Affective Generative Visuals Based on Data Input Influenced by User's Emotions

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Abstract. Generative art, a subdomain of new media art focuses on an autonomous system created by the artist. Personal data in the digital environment are becoming increasingly valuable, especially within the globalising environment which is the key development of organisations. However, the data visualisation of personal data is being consumed by global industries and not merely the data provider itself. The shift in consumption needs to be further explored to allow data providers to have emotional valuation and visualisation of their personal well-being in a digital environment. This research addresses the topic by focusing on the potential of generative visualisation based on affective data in a creative collaboration environment. Generative visualisation is necessary to study the emotion valuation process. The findings of the study identify generative visuals as an affective data visualisation method. The result is to expand the function of generative visualisation and the significance of emotions in creative collaboration based on a computer-mediated environment.

Keywords: Generative Visualisation, Affective Data, Computer-mediated Environment.

1 Introduction

This paper discussed the usage of creative collaboration theory in using generative visualisations to map out human emotions. The focus is on designing effective visualisation in representing complex emotional states. Generative visualisation is to capture complex emotions and incorporates interactive elements. Advancements and data harness accessibility and foster trust throughout the process and there is a substantial interest in applying new approaches in other sectors such as virtual healthcare systems [1]. Advanced visualisation enables the personalisation of information in real-time, evolving into a personal administrated process based on user-generated data [2]. The involvement of motion and interactivity, allows artists to create a dynamic environment that responds to real-time data.

Simultaneously increase engagement and actual representation of emotions. The key difference as compared to traditional art, the new media merges the subjective consciousness with the usage of computer-mediated environment and technology. Computer technology optimises the creation process by integrating data into the field of art

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computer, digital and non-commercial sectors [3]. Art and design should keep pace with the current time and innovate constantly. With the emergence of new media art, the form, techniques and outcomes have changed and promoted the usage of information technology [4]. From the interactivity perspective, generative art carries a new representation and interactions in designing emotionally intelligent systems [5]. The priority is ensuring that users know how to interpret the visualisation and that good visuals represent the data [6].

2 Generative Visuals as Data Representation

Art which is created by an autonomous system or process is frequently referred to as 'generative art'. Many generative artists define generative art as art randomisation, using generic systems to bring form evolution. This relates to evolving form changing over time and is created by running code on a computer system [7]. In the field of contemporary art, computer technology has expanded the capabilities and possibilities of artistic expression within the creative collaboration environment [8]. Muqarnas (2019) is a project created in the context of the fourth industrial revolution and the earliest and most impressive samples of role-based architectural design. Fifty Sisters [9] was created using computer-generated code through artificial evolution and algorithms. The visual forms are derived from graphics of oil company logos. Referenced from the seven oil companies that dominated the global industry in the 1970s. Existing generative art is divided into two methods; (1) a model that generates unsupervised and random results based on mathematical models and (2) one that involves non-photorealistic rendering (NPR). the second method focuses on a variety of expressive styles of digital art in the area of computer graphics and image processing [10].

2.1 Computer Graphics

The first algorithm-based 3D generative garment model is created in a virtual space and is collision-free to facilitate the nature of virtual try-on applications. The system generates garments based on the virtual body formation and yields a higher quality model of representation than the previous [11]. HuMoR, a learned generative 3D model of human motion that optimises recovery of human pose in 3D and RGB space. The ability of the generative model to optimise human pose from visual noise and its surroundings [12].

2.2 Real-Time Visualisation

This creative coding practice involved writing code in real-time performance that generates media such as patterns, visuals and music. The challenge faced by the artist is to find a balance in the language design, describing what the code should do. This method explores artistic visions and scientific enquiry. The improvisatory process is an essential part of collaboration not only with performative arts but also paintings [13]. MachinesMemory [14] was built based on the emotional interpretation that focuses on the potential of the narrative-structured installation. The installation allows audiences to try

and make connections between the generated images and part of the data visualisation process. The impressive collaborative effort between human-created art forms and algorithms created synesthesia, a rare condition developed when our senses melt together. A result of a neural network that turns music into trippy visualisations [15]. Exquisite Corpus, is a live performing installation by Sougwen Chung that explores the feedback loop between the human and machine body. Merging three generations of robotic collaborators in a visual projection and sound stage (Figure 1). Linking the human and non-human in terms of relational and consequential [16].

Fig. 1. Exquisite Corpus (2020) a 30-minute performance installation by Sougwen Chung exploring the collaboration between the human body and the machine.

Platforms for Generative Visualisation

Over the years, MIT Media Lab has been instrumental in the evolution of generative art and John Made, a graduate of MIT who is the former president of Rhode Island School of Design (RISD) had a major impact with his works and inventions. As a talented generative artist, his greatest contribution is the creation of a programming platform called Design by Numbers (DBN). It was further developed by Ben Fry and Casey

Read and called Processing, a free platform available to the public [17]. Processing has revolutionised data visualisation and generative art for an entire generation of artists and programmers [18]. Processing uses Java programming language and also a graphical user interface (GUI) to simplify the execution process.

TouchDesigner is known as the real-time platform for creativity and is built for artists, performers and researchers to experiment and work with generative media by using node-based systems. Node-based programming visualises the data flow through the process and experimentation is the core of this rapid-prototyping tool [19]. Joel Zimmerman who is known as Deadmau5 mentioned the potential of GPU-accelerated graphics generated in real-time and changing visuals involves only a few lines of code as compared to the usual way in post-production. This transforms the way performance is being curated and shifted according to the music and audience [20].

2.3 Sense-Making in Generative Visualisation

People's motivations are affected in subtle ways as the reasoning process derives from evidence, arguments and past memories. People generally reason their way to a conclusion that favours them based on the reasoning processes [21]. The rise of the internet has expanded the sense-making process access ranging from digital documents to user-generated content [22]. The emergence of social media has greatly exposed the sense-making produced by others, creating a dense layer of new knowledge that is instantaneous, bringing new insights into a global knowledge platform. Sense-making is becoming increasingly important so much so that behavioural and data science is being applied to predict, engage and persuade [23]. Interactive and generative techniques are common forms of installations. [24]. The challenge lies in the interaction between devices. Using a common interface and tools will help participants with previous knowledge and experiences to engage in the work. The role of the interface in generating a deeper engagement between spectator and artwork is important, especially in real-time generative processes.

2.4 2.5 Data as Artefact

Art and technology are combined in the modern visualisation technique which can be displayed on different platforms that focuses on scalability, and accessibility [25]. There are missing techniques in visualising personal data in augmented reality and mixed reality which is an interactive and fresh approach towards personal data visualisation. Animation visualisation reported more confidence in a study on user feedback by comparing large datasets in static and animated techniques [25]. There are different visualisation types ranging from line graphs, pie charts, infographic visualisation, map visualisation, colours, patterns, time-series graphs and animated visualisation [25],[26]. Four different types of techniques need to be further explored. They are data storytelling, self-service application, visual analytics and interactive or real-time presentation [27]. Data sculptures, ambient display, pixel sculpture and wearable visualisation appeared as the new physical methods of data representation based on new search areas [28]. Experiments show that interactive data visualisation can reduce the heart rate of

users during traffic jams. Interactive data visualisation is common, especially in emotion regulation products [29]. This allows users to monitor and objectively measure their stress daily and increase self-awareness in promoting emotional well-being.

Data visceralisation is a process of sense-making, seeing or experiencing the scenario is believing. This process enables audiences to gain knowledge and experience it rather than mentally envisioning what it actually looks like. Showcasing visuals such as tall buildings is common but visualising them in a virtual environment or getting a sense of realism of scale is difficult [30]. Graphical elements with simple shaders and lower polygon counts provide just a good VR experience as photorealistic graphics [31]. A study focused on the human-plant interaction process intending to change people's perception of plants and the long-term outcomes [32]. The visualisation of data involved the human ability to cope with plants' slow response and most important of all, the visceral data associated with the study. Incorporating the participants' memories and emotions attached to the plant-based interface.

2.5 Brain-Computer Interface (BCI)

The human-computer interaction increases the application of brainwave signals into smart devices and superficial interactions in the form of electroencephalograms (EEG). the device is measured using voltage through electrodes placed around the scalp of an individual [33]. Brain-Computer Interfaces are created for the purpose to help users interact with external environment based on predictions about their brain activity (Figure 2). This system consists of hardware and software which has been studied and used as a tool for people with disabilities to speak and write to voice their opinions, such as silent speech communication. [34], [35]. The BCI system established a bridge between the human brain and the outside world, interpreting their silent thoughts, assistive robots based on BCI provides support for people in their personal and professional life [36].

While BCI devices are being used to explore and understand further brain signals, there is privacy threats running in the background that extracts private data such as demographic, user identity, mental condition, emotions and interests. Compromised data can be used for targeted advertising to financial attacks [37].

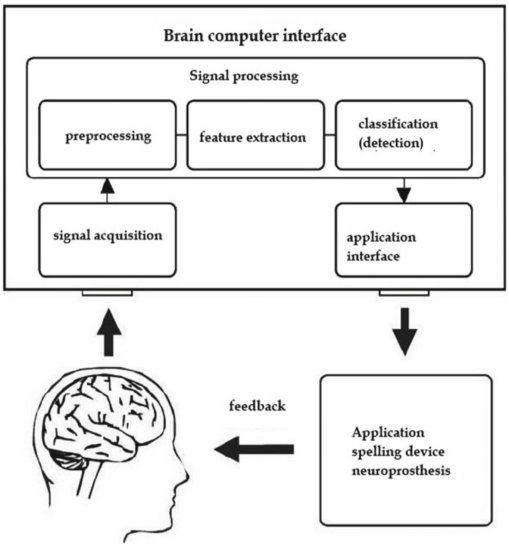

Fig. 2. Brain-computer interface (BCI) components and process flow. Signals are acquired and processed for classification purposes; The classifier output is transformed into feedback.

2.6 Brainwave Classification

Hertz (Hz), or cycles per second, is used to measure brain waves, and the higher the number, the more active or frequent the brain is. German Hans Berger developed the first method for identifying brain waves in 1924, and from 1930 to 1940, five groups were identified to label brain waves (Table 1) [38].

Table 1. Brainwave classifications.

Waves	Ranges	Mental states
Delta (δ)	< 4 Hz	Unconsciousness, deep sleep.
Theta (θ)	4Hz – 7Hz	Relaxation, intuition, creativity, remembrance, Imagination.
Alpha (α)	8Hz – 12Hz	Mental effort, sleepless relaxation, stillness, awareness.
Low Beta (β)	12Hz – 15Hz	Relaxation and focus.
Mid Beta (β)	16Hz – 20Hz	Thinking, self-consciousness.
High Beta (β)	21Hz – 30Hz	Alert, agitation, disturbance.
Gamma (γ)	30Hz – 100Hz	Motor functions and high mental activity.

The tracking and monitoring of brain activity, emotional state, pulse, and other motor processes is permitted for BCI devices. Alternatives can be classified as either non-intrusive or invasive. The intracranial electroencephalography (iEEG), which is invasive, is known to provide a better signal. However, it must be implanted inside the subject's cranium. The external divide is non-evasive, simpler to adapt, and encompasses a variety of applications for the acquisition of EEG signals.

There are two ways to deal with a fading EEG signal; the first is evoked potentials (EPs), which capture the average EEG signal based on a time period assigned to a stimulus (which could be visual, auditory, or other sensory). The second technique is known as event-related potentials (ERPs), which capture the typical EEG reaction to processing of more complex stimuli and is frequently used in cognition, cognition psychology, and related research [39].

2.7 Neuroaesthetics

The academic practice of critical neuroscience examines the social and cultural challenges posed both to the field of science and to society in general by recent advances in the behavioural and brain sciences as a reaction to the popularity of the neurosciences. It's highlighted when applied with objective and self-assurance, the understanding of materials is limited and concepts of what it means to feel human are entangled between the intersection of the art-science [40].

The association of generative and bio art with themes and techniques popular in the rapidly developing sciences exposes neuroarts to critical analysis within a broader framework of contemporary culture. The accessibility to the scientific community and generative art helps us both from a historical and contemporary perspective [41]. EmoScape is an exhibition that uses generative art to produce moving paintings by scanning brain activity to portray emotions. The equipment examines the electrical activity of the brain and extracts the waves into datasets that are mapped across algorithms built using Processing [41]. The Art of Feeling illustrates the flocking algorithm is inspired by swarms of birds or movement of the fish in the sea and the experiment focuses on 7 major emotions and is ranked based on intensity [42].

3 Creative Collaboration Framework

The research is based on the creative collaboration model [43] and participants are engaged in self-tracking using electronic devices that produce data visualisation of their emotions. Mediums such as mobile applications and fitness trackers generate personal data for the physicalization of data [44]. Within the creative collaboration study, the qualitative research approach has been widely utilised especially in the virtual objects. The qualitative approach gives a basic understanding towards the subject matter than isolating the factors in proving a hypothesis. The qualitative research method will be used to obtain the data from participants that will be used as input for the generative visualisation system and the output will be a visual representation of data. The

appropriateness of qualitative data in studying research areas that needs further exploration [45].

Qualitative fulfills the desire for contextual understanding, in studying the impact and from the origins' point of view [46]. The intrinsic-art-based research is a systematic study in the are of psychological, emotional, relational and art-based phenomena that uses both individual and collective intrinsic immersive experiences in combination with qualitative and arts-based research method [47]. Arts-based research uses artistic forms and expressions to explore, understand, represent, and even challenge human experiences [48]. One of the strength art-based research (ABR) methodology is to engage audiences in challenging [49] and authentic experiences [50].

The creative collaboration model will be used as a guideline to analyse the data obtained from the participating audience. Striving to implement the valuation of representation, meaning and emotional valuation is an important part of everyday lives. The information gathered will be used to assess the emotional valuation of the visual representation of their personal data in the creative collaboration theory.

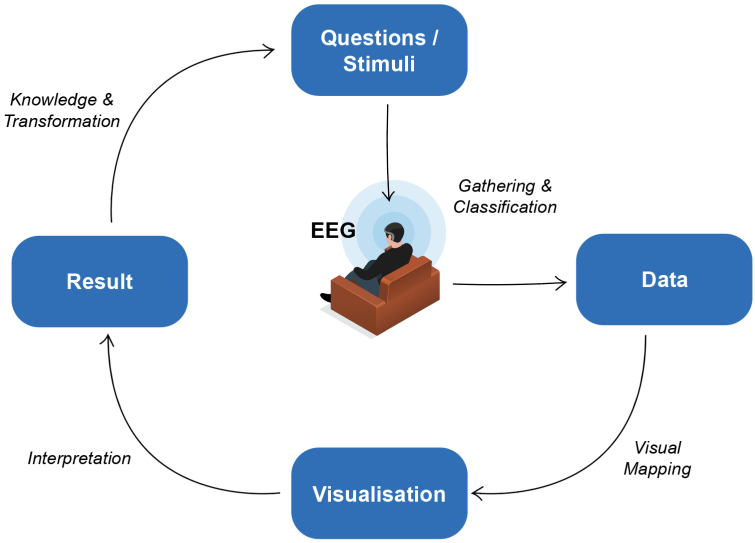

Fig. 3. Creative Collaboration framework. Raw signals are processed and classified evoked by stimuli and mapped into a real-time platform. Results are used for analysis purposes.

3.1 Development Stages

The research structure is adapted from the Creative Collaboration theory [43] and the components are Generative Visuals, Data and Computer-Mediated Environment (CME). The research will include 4 different phases which are stimuli, data classification, data visualisation and visual output (Figure 3). The development process for stimuli consists of visual and textual-based that evoke memories and emotions. The

classification of emotion in this research is anger, happiness, and sadness [51]. Data classification is the extraction process that involves an external device to obtain real-time brain waves. An electroencephalography (EEG) headband will be used to extract raw brain frequency data (Figure 4). EEG is a method to record an electrogram of the spontaneous electrical activity of the brain [52] and the raw data will be classified into Alpha, Beta, Theta, Delta and Gamma. The data visualisation process involves characteristics and parameters of particles and movement from *Hooloovoo*, *Synemania* [53] and Existence [54]. The raw EEG data is classified and processing and mapping of the data is parsed to a real-time visualisation platform. Classified data are assigned to individual parameters within the digital platform which uses node-based operators and reacts according to the information (Figure 5). The final phase brings out the affective generative visuals based on the classified emotion data. Participants will be able to analyse their generated visuals based on their emotions and enable future discussion on emotion mapping and its implications towards well-being.

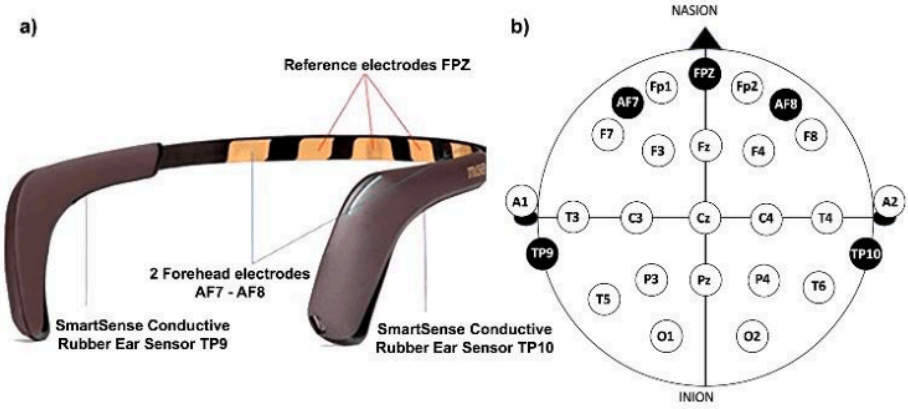

Fig. 4. a) Electroencephalography (EEG) headband sensors overview. b) Top-down view of the EEG electrode positions on the subject's head.

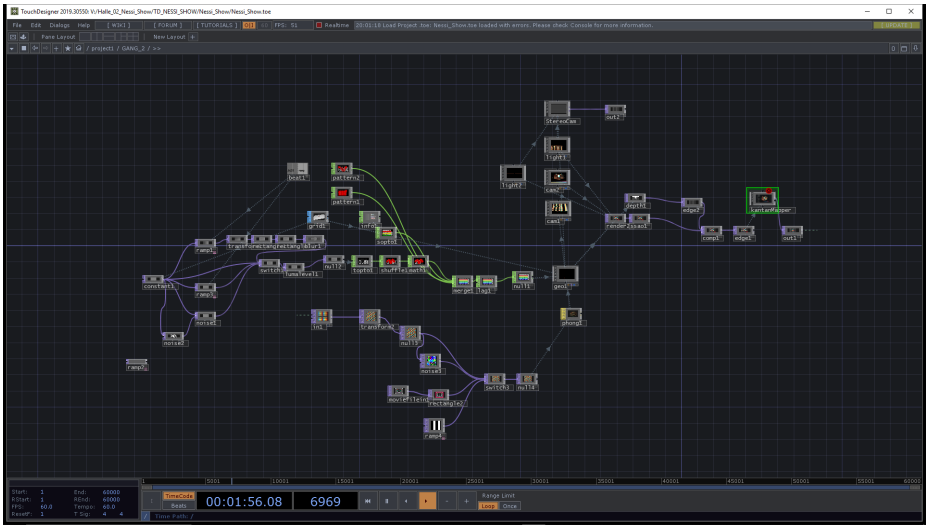

Fig. 5. A working environment of node-based operators in TouchDesigner.

4 Methods

Methods to assess the affective generative art are in two parts, self-report questionnaires and curation of real-time visuals and brainwaves. Some assessment tools are available for affective responses such as Self-Assessment Manikin (SAM) [55] and Pick A Mood (PAM) [56]. SAM method consists of three areas which are valence, arousal and dominance, each area has five pictograms. Participants are encouraged to select the blank areas between pictograms to indicate intermediate states. PAM is an instrument to assess participant's states and there are eight mood types plus neutral, excited, relaxed, cheerful, bored, calm, sad, irritated and tense. PAM's characters consist of a man, a woman and a robot and an advantage because participants can easily identify. PAM has been used to understand how to design experiences that stimulate mood and analyse the effect of visual elements on affective states [57].

4.1 Participants

20 students from the National Institute of Arts, Culture and Heritage will be participating in the study. Participants with a flat line of more than 80% are excluded from this study. The analysis was conducted with the data of successful participants. Their age is between 19 and 50 years old. All participants provided written informed consent before participating in the experiment. The result shows 9-17 interviews or 4-8 focus group discussions can reach saturation at relatively small sample sizes. Typically sample size can range from 6-20 per segment [58], [59].

4.2 Data Collection

The generative visualisation is projected on a visual resolution of 1920 x 1080 externally with a frame rate of 45-60fps. The EEG headband is fitted comfortably onto the participant's forehead and all main contact points are as reflected in Figure 6. Raw EEG data is captured using Mind Monitor and synced to TouchDesigner for classification. Generative visuals on TouchDesigner will be recorded and output in a video format.

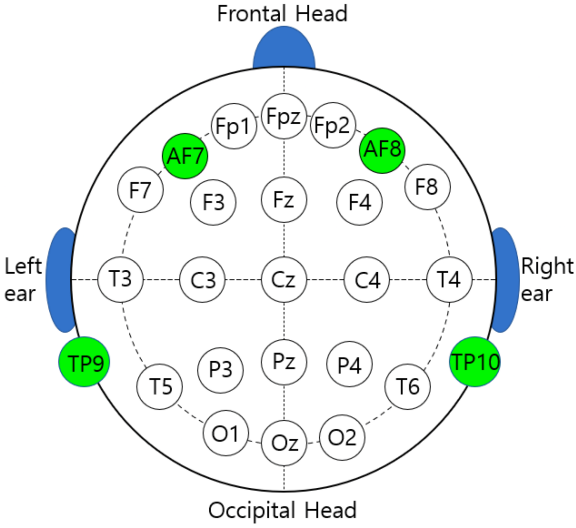

Fig. 6. EEG headband sensor positioning. AF7, AF8, TP9 and TP10 sensors will be individually measuring Gamma (above 30Hz), Beta (13-30Hz), Alpha (7-13Hz), Theta (4-7Hz) and Delta (below 4Hz).

4.3 Procedure

Participants signed the consent form upon arrival to the hall. Next, participants were fitted with the EEG headset and showed their brain signal visualisation on Mind Monitor in real-time. Participants were asked to interact with the researcher and are shown their brain signals and how it interacts with the generative art. Physical movement such as walking is encouraged in order for participants to understand how movement affects brain signals and decreases the signal quality. Before the start of the data collection process, the researcher explains to participants that they should think about how they feel while different stimuli are shown on screen.

Once the participants are ready, they are allowed to start the stimuli process on the screen. The researcher records the brain signals on Mind Monitor and on TouchDesigner. The researcher leaves the room after initiating the recording process. Participants can fully control the slides and take their time to reflect and immerse themselves in the process. Participants are advised to remain still and minimise mind wandering and there is a five-second blank space between stimuli which serves as intervals.

4.4 Results

This is an ongoing study and the expected results will be a range of generative visualisations based on emotions. The recorded brain signals and generative visuals will be analysed and the highest and lowest range visuals are recorded based on specific stimuli. The PAM questionnaires will be analysed together with the recorded visuals and data. The documented generative art is fully displayed as curation in a digital platform.

5 Conclusion and Future Works

In this paper, the objective is to open up the opportunity for generative visualisation to play a significant role in relation to emotional well-being. This allows users to visualise their emotions in real-time and as a continuous development chart which they are able to to compare real-time data visuals anonymously [60]. This study extends to improve emotional well-being by providing effective visualisation that conveys complex emotional states. Providing visual representation allows individuals to better understand, express and regulate their own emotions. The main challenge would be visually representing emotions in the most accurate and holistic way without bias. Limitations, subjectivity and individual preferences may vary significantly among individuals and might not be able to capture the full range of emotional responses. The influence of cultural context adds complexity in accommodating general visualisation. Cultural values and beliefs may not hold the same significance towards the objective of this study. This understanding contributes to improved mental health, emotional self-awareness and building resilience. Future work will be exploring the possibility of generative visualisations in providing real-time mapping for emotional well-being platforms.

References

1. Mohanta BK, Panda SS, Jena D. An Overview of Smart Contract and Use Cases in Blockchain Technology. In: 9th International Conference on Computing, Communication and Networking Technologies, 2018.
2. Hasselgren, A., Rensaa, J. A. H., Kralevska, K., Gligoroski, D., & Faxvaag, A. Blockchain for increased trust in virtual health care: proof-of-concept study. Journal of Medical Internet Research, 23(7), 2020.
3. Zheng, L. & Fan Z. Analysis of Art Form Composition of New Media Based on Computer Network Technology. Association for Computing Machinery, New York, NY, USA, 1438–1441, 2021.
4. Wu Tie. Discussion on Digital Teaching of New Media Art. Journalism and Communication, vol. 329, no. 8, pp. 45-46, 2018.
5. Moroni, A. Dezotti, C. & Manzollo, J. RABISCO, an artistic creative environment using movement as a form of self-expression. XXIII Generative Art Conference, 2020.
6. Unwin, A. Why is Data Visualization Important? What is Important in Data Visualization? 2.1. https://doi.org/10.1162/99608f92.8ae4d525, 2020.
7. Galanter, P. A Companion to Digital Art. John Wiley and Sons, 2016.

8. Li, M., Lv, J., Li, X., & Yin, J. Computer-generated abstract paintings oriented by the color composition of images. Information, 8(2), 68, 2017.
9. McCormack, J., Jon McCormack: Fifty Sisters – ACM SIGGRAPH ART SHOW ARCHIVES. [online] Digitalartarchive.siggraph.org. Available at: <https://digitalartarchive.siggraph.org/artwork/jon-mccormack-fifty-sisters/> [Accessed 21 February 2022], 2019.
10. Wu, T. Saliency-aware Generative Art. In Proceedings of the 2018 10th International Conference of Machine Learning and Computing (ICMLC 2018). Association for Computing Machinery. New York, NY, USA, 198-202. DOI: https://doi.org/10.1145/3195106.3195143, 2018.
11. Santesteban, I., Thuerey, N., Otaduy, M. A., & Casas, D. Self-Supervised Collision Handling via Generative 3D Garment Models for Virtual Try-On. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 11763-11773), 2021.
12. Rempe, D., Birdal, T., Hertzmann, A., Yang, J., Sridhar, S., & Guibas, L. J. HuMoR: 3D Human Motion Model for Robust Pose Estimation Supplementary Material, 2021.
13. Bertinetto, A. & Ruta, M. The Routledge Handbook of Philosophy and Improvisation in the Arts. Taylor & Francis, 2021.
14. D, Liu. machinesMemory: Malleability of AI technique, the data generated by machine learning algorithms. DOI: 10.14236/ewic/EVA2021.31, 2020.
15. Tangermann, V. Watch an AI turn music into a brain-melting visualization. Futurism. Retrieved March 9, 2022, from https://futurism.com/the-byte/ai-music-brain-melting, 2019.
16. Chung, S. Exquisite Corpus – Sougwen Chung (愫君). Retrieved 9 March 2022, from https://sougwen.com/project/exquisite-corpus, 2019.
17. Bailey, J. Why Love Generative Art? Artnome. https://www.artnome.com/news/2018/8/8/why-love-generative-art perspectives, 30(3), 133–40, 2018.
18. Ristimaki, S. Expanding Flutter Framework: Generative Art with Alternative Tools. Aalto University, 2021.
19. Derivative. TouchDesigner documentation. Retrieved March 31, 2023, from https://docs.derivative.ca/TouchDesigner, 2021.
20. Baltin, S. Who I am: Deadmau5 on film scoring, NIN, getting married, and quitting social media. Forbes. Retrieved March 31, 2023, from https://www.forbes.com/sites/stevebaltin/2019/01/22/who-i-am-deadmau5-on-film-scoring-nin-getting-married-and-quitting-social-media/?sh=46f04fe97565, 2019.
21. Epley, N., & Gilovich, T. The mechanics of motivated reasoning. Journal of Economic Soler-Adillon, J. (2015). The intangible material of interactive art: Agency, behaviour and emergence. Artnodes: Revista de Arte, Ciencia y Tecnología, 16, 43–52, 2016.
22. Wojtowicz, Z., Chater, N. & Loewenstein, F. The Motivational Processes of Sense-Making. Available at SSRN: https://ssrn.com/abstract=3785708 or http://dx.doi.org/10.2139/ssrn.3785708,2021.
23. Zarouali, B., Dobber, T., De Pauw, G., & de Vreese, C. Using a personality-profiling algorithm to investigate political microtargeting: assessing the persuasion effects of personality-tailored ads on social media. Communication Research, 0093650220961965, 2020.
24. Enrique, H., Mikel, A., & Josu R., (2021). Simple interfaces for interactive and generative art installations. In Proceedings of the XXI International Conference on Human Computer Interaction (Interaccion '21). Association for Computing Machinery, New York. DOI: https://doi.org/10.1145/3471391.3471417

25. Alshehhi, Y. A., Abdelrazek, M., & Bonti, A. Personal Data Visualisation on Mobile Devices: A Systematic Literature Review. arXiv preprint arXiv:2203.01374, 2022.
26. Zoss, A. (2022). LibGuides: Data Visualization: Visualization Types. Retrieved 16 March 2022, from https://guides.library.duke.edu/datavis/vis_types.
27. Bohman, S. Civic participation and empowerment through visualization. In Proceedings of SIGRAD 2015, June 1st and 2nd, Stockholm, Sweden, number 120, pages 20–23. Linköping University Electronic Press, 2015.
28. Reipschlager, P., Flemisch, T., & Dachselt, R. Personal augmented reality for information visualization on large interactive displays. arXiv preprint arXiv:2009.03237, 2020.
29. Fairclough, S. H., and Dobbins, C. Personal informatics and negative emotions during commuter driving: effects of data visualization on cardiovascular reactivity & mood. Int. J. Hum Comput. Stud. 144:102499. doi: 10.1016/j.ijhcs.2020.102499, 2020.
30. Lee, B., Brown, D., Lee, B., Hurter, C., Drucker, S., & Dwyer, T. Data visceralization: Enabling deeper understanding of data using virtual reality. IEEE Transactions on Visualization and Computer Graphics, 27(2), 1095-1105. https://arxiv.org/pdf/2009.00059.pdf, 2020.
31. Facebook Technologies. Guidelines for VR Performance Optimization. https://developer.oculus.com/documentation/native/pc/dg-performance-guidelines/ [Accessed: 2022-05-15], 2022.
32. Seow, O., Honnet, C., Perrault, S., & Ishii, H. Pudica: A Framework for Designing Augmented Human-Flora Interaction. In Augmented Humans 2022 (AHs 2022). Association for Computing Machinery, New York, NY, USA, 40-45. https://dl.acm.org/doi/abs/10.1145/3519391.3519394, 2022.
33. Bird, J. J., Ekart, A., Buckingham, C. D., & Faria, D. R. Mental emotional sentiment classification with an eeg-based brain-machine interface. In Proceedings of the International Conference on Digital Image and Signal Processing (DISP'19), 2019.
34. Nicolas-Alonso, L. F., & Gomez-Gil, J. Brain computer interfaces, a review. Sensors. https://doi.org/10.3390/s120201211, 2012.
35. Pal, D., Palit, S., Dey, A. Brain Computer Interface: A Review. In: Mitra, M., Nasipuri, M., Kanjilal, M.R. (eds) Computational Advancement in Communication, Circuits and Systems. Lecture Notes in Electrical Engineering, vol 786. Springer, Singapore. https://doi.org/10.1007/978-981-16-4035-3_3, 2022.
36. Prataksita N., Lin T., Chou H., & Kuo H. Brain robot control interface: Development and application. In: 2014 IEEE international symposium on bioelectronics and bioinformatics (ISBB). IEEE, pp 1–4, 2014.
37. Anuradha, M. & Nitesh S. SoK: Your Mind Tells a Lot About You: On the Privacy Leakage via Brainwave Devices. In Proceedings of the 15th ACM Conference on Security and Privacy in Wireless and Mobile Networks (WiSec '22). Association for Computing Machinery, New York, NY, USA, 175–187. https://doi.org/10.1145/3507657.3528541, 2014.
38. Diaz Rincon, Ricardo. Generating Music and Generative Art from Brain activity, 2021.
39. Roohi-Azizi M, Azimi L, Heysieattalab S, Aamidfar M. Changes of the brain's bioelectrical activity in cognition, consciousness, and some mental disorders. Med J Islam Repub Iran. doi: 10.14196/mjiri.31.53. PMID: 29445682; PMCID: PMC5804435, 2017.
40. Gruber, D. Toward a Critical NeuroArt for a Critical Neuroscience. Leonardo. 53. 123-127. 10.1162/leon_a_01606, 2018.
41. Grba, D. & Todorovic, V. Rendering Life: Transgressive Affinities Between Bio Art and Generative Art. Technoetic Arts a Journal of Speculative Research. 18. 235-260. 10.5281/ZENODO.4663399, 2021.

42. Mezzofiore, G. Watch your raw memories become mind-blowing abstract art. Retrieved March 31, 2023, from https://mashable.com/article/brainwaves-painting-eeg-art-memories-emotions, 2017.
43. Papatheodorou, T. & Chambers, T. The Art of Feeling. Saatchi Wellness. Retrieved March 20, 2023 from https://www.saatchiwellness.co.uk/case-study-the-art-of-feeling, 2017.
44. Alahuhta, P. Shared Artefacts and Virtual Worlds in Computer-Mediated Creative Collaboration, 2015.
45. Karyda, M., Wilde, D., & Kjaersgaard, M. Narrative Physicalisation: Supporting Interactive Engagement with Personal Data. IEEE Computer Graphics and Applications, 2020.
46. Edmondson, A., & McManus, S. Methodological fit in management field research. Academy of Management Review, 32(4), 1155–1179, 2007.
47. Van Maanen, J. Reclaiming qualitative methods for organizational re- search: A preface. Administrative Science Quarterly, 520-526, 1979.
48. Gerber, N., Bryl, K., Potvin, N., & Blank, C. A. Arts-Based Research Approaches to Studying Mechanisms of Change in the Creative Arts Therapies. Frontiers in psychology, 9, 2076. https://doi.org/10.3389/fpsyg.2018.02076, 2018.
49. Wang, Q., Coemans, S., Siegesmund, R., & Hannes, K. Arts-based Methods in Socially Engaged Research Practice: A Classification Framework. Art/Research International: A Transdisciplinary Journal, 2(2), 5–39. https://doi.org/10.18432/R26G8P, 2017.
50. Lapum, J. L. Installation: The Voyage Never Ends. In Handbook of Arts-Based Research, edited by P. Leavy, 377–395. New York, NY: Guildford Press, 2017.
51. Morris, J. and Paris, L. Rethinking arts-based research methods in education: enhanced participant engagement processes to increase research credibility and knowledge translation, International Journal of Research & Method in Education, DOI: 10.1080/1743727X.2021.1926971, 2021.
52. Gu, S., Wang, F., Patel, P., Bourgeois, A. & Huang, H,. A Model for Basic Emotions Using Observations of Behavior in Drosophila. Front. Psychol. 10:781. doi: 10.3389/fpsyg.2019.00781, 2019.
53. Puthankattil, Subha, D. & Joseph, Paul & Acharya, U Rajendra & Lim, Choo. EEG signal analysis: a survey. Journal of medical systems. 34. 195-212. 10.1007/s10916-008-9231-z, 2010.
54. Krcadinac, U., Jovanovic, J., Devedzic, V., & Pasquier, P., Textual Affect Communication and Evocation Using Abstract Generative Visuals. IEEE Transactions on Human-Machine Systems. 46. 10.1109/THMS.2015.2504081, 2015.
55. Amodou, L., Program: Existence. LPM Live Performers Meeting. https://liveperformersmeeting.net/editions/2022-rome/program/detail/existence/, 2022.
56. Lang, P. J., Bradley, M. M., & Cuthbert, B. International Affective Picture System (IAPS): Affective Rating of Pictures and Instruction Manual. FL: University of Florida. Technical Report A-8, 2008.
57. Desmet, P. M. A., Romero, N., & Vastenburg, M. H. Mood Measurement with Pick-A-Mood: Review of Current Methods and Design of a Pictorial Self- Report Scale. Jdr 14 (3), 241. doi:10.1504/JDR.2016.07975110.1504/ jdr.2016.10000563Vastenburg, 2016.
58. Pinilla A, Garcia J, Raffe W, Voigt-Antons J-N, Spang RP & Möller S. Affective Visualization in Virtual Reality: An Integrative Review. Front. Virtual Real. 2:630731. doi: 10.3389/frvir.2021.630731, 2021.
59. Hennink, M. & Kaiser, B. Sample sizes for saturation in qualitative research: A systematic review of empirical tests. Social Science & Medicine, Volume 292, 14523. ISSN 0277-9536. https://doi.org/10.1016/j.socscimed.2021.114523. 2022.

60. InterQ. How to Justify Sample Size in Qualitative Research [web log]. Retrieved June 15, 2023, from https://interq-research.com/how-to-justify-sample-size-in-qualitative-research/. 2023.
61. Achlioptas, P., Ovsjanikov, M., Haydarov, K., Elhoseiny, M., & Guibas, L. J. Artemis: Affective language for visual art. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 11569-11579). 2021.