual experience and to emphasize the colors of the iris image, this artwork transforms the two-dimensional iris images to three-dimensional animated iris images. The depth of vertices (z-axis) is determined by the color and brightness of pixels. For example, if there are brighter colors with high intensity in the core of a pupil, the vertices on the location have longer height, which increases the depth of the three-dimensional image. This means that if an iris image is clear and bright, overall final image will be richer and more dynamically created.

All the colors are extracted from the RGB planes and created a musical score into the skeletonized patterns. Each layer/plane passes to the different sound synthesis with various parameters, create separate audio, and all the audio layers are combined and played together. The scanning process checks if the current pixel value is equal to the top ten dominant colors that we identified. If it is equal, then we send the pixel value via Open Sound Control (OSC) message to the Max/MSP system. Details of the variables of sound synthesis and the mapping scale are described in Table 1. The sonification was created in Max/MSP and image analysis was implemented in JavaScript.

4. RESULTS AND CONCLUSION

This artwork developed an artistic and experimental system generating distinct sounds for each different iris data using the iris recognition techniques and sound synthesis. It has potentials to lead the new way of interpreting complicated dataset with the audiovisual output. More importantly, aesthetically beautiful and mesmerizing artwork driven the human body can be created with the personalized art experience and multimodal interaction. Biometric data can reveal fascinating stories as it contains genetic information and relationships with others, culture or society. While the biometric body is a way to assess and distinguish individuals, the ability to measure is also an ability to standardize. Sonic interpretations of the iris data could lead a new opportunity to reveal users' narratives and create a new way of measurement by creating their own "sonic signature," which will be able to trigger a new way of interaction in the fields of art and science.

In May 2018, we conducted an informal user study in California State University, Fullerton for understanding user response for the project. Based on the conducted survey, 70% of the users

Table 1: Transforming Raw Data into Sound Synthesis

Raw Data	***Variables of Sound Synthesis***	***Mapping Scale***
Mean Brightness	Amplitude	0-150 to 0.0-1.0
Colors	Frequency Map Range	Whole tones, semitones, micro, pythagorean, major scale, minor harmonic
Size of Pupil	Low Frequency of Sound	Range of Lower Frequency
Skeletonized Pattern	Melodical Sound	Y positions of Distinct Color Pixels – Frequency of Sound

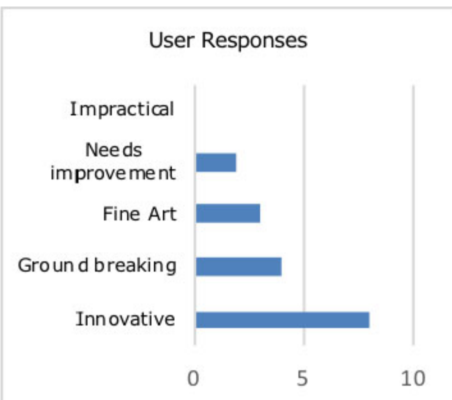

Figure 4: Responses from the user study at CSU Fullerton, May 2018

believe this project is very "innovative" and "groundbreaking" as Figure 4 shows. We also asked the users on the scale of 10 how they would rate their experience between iris image and sound, and 36% of the users answered 10 on the question.

In order to achieve the final results with the best quality of the iris images, we need a high-quality camera with macro lens. The most challenging part is to capture all the textures from the iris. This can be achieved with exposing right amount of light to the iris subject. Furthermore, it will be beneficial to have a larger number of iris data to tune the range of mapping parameters in the sound synthesis. The number of iris image we have used was not enough to accurately adjust the range of sonification in the best quality yet. We are planning to have a formal user study soon to achieve higher number of iris data in a longer period of exhibition time, which will enhance the richness of the data and improve the quality of visuals and sound and allow users to have more engaging experience.

ACKNOWLEDGMENTS

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