Emotional Representation Tool Design and Development

**Design.** For our study, we designed and developed a generative art tool to represent emotions through parametric design and animation. The design of this tool draws inspiration from radial audio visualizers in consideration of the structure of biometric signals utilized in emotion modeling. Biometric signals like ECG and EDA share similarities in their basic structure with audio waveforms, further informing our decision to model our tool after radial audio visualizers [1][2].

We chose radial visuals for their aesthetic appeal and efficient space utilization [3], which aligns with our goals to represent dynamics through visual symmetry and asymmetry. We believe that these deviations from a central focal point can evoke positive or negative emotional responses [4].

Our parametric design consists of multiple radiating layers of rings. A brief description of each parameter follows.

Polygon shape defines the visualizer’s geometry, ranging from a circle to a decagon. This aligns with previous studies that discuss emotion recognition through shapes [5]. Polygon deviation and deviation speed control the distortion of the shape and animation dynamics which are intended to visually valence (symmetry) and arousal (animation intensity) dimensions of emotion [6][7]. Ring thickness and layer spacing correspond to the stroke weight and spacing of the rings within the layers.

In summary, our design establishes a framework between biometric signals and parametric design elements to represent emotions through animated visuals.

**Development.** To implement the proposed design, we used p5.js, a JavaScript library well-suited for creating interactive and dynamic visuals. Each of the multiple radiating layers of rings is represented by 360 points evenly distributed around a circle and connected by lines. The designed parameters ring thickness and layer spacing each control the thickness of the lines and the distance between each ring respectively. The implementation of polygon deviation and speed was achieved by slightly altering the position of each point in the ring, causing them to oscillate away from their original position at a defined speed. This motion creates a distorted shape, forming jagged peaks along the polygon’s sides.

To further explore the impact of visual stimuli on emotional response, we introduced a feature that allows users to modify the color scheme of the rings. This feature was included to explore whether different color schemes could have an emotional impact on viewers, potentially enhancing the emotional engagement of the visual representation [8].

To assess the tool’s effectiveness in representing emotions, we structured a two-phase experimental study. A pilot and a follow-up study, both of which are designed to assess the relationship between the tool’s design parameters and the emotional dimensions of valence and arousal.

Pilot Study: Eliciting Parameters for Emotional Representation

**Method.** The participant pool for the pilot study (53 total) was chosen to represent a broad demographic spectrum, ensuring variability in emotional perception. Most participants were within the 20-30 age group (73.6%) to maintain focus on younger adults, but the findings may have limitations in applying to other age groups. The primary aim of this pilot was to allow participants to interact with the tool and define their subjective parameters for representing the five discrete basic emotions (joy, sadness, anger, fear, and disgust), which were chosen for their well-established representation in discrete emotion theory and to maintain a manageable variety for deeper analysis [9].

The elicited parameters were then analyzed into frequency tables and probability distributions, with the latter used to generate a directed acyclic graph (DAG) for each emotion. The directed acyclic graph (DAG) allowed us to generate random samples from the elicited parameters for each emotion, ensuring a balanced representation of emotional profiles to be tested in the follow-up study.

Study: Validation of Parameters through Random Sampling and Participant Classification

**Method.** The follow-up study involved 10 participants (5 male, 5 female), all within the 20-30 age group. We also recruited participants who did not participate in the pilot study to remove potential biases. The main purpose of this follow-up study was to validate the parameters generated in the pilot study. The samples were shown through recorded GIFs of the visualizer using the randomly sampled parameters.

To avoid bias and encourage objective classification, participants were asked to assign each GIF to one of the five emotions, or the ‘none’ category if they felt no clear emotion was represented. This helped identify whether the generated visuals could be interpreted as intended. Interviews were also conducted with the participants where they discussed their assignments of the emotions to the visuals. The classifications made by the participants were then analyzed for accuracy, and thematic analysis was conducted on their responses to identify key visual features that influenced their emotional perception.

These two studies aim to both validate the emotional representation tool and investigate how the selected design parameters influence emotional perception. By comparing the pilot and follow-up studies, we seek to validate our design parameters and its relation to the dimensions of emotions.

Citations

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