AffecTech- an affect-aware interactive AV Artwork

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New developments in real-time computing and body-worn sensor technology allow us to explore not just visible gestures using inertial sensors, but also invisible changes in an individual's physiological state using bio-sensors (Kim & André 2008). This creates an opportunity for a more intimate interaction between the observer and technology-based art (Gonsalves 2008). We present a technical overview of the AffecTech system; a bio-signal based interactive audio-visual installation commissioned as part of the pre-ISEA symposium in November 2008. Observers were invited to sit on one of 2 sensor-enhanced chairs (Coghlan & Knapp 2008), which transmitted physiological data about the occupant to a central control system. This data was used to control and modulate interactive visuals, live video feeds and a surround sound score, with events and interactions dependent on the observers' affective/emotional state and the disparity or similarity between the bio-signals of the chairs occupants. This technical overview is followed by an examination of the outcomes of the project, from both the artistic and technical viewpoints, with recommendations for modification in future implementations.

Introduction

Works such as the bio-aware jewellery of 'Medulla Intimata' (Gonsalves, Donaldson 2004) have sought to bridge the gap between the aesthetically pleasing and the raw inner world of the wearer but we are only recently seeing the emergence of works that attempt to interact with and react to the viewers emotional state (Chameleon, Gonsalves 2009). We are still far from establishing universal templates for interactive aesthetics but with every work that embraces affective sensing or every engineer that applies their research to the creative arts we come closer.

Recent years have seen the boundaries between art and science become amorphous, with technologies that would have been inaccessible due to cost or complexity come within the reach of the 'average' computer literate artist. Low cost sensor data acquisition systems such as the Arduino microcontroller[1] with active user communities and an open source, copy and paste collaborative ethic allow artists to incorporate elements of sensory/environmental awareness into their work (Blast Theory 2009). At the same time some practitioners have embraced 'virtual reality' technologies to embody the viewer in their works in an attempt to immerse the viewer in a world/universe of their creation, arguably a goal of many creators throughout history. Most of

[1] www.arduino.cc. Accessed 16/06/09.

these virtual reality technologies have concerned themselves with external sensing or representation of the viewer and it is only through the addition of physiological sensing that we may incorporate the viewers' internal as well as external state.

With AffecTech we hoped to create a work that would respond to the internal affective or emotional state of the viewers and would in turn have the ability to trigger a corresponding or at times conflicting response in the viewers. We sought to play with the boundaries of the relationships between the installation space, the viewers and the artwork using external sensing (camera), physiological sensing (pressure, galvanic skin response), interactive visuals and immersive sound. In development of the AffecTech system we used a biological analogy, the sensors as its eyes/ears/skin, the audiovisual system as its face/mouth, and the decision-making systems its 'brain'.

The Experience

As a visitor of AffeTech, you sit on one of the two empty chairs in front of the projection screen. The chair senses your presence and gives the instruction to turn the system ON. The brightness of the projection and the overall audio level increases. Also, an avatar fades in on screen, which displays an image sequence of you (figure 2). You place one hand on the electrodes attached to the chair and your avatar changes colour according to your cortical arousal level, as measured by the chair's sensor. If there is any sudden change in your signal (e.g. after taking a deep breath or being startled), your avatar makes a rapid movement accompanied by a breathing sound. If there is another participant in the other chair, both avatars are displayed on screen and the virtual distance between them varies according to the correlation of both signals (figure 2). In the case when the signals of both chairs are entrained, both avatars merge into a synchronous movement accompanied by a harmonic sound. The video and soundscape material reproduced are selected according to the average arousal level of both participants. Once you have finished experiencing the installation, the system goes back to the OFF mode automatically upon rising from the chairs.

Figure 2. An image loaded inside a visitor's avatar (left) and two users with their avatars on screen (right).

Interaction

The system for AffecTech is based on a two way interaction model as can be seen in figure 3. The installation's audiovisual outputs are through a projection screen and a four-speaker surround system. The system was awoken from its default stand-by state upon activation of the pressure sensors (Force Sensing Resistors - FSRs) mounted in the seat of each chair. The system represents in real-time the Galvanic Skin Response (GSR) of each chairs occupant, measured as changes in skin surface resistance (sweating), known to be linked to the level of cortical arousal in a subject (Lang, 1995). This is visualized using Avatars which change their colour according to the GSR of the participant, and the virtual distance from each other depending on the similarity or difference of the signals of both participants. On a second level, the selection of visual and audio material played back is calculated on the participant's level of arousal. This works with three banks of material, selected for low, mid or high excitement. On a third level, the AffecTech system 'pokes' the participants if there has not been any significant change in their signals after a certain period of time. In order to do this, the system plays specific stimulating video and audio material to produce a response in the participants (e.g. lighting, white noise, etc.).

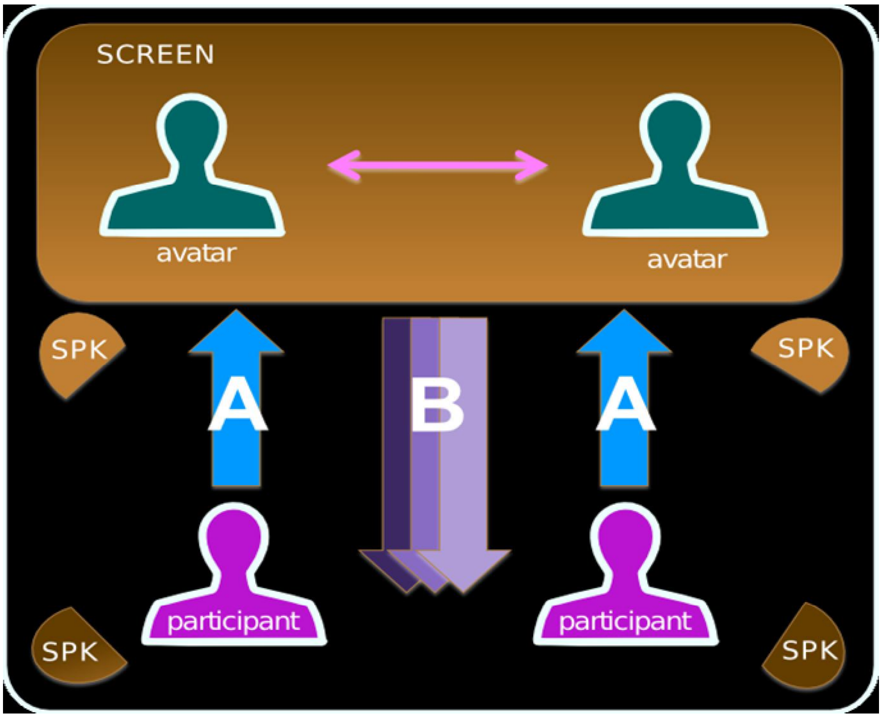

Figure 3. Interaction Model for AffecTech. The participant feeds the system (A), which analyses the signal and reacts through real-time representation (B.1) of the signal, selection of audio and visual content (B.2), or an audiovisual stimulus (B.3) in order to generate a reaction in the participant.

The Central Control System

A Central Control System (CCS) was implemented in Max/MSP[2]. Its purpose was to coordinate the interactions between the users and the AffecTech system. In doing so it received data from the sensors, categorized the arousal level of the chairs occupants, identified significant changes in state and output control messages, which triggered audio playback, flash animations and camera operations (figure 4).

Based on data from the pressure sensors, the CCS detected the number of chairs that were occupied (zero, one or two). This allowed for either one or two person interactions and ensured certain audio / video excerpts were not triggered once the system was already activated. Taking data input from the GSR sensors, control changes were sent to the audio system and synchronously relayed to Flash to trigger occurrences of 'background', 'entrained', 'sudden' and 'system-poke' audio / video excerpts (discussed below) meant to represent and / or provoke arousal in the participants.

Three levels of participant arousal were determined ranging from low to high. Such levels were established based on simple rules regarding how the data from the sensors changed in the short, medium and long term. Since GSR readings can vary significantly from one participant to another, where possible, the control system was designed to change the criteria on which these rules were based in order to more accurately reflect the arousal levels of the user group throughout the course of the installation.

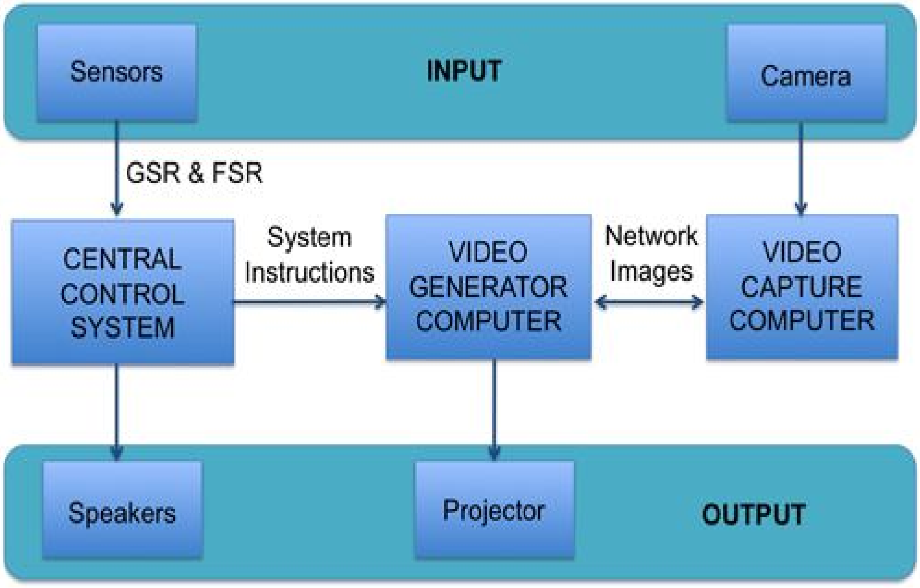

Figure 4: Signal flow diagram for AffecTech

Visuals

The visual content in AffecTech, consisted of two main elements that covered abstract and concrete imagery. On one hand it displayed an interactive set of movies displayed using a Macromedia Flash[3] movie, which was controlled by Max/MSP using flashserver[4]. The patch

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2 www.cycling74.com. Accessed 16/06/09.

3 www.adobe.com/products/flash. Accessed 16/06/09

controlled the video parameters (avatars, movies, etc) based on the instructions received from the central control system.

For the concrete content, a camera was set up just below the screen to record both participants. The image was then split, zoomed and cropped in order to have two images, one for each chair. Each frame was then saved as a jpeg image to an external computer through the network to be used as part of the composite video content on the screen. This was displayed inside the avatar after a new participant would sit on the chair, for a short duration of time.

By using real video within the flash images, we established a link between the user and the avatars. The avatars represent them and their perception shifts from an external view (mirror) to an internal one, the changing colours controlled by the GSR signal. The simultaneity of said contents meant that this shift of perception was not linear or time based but interactive and individual to each participant.

Audio

All sounds were sourced from the Freesound Project[5]. A compositional approach was taken to the audio aspect of the installation. Our priority was to create an enjoyable sonic experience for the users whilst not compromising the integrity of the artistic concept. As such, sounds were sculpted to create a sense of continuity and fluidity whilst repetitive or 'static' sounds were avoided where possible. This was achieved by creating a large pool of relatively long sounds which were themselves dynamic in their changing timbres and amplitudes. The categories of sounds used are outlined below.

Welcome sounds: These sounds were triggered by the CCS when the system first became active, i.e. when the first user sat down. They were chosen to represent the system 'coming to life' and were not further used during each participant's session.

Background sounds: Three categories of background sounds were chosen to reflect the three levels of arousal categorized by the CCS. Dark, brooding and intense sounds were mapped to low levels of arousal. 'Neutral' sounds were mapped to medium levels of arousal and bright or colourful sounds were mapped to high levels of arousal.

Sudden sounds: These were chosen to reflect sudden changes in the arousal levels of the participants (as decided by the CCS). Bodily sounds, i.e. fast respiration or heartbeats were heard, representing physiological shock.

Entrained sounds: The sound of angelic choirs, Tibetan throat chanting and deep meditative drones could be heard when the participants' arousal levels were 'in tune' or entrained with each other.

System-poke sounds: These were used to provoke physiological reactions when the CCS detected inactivity or non-responsiveness in the users. Harsh drilling sounds or loud sirens were used in this situation.

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4 www.nullmedium.de/dev/flashserver. Accessed 16/06/09.

5 www.freesound.org. Accessed 16/06/09.

Conclusions

AffecTech was developed with the intention of creating an empathic dialogue between the participants and the work, and was designed to respond to changes in state as well as synchronicities in state. The 3 determined states of arousal (low, medium, high) are notional in nature and cannot be considered a true indicator of affect. Nevertheless the system was capable of sensing change, direction of change and lack of change, and could respond to these states with appropriate content, some of which was intended to trigger a change of state. Despite these predefined responses we were surprised by the complex behaviour of the installation in practice, without noticeably repetitive patterns and longer than expected periods of user interaction. We believe this is testimony to the intrinsic richness and complexity of working with physiological data.

Another unexpected (though welcomed) outcome of the extended periods of user interaction was our observation of entrainment between users. During these longer sessions (usually around the 10 minute mark) there appeared to be a tendency for the physiological states of participants to synchronise. We feel this could be a very interesting avenue of exploration for subsequent versions of the work.

While the *user → system* aspects of the installation worked well, we were less happy with the *content → user* feedback. The 'poke' stimuli did not have as great an effect on the viewers' physiology as we had hoped and we would recommend using stronger psychological stimuli. This does of course impact on the suitability of the work for a general audience which must be taken into consideration.

In order to make AffecTech capable of emotion or affect sensing, the system would require more channels of sensor data, so that they can be cross-referenced (Russell, 1980) and in future versions we would recommend the addition of Heart Rate and Respiration sensors.

We intend to continue our experimentation with physiologically based art and engineering and look forward to feedback from our readers and participants.

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