Gestures – Emotions Interaction: e-Viographima application for visual artistic synthesis

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ABSTRACT

This study aims at developing an application, called "E-Viographima", for real time artistic synthesis that utilises low-cost human-computer interaction devices. The diverse possibilities of artistic expression are approached through variations of visual stimuli whose parameters are altered according to motion captured data recorded while the users wag their hands, together with concurrent emotional states derived from the users' brain activity. The hands' movements are recorded by a motion capture system (Leap Motion) and four different emotional states are identified through electroencephalography signals (EEG) recorded by a brain signal detection headset (Emotiv Epoc). The primary scope of this project is to produce in real time a visualised output in the form of an interactive line that results in the creation of a synthesis out of contoured forms made by the automated and semi-automated elements.

Author Keywords

Artistic application; Human-computer Interaction; Brain Computer Interaction; Emotional states; Visual synthesis.

ACM Classification Keywords

J.5.2 Arts and Humanities: Arts, fine and performing
H.5.m Information Interfaces and Presentation: Miscellaneous

INTRODUCTION

The line, as an element of drawing and painting, is one of the structural principles of Visual Art. Actually, it consists of consecutive points on a plane and it can be the trace of a moving point [15]. The line itself, but also its manifestations (e.g. curves), can constitute a number of expressive tools. In this study, an attempt to convey the idea of line as an expression tool into a virtual world, by giving to it a rather "alive" and volatile character, is presented. In addition, alternative ways of interaction between human and

computers, in order to achieve the active participation of the humans in the visual output, constantly changing based on their emotions and reactions, is studied.

We are wondering about the resonance of sensory acquaintance with the image, when it is formed by lines, and how the cognitive perception of various visual art's elements is formed. Based on the Model Human Processor (MHP) [3], a human receives stimuli through sensory organs, it processes them, compares results to information stored in sensory memory and reacts through emotional or sensorimotor responses. On the other hand, the computer receives data, encodes, processes them and produces output with visual information. The user receives them in the form of stimuli. In interactive systems, the users can get valuable information through continuous feedback that they can further process in order to improve their tactics to gain specific goals. The model of user-system interaction by Norman, based on MHP, considers a sequentially repetitive cycle of user's actions until achieving the final target [22]. The cooperation of these two different systems (the computer and the user) was until recently achieved using conventional means of interaction, such as a mouse and a keyboard. Today, by dint of innovative techniques and devices, such as mobile low-cost EEG headsets and gesture recognition devices, human-computer interaction in now feasible with emotional states and gestures. In the case of "e-Viographima", the usage of such types of inputting results into giving "life" to a line in the virtual space.

RELATED WORK

The use of interactive technology in artistic applications and performances has increased dramatically during the past decade. Lately, more and more developers and computer artists utilize the virtual space and design expressive forms of experiences due to the apparition of accessible and affordable devices.

A line can be used to visualize different types of data, such as physiological signals (e.g. heart rate, brain signals etc.). The use of line as visual element has been analysed [15, 16, 14] and incorporated in their visual synthesis by a plethora of artists (e.g. Kadinsky, Paul Klee, Kontos D., Jeremy Woods). An example of artistic expression using the line is the "Action Painting", also referred to as "Gestural Abstraction" [10]. Osvaldo Cavandoli created a series of narrations "La linea" [7] that were recorded in a video with

interactive capabilities and uploaded on YouTube in 2008. Hervé Huitric and Monique Nahas, pioneers of Computer Art, started from 1970 creating figurative 2D drawings and developing 3D realistic techniques. In their first two-dimensional digital plans (1979-1981) they experimented in creating lines and curves, especially with B-splime curves [13]. The form of the line has also been situated at most of the first interactive artworks such as the "Le plume" [2], where the user could interact by blowing on an image of feathers created by lines.

With the evolution of technology, many modern artworks slowly are increasingly spread in space and integrate the public. In the case of interactive artworks, the public intervenes in the actual work depending on the scenario of interaction. It is common that many interaction scenarios are designed to be carried out by multiple individuals simultaneously. In modern art installations, the visitors are often invited to interact, using their body, as in the interactive installation of Scott Snibbe, "Boundary Functions" [25]. In the case of interactive environments allowing the free-flowing collective action of users, a common atmosphere is created, wherein a shared behavior is leading to emergent phenomena and new unforeseen structures [4]. In the interactive installation "Quorum Sensing" [5], a kind of communication is established between the virtual and the real world, where visitors can interact with multiple body movements, from simple gestures to ritual dances, on an interactive carpet containing sensors.

The philosopher Jean-Luc Nancy [20] argues that all philosophical considerations agree that in art there was always a question of gesture**.** For Nancy, the gesture is "*a movement or the outlining of a form*" and "*is a sensible dynamism that precedes, accompanies or successes meaning or signification*". Nowadays, performers are using technology to create multisensory experiences for the audience using new interaction tools. Brain Computer interfaces have entered the palette of expressive interaction tools used by artists and developers of virtual experiences [17] and performances; some indicative examples are the interactive musical interface «On being invisible II» [23] by Rosenboom**,** Mariko Mori's 'Wave UFO' [19] where participants are manipulating audiovisual elements, Luciana Haill's performance [12] in which images and sounds were created using EEG detection devices, Marina Abramovic's to "The Magic of the Mutual Gaze" [1] in collaboration with the neuroscientist Suzanne Dikker [9], the "Eunoia" project by Lisa Park [8] where EEG data are translating into sounds using the Neurosky MindWave headset [21] and the "Brainwarm" [11] by Leontios Hadjileontiadis, a music performance composition system based on hand gestures and EEG data. More and more artists are expected to engage into using Brain - Computer Interfaces (BCIs), as besides using them for communication and control, monitoring the user's affective or cognitive state can evolve into a powerful tool for artistic expression.

E-VIOGRAPHIMA: THE INTERACTIVE LINE

The basic approach followed was driven by the visual series "Viographima"(http://ifigeneiamavr.tumblr.com/biographics) that were presented in relative exhibitions. The potential of utilising the concept of "Viographima" in the interactive e-Viographima application was explored, in the context of developing an expressive structure representing emotional states in real time. In the framework of the aforementioned application, an individual can interact through an expressive interface, thus manipulating the basic visual elements, into creating forms, shapes and figures in the virtual world, which accrues during a perpetual cycle of action – reaction (Figure 1).
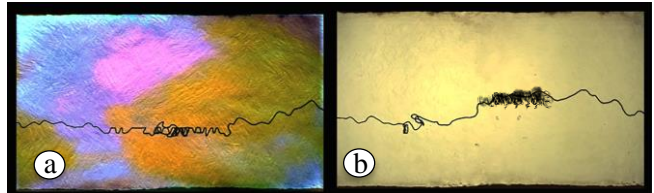

Figure 1. Screenshots (a, b) from the application

Apparatus

At this point, the equipment used by the interactively participating users and the technical framework followed to design the virtual space of the application are described.

Peripheral devices – Through various experiments, the appropriate equipment were selected for the application, in order to inspire the direct and creative interacting engagement of the user. For this purpose, the input devices Leap Motion Controller (LMC), for the tracking of hands' movements, as well as the Emotiv Epoc (EE) headset, for the recording of the EEG brainwaves responses, were selected (Figure 2). For the visual output, a standard monitor of 15 inches was used.

Figure 2. Peripheral devices used: Emotiv Epoc headset (right) and Leap motion controller (left).

The range of interaction space supported by the LMC device (https://www.leapmotion.com/) is 0.22 m^3, offering a maximum 60cm height of its cameras' viewing range with an angle of approximately 150 degrees [6]. The device came with the Leap Motion Software 2.3.1+31549 version. For the regulation of behavior and performance diagnostics, the Leap Motion Control Panel was used.

EE is a headset consisting of seven pairs of dry non-invasive electrodes, i.e. 14 electrodes in total (http://emotiv.com/epoc.php). The EEG signals from each electrode are transmitted via Bluetooth. This way, the headset's mobile structure provides an untethered interaction option. The EE headset comes with the EPOC

Control Panel software for managing the device characteristics. With the support of this software product, the following configurations of detection suites are provided:

- *Affectiv* (Performance Metrics) for four basic emotional states Excitement, Boredom / Engagement, Frustration (Anger) and Meditation,
- *Expressiv (Facial Expressions),* such as blinking and winking,
- *Cognitiv (Mental Commands)* that require training.

The EmoKey application built in the EPOC Control Panel was utilised to match the detection results as conditions that can be set up to trigger events. These events are then identified by the application as predefined keystrokes.

Designing the VE – For the design and development of the e-Viographima application, the game engine Unity3D running on Windows 7 operating system and the object-oriented programming language C# were selected. The Unity3D is an independent cross-platform game engine [26] that is widely used for the development of video games and applications.

The key design goal was to create a seemingly two-dimensional virtual line, which oscillates and behaves in a way that approximates the natural behavior of a cord receiving impulses at various points. For this purpose, forces such as gravity and collisions were taken into account by utilising the physic engines built in Unity3D, which provide simulation of physical laws and behavior (physical simulation).

The creation of a line responsive to emotional states and gestures, with whom the user can interact in a virtual seemingly two-dimensional space was intended. For this reason, the line's main desired characteristics were to:

- resemble realistic (ink traces) and flexible without losing its structure and cohesion,
- remain at the same level (two-dimensional approach)

User's state data	Keystrokes	Actions
Excitement (> 0.20)	R	Creation of animated elements; in the center of the curvatures of the fingers.
+/- Frustration	Y / U	Increase / decrease the magnetic force of the fingers by 10 units
+/- Meditation	I / O	Increase / decrease the magnetic radius of the fingers of 10 units
Blinking	Space	Restore the system to its original state; starting point
Engagement / boredom	W	Affect colors parameters (dynamic)
Frustration (> 0.55)	T	Cause displacement in different points of the line

Table 1. The predefined rules and conditions

Functional outline – As interaction input, the emotional states "Frustration", "Meditation", "Excitement" and "Engagement/Boredom", as well as the facial expression "Blinking" were chosen. Thereby, training and calibration activities were not required prior to launching the application.

In the EmoKey mapping created for the application, a subset of rules that correspond to the detection of the aforementioned emotional states and facial expressions, along with the corresponding keystroke commands, was composed (Table 1). During runtime, the user is able to watch the effect of her actions on the transformation of the visual output and re-affect it within a process of continuous feedback (Figure 3).
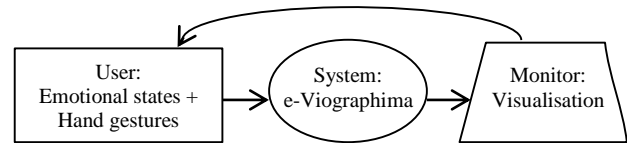

Figure 3. Proposed solution for the affective interaction

INTERACTION MECHANISMS
In the implementation process, the development of the virtual environment(VE) takes place, hosting the basic visual elements regarding the background canvas, as well as the creation of the oscillating line. Furthermore, the design of interaction between the user's physical hands and their 3D counterparts in the VE, as well as the affective interaction layout used, will be described.

Canvas – A constant level in the VE, on which the final outcome of the interaction activity would be shown, was created. This digital constant level looks like a canvas on whose surface/space the interactive line is placed. In the VE, a virtual camera is adapted to the viewing angle of the user, which is fixed above the canvas. That way, users can continuously monitor their activity taking place in the VE, thus observing the results of their actions. The background environment in the application was created with reference to the video entitled «Notebook», from the series «Viographima» (https://vimeo.com/128010310).

Oscillating line – The primary objective was to create a three-dimensional line, which could oscillate and react to collisions. To simulate the interactive line with Unity 3D, the *Line renderer* component was utilized, on which physics were applied. That way, the line was divided into individual interdependent parts, connected with joints. By moving one part of the line, the forces created the movement could be conveyed concurrently on their neighboring line parts, thus causing the movement of the overall line. Having a smooth flexible moving across all the parts of the virtual line, one can use it to design various schemes from a simple straight line to composite line forms.

User's virtual hands – In order to stimulate movement on the virtual line according to the user's physical hands' movement, their 3D counterparts were created and were placed in the VE. The objective was to affect the virtual line by forces of the virtual hands whose movements would correspond to the user's hands. During runtime, virtual hands

are generated in the VE in accordance to the placement of the user's hands over the LMC device (see figures 6&7).
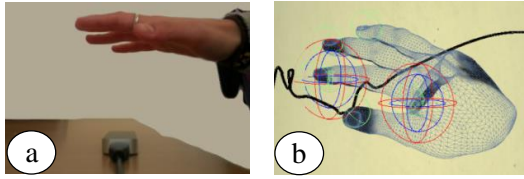

Figure 6. Real hand's (a) and virtual hand's (b) position when touching the virtual line
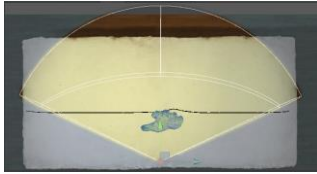

Figure 7. Virtual hands' interaction space

Animated designs – Ten series of two-dimensional imagery figurative designs were created, with each series consisting of nine different snapshots. Four of the ten series are shown in figure 8. By giving the command to display them in the scene, a series is randomly selected and its highlights/frames begin to appear one after the other at a pace appropriate to create a sense of animation (see figures 1b & 9). Their appearance is made under certain conditions; a) when the line embraces the virtual fingers - the line segments are forming a curve around them, and b) when the appearance of designs is commanded (e.g. the first predefined rule in table 1).
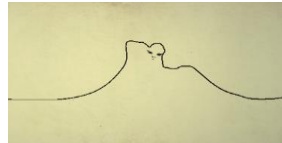

Figure 8. Series of figurative designs

Figure 9. Design appearing during play-mode

Affective interaction layout – The synthesis of visual elements constructed on the canvas is the result of the coordination between the user's hand gestures and her current emotional state. However, the way we feel is usually susceptible to external stimuli [18], with regard to e.g. affective images, faces and sounds. In this paradigm, the user is constantly watching the monitor while interacting with the system. In other words, we can presume that the visual outcome on the monitor is also the ephemeral and local manifestation of affective feedback.

The interactive line plays the role of the taut string which reflects the vibrations sustained by the coordination of the aforementioned user's actions. At the beginning of the application the line is straight and stable (neutral state). By waving her hands, the user can slowly affect the line's behavior into a flexible, oscillating line which gets easily manipulated by her hands and also by her emotional states (explicit interacting state). During the interaction with the application, the constantly evolving visual output (due to e.g. the apparition of the animated designs in conjunction with the line movements) can fuel the user's contingent additional emotional stimulation, which is read and reciprocated in the form of visual stimulus (implicit interacting state), as shown in figure 3. The user can gradually learn how her emotional states are manifested in the application, assisting in their conscious monitoring and regulation.

DISCUSSION
The basic idea underlying this work is the exploration of the usage of different emotional states' detection, together with the hands' movement tracking as alternative real-time interaction techniques. Thus, the possibilities of a creative-expressive interaction are examined in which the user does not simply perform specific commands or suggestions. The user additionally explores, understands and even tries to control her emotional states through the interface that has been developed in the framework of the application "e-Viographima". The visual output was intended to reflect the emotional state of the user, based on the author's personal artistic interpretation, but also to trigger visual stimuli indented to alternate the user's affective state.

Since a user study was not conducted, we have concluded the systems limitations based on our observations. In some cases, a delay with impacts to user-system communication can be caused when the contractility of the sensors is low or the user moves her hand outside the tracking range. Another suspected limitation is that the level of difficulty in controlling the system with emotional states increases over time, as the user may face inconveniently rapid changes in the visual output, as a result of the explicit and implicit interacting circle.

Overall, the use of low-cost interaction devices has proved as a promising way to interact and encourage us to expand our efforts to more complex interaction scenarios and exploration of human responses to stimuli, beyond the visual. Therefore, we plan to explore the impact of VE in terms of visual elements in shaping the emotional state. Additionally, physiological signals, such as heart pulse and galvanic skin conductance could be utilised. A future attempt to enhance this exploratory study could be achieved in collaboration with scientists from other disciplines (e.g. psychologists, neuroscientists). Therefore, specialized knowledge from different domains could be contributed in providing insights for new applications.

Nowadays, a variety of technological tools ranging from virtual reality and gaming are used in applications beyond entertainment; such a paradigm of «Επιλογή (epilogi) in crisis» [24]. Moreover, similar tools are increasingly proposed for training and simulation purposes. As a result, it is expected that the new connection between BCI and VEs will be able to open new application areas.

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