GazeViz 1.0: Interactive Gaze Visualization Tool

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***Abstract*— This paper introduces an interactive software tool called GazeViz 1.0 that visualizes gaze tracking data. This paper discusses other gaze visualization techniques that contextualize the contributions of GazeViz 1.0. Additionally, it describes the software design, describes the interface and presents examples of output.**

I. INTRODUCTION

This paper proposes a method to visualize gaze tracking using an interactive interface. Gaze tracking visualization can be applied to a variety of fields including art history, perception science, advertisement, media studies, and art. As gaze tracking technology becomes more advanced, it is important for researchers to think about how to visualize this data in a meaningful way. No matter how advanced gaze tracking technology is, without meaningful visualizations the data is useless. This paper would most benefit researchers who already have gaze data but are trying to visualize it. This paper does not offer any useful information about how the gaze tracking data was collected. Instead, it focuses on the gaze tracking visualization software.

II. RELATED WORKS

This paper builds off of Kurzhals, Hlawatsch, Burch, and Weiskopf's approach to visualizing gaze tracking data using Fixation-Image Charts. The Fixation-Image Chart is an interactive visualization tool that presents the gaze tracking data in a thumbnail timeline and fixation/saccade view [1].

Fig. 1. Fixation-Image Chart [1].

The thumbnail timeline in the top left of figure 1 grabs thumbnails of fixations points for different participants and places them on a timeline [1]. Although square thumbnails seem like a natural way to visualize a fixation point on an image, gaze fixation is a lot more complex. A square thumbnail suggests that gaze fixations are squares and more importantly that the gaze is as fixated on the center of the thumbnail as the edge of the thumbnail. This view is hard to read because the fixation thumbnails are spatially decontextualized from the original image. In other words, when a viewer looks at a thumbnail on the timeline they don't know where it came from on the original image. The thumbnail timeline does provide a visual color cue to indicate spatial direction between fixation thumbnails. The colored bar under each thumbnail represents each saccade, or jump between two fixation points. The saccade distance is mapped to the length of the colored bar. The saccade direction is mapped to color legend in the bottom left of figure 1 [1]. So for example, if the color of the bar is on the upper left of the color legend then the saccade direction is up-left. This isn't a very effective to visualize saccade direction because it requires the viewer to constantly be referring to the color legend.

The fixation/saccade view on the right side of the figure 1 is more effective because it is able to demonstrate the spatiotemporality of the gaze by plotting fixation points and saccades with temporal labels. It is important to note that this visualization conveys temporal data with a static graphic, which could potentially become messy with more fixation points. It is also worth noting that this method requires processing on the original data to extract these fixation points.

III. METHODS

A. Data Format

The software tool presented in this paper, Gaze Viz 1.0, assumes the user has a gaze data text file and the original image associated with the gaze data. The gaze data text file should have the width,height on the first line and then an X,Y pair on each subsequent line.

$$
\begin{aligned}
&width,\ height\\
&x_0,\ y_0\\
&x_1,\ y_1\\
&x_2,\ y_2\\
&\dots\\
&x_n,\ y_n
\end{aligned}
$$

B. Technologies

The software tool was written in Python with the PIL library for image processing and graphics and the Tkinter library for the graphical user interface.

C. Visualization Overview

This software tool uses thumbnails to plot gaze points similar to the approach described above in the Fixation-Image Chart [1]. Instead of plotting the thumbnails in a timeline, it plots them in their original spatial context. GazeViz 1.0 plots a thumbnail for each x, y data point on a black background. The visualization tool has variable thumbnail size, border size, and thumbnail zoom. GazeViz 1.0 can output a static image or animation.

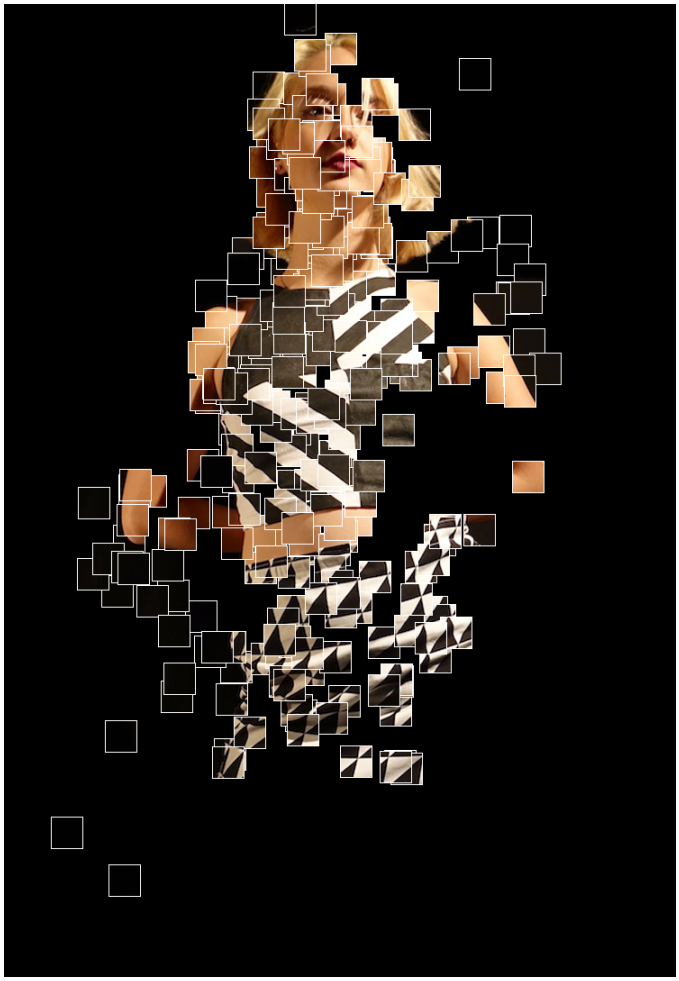

Fig. 2. Static image.

D. Algorithm

Algorithm 1 GazeViz Algorithm

procedure RENDER($data$)
  for `each xy in data` **do**
    $thumb_{src} \leftarrow image_{src}.get(xy, thumbSize_{src})$
    $thumb_{dest} \leftarrow thumb_{src}.resize(thumbSize_{dest})$
    $thumb_{dest}.border(borderSize)$
    $image_{dest}.paste(xy, thumb_{dest})$
  end for
end procedure

Where $image_{src}$ is the source image, $image_{dest}$ is the destination or visualization image, and $thumbSize_{src}$ and $thumbSize_{dest}$ are the lengths of one side of the source and destination thumbnails.

GazeViz goes through each xy data point and 3) grabs the thumbnail from the source image, 4) resizes the thumbnail, 5) adds a border to the thumbnail, and 6) pastes the thumbnail on the destination image.

The zoom factor of each thumbnail is a function of size of the source thumbnail and size of the destination thumbnail.

$$\frac{{thumbSize_{dest}}^2}{{thumbSize_{src}}^2} = zoom \tag{1}$$

Where zoom is number of pixels in destination thumbnail divided by the number of pixels in the source thumbnail. So if the source and destination thumbnail size are the same the zoom is 1. Likewise, if the source thumbnail size is half of the destination thumbnail size the zoom is 4.

The thumbnails are plotted onto a blank black image with the same dimensions of the source image. Each thumbnail is pasted on the destination image, or displayed visualization, in the original xy location it came from to maintain the spatial context.

E. Animation

GazeViz 1.0 also has the ability to export an image sequence of the entire gaze visualization to create an animation. In other words, after each thumbnail is drawn the program exports a frame. A video of the animated visualization can be found at https://www.youtube.com/watch?v=MTNr80FOChY.

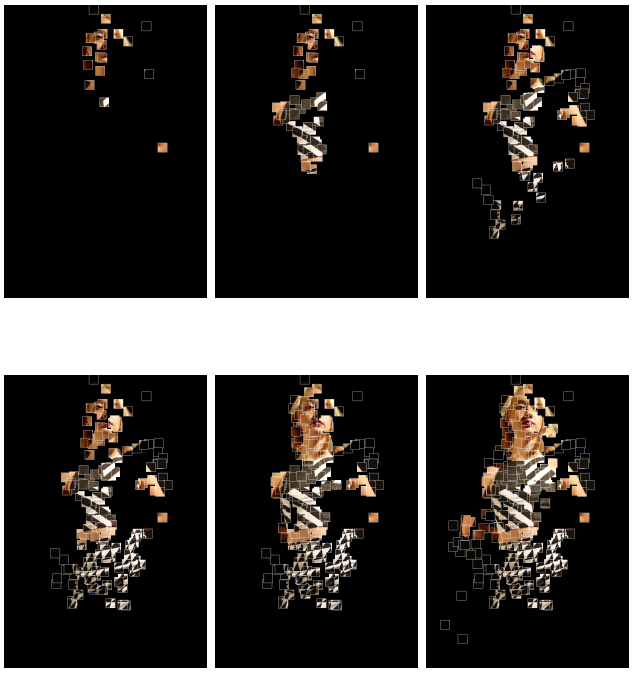

Fig. 3. Image sequence.

F. Graphical User Interface

GazeViz has an interface that allows the user to change the thumbnail size, thumbnail zoom, and border size with sliders. It has a button to save the a static image and a button to save the image sequence. The preview button allows the user to display a preview of the visualization before saving it.

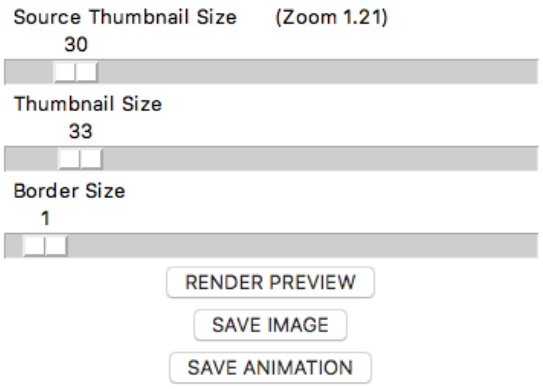

Fig. 4. Graphical User Interface.

IV. Discussion

Ultimately, GazeViz 1.0 visualizes the gaze tracking data in the most straight forward way possible: plot a thumbnail for each xy gaze point. GazeViz is not processing or transforming the raw data in any way in between loading the data and plotting it. This approach is different from the Fixation-Image Charts that extract fixation points and then plots them [1].

GazeViz 1.0, and most data visualization in general, has practical and artistic contributions. On the practical side, GazeViz provides empirical evidence of how someone visually interprets a digital image. The visualization can help researchers understand where viewers are focusing their attention in a graphic image or photograph. This might be useful in evaluating the composition of a photograph, the effectiveness of a design, or perhaps more complex cognitive evaluations. A gaze visualization not only reveals something about an image, but also reveals something about the viewer. Every viewer will have their own unique signature gaze that reveals something about how they interpret the image.

In addition to practical concerns, GazeViz 1.0 was designed to produce high quality visualizations that are interesting and artistic. The graphical interface allows the user to creatively customize the thumbnail size, border size, and thumbnail zoom. These variable parameters give the user a lot of creative freedom to produce a range of artistic visualizations that can be practically informative or artistically absurd.

Art historically, these visualizations resemble works from the 20th century Cubism movement . The visualization can be interpreted as a digital collage of body parts, which is influenced by Cubism. The thumbnail zoom causes a warped perspective that is reminiscent of Cubism. The way the thumbnails are drawn on top of each other give the illusion of 3-dimensional planes stacking on top of each other. In addition, the square geometric thumbnails are directly in dialogue with Cubism.

V. Conclusions

GazeViz 1.0 builds off of the Fixation-Image Charts [1] with new functionality that allows the user to produce high quality data visualizations and visual art. GazeViz addresses some of the problems of the Fixation-Image Charts [1] discussed above. The interactive interface gives the user freedom to customize their visualization and save it as an image or image sequence. GazeViz 1.0 is an effective and user-friendly software tool that produces artistic visualizations that empirically reveal critical insight about the image and how the viewer interprets it.

The next step is to add functionality that can filter or process the raw gaze data to draw high level insight similar to the fixation points and saccades in the Fixation-Image Charts [1]. Then functionality that lets the user choose from a variety of thumbnail shapes such as circles, triangle, and irregular polygons is going to be added to the interface. Finally, GazeViz 1.0 is going to be able to support gaze tracking visualization for video.

References

[1] Kuno Kurzhals, Marcel Hlawatsch, Michael Burch, Daniel Weiskopf, "Fixation-Image Charts", ACM, 2016.