AffectiveWall
An intermedia instrument for affective generation of music and paintings through gestural expressivity

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Abstract—In this work we present AffectiveWall, an intermedia instrument that connects music and painting through emotions/affective states expressed by a performer’s body-language. This gestural expression happens on a wall/canvas (a multi-touch interface) that analysis features of gestures performed on the surface, feeding an “affective eco-system” that decides the affective states expressed and composes music and abstract paintings projected on the wall in real-time according to them. Therefore, artistic creation is based on two universal languages – corporal and emotional – enabling the free expression of people regardless their background (artistic or not), in an instrument with a minimal learning curve, in order to bring Art closer to people. We reviewed the state-of-art of artistic trends and technologies related to AffectiveWall, and the classification of affective states, after all, the main interface between music and painting, and between users and system. We defined an aesthetic/artistic approach to an “affective model for gestural expressivity” by evaluating performers expressing themselves on a wall to find gestural patterns. Thus, we present an architecture and implementation, evaluating the recognition by spectators of expressions using the system. We found that our “augmented affective states” as output (a multimodal stimuli composed by sounds, visuals and physical movements) are universal and can help an audience to better perceive the affective expression if the person performs a focused and intimate interaction with AffectiveWall. We also concluded that, in this kind of interfaces for affective expression, joy is the easiest recognizable affective state and arousal the most perceived feature of interaction.

Keywords-affective interface, gestural expressivity, augmented affective states, music and painting

I. INTRODUCTION

This According to Collingwood, Art is the expression of emotions in a given language [1]. And if body language can be a universal way to communicate, a system that uses affective expression through gestures as its interface emerges as a way of bringing Art closer to people, facilitating the process of communicating emotions to an audience. In addition, if one of the most effective tools for creativity is multidisciplinarity, then using emotions to connect two different types of media can be a drive for a fully connected and intuitive intermedia instrument for live performances. As such, we chose “Another Thrill in the Wall” as the leitmotif for the present work, in which the word “thrill” refers to the physical manifestation of an emotion through the whole body.

Therefore, it is possible to name two motivations/commitments for our work, the first being the reduction of the learning curve of the instrument, i.e., the absence of manuals or any need of introductory classes (note that the interaction is based on the contact with the body itself, without the use of mouse, keyboard or other devices). For this purpose, AffectiveWall uses the visual and sound feedback for better understanding of the musical creation and instrument control (therefore reducing the frustration of the typical first contact with, for example, a musical instrument, which in most cases leads to meaningless sounds or no sound at all).

The second motivation, and that stands for the main theme developed in our work, is that affective states are the link between the two artistic fields - music and painting – and stand for the interface to the user. We want to explore this and understand if there are some affective states that are easier to recognize than others, and the influence that the person who is expressing and the person who is watching/listening have in the recognition of affective states. We want to study how different people from different backgrounds (artistic, non-artistic, etc.) establish a relationship with our system, in a quest to define what we need to create a universal instrument.

In the end, the main contributions of this thesis are the development of the concepts “affective model for gestural expressivity”, that links gestures and affective states in an aesthetic/artistic perspective, the “affective ecosystem as interface”, where the system manages the decisions about the affective expressivity and users interact by performing actions
to change this ecosystem controlled by AffectiveWall, and the “augmented affective states as output”, which is perceived by the audience as a multimodal stimuli composed by sounds, visuals and physical movements.

So, in this paper we will present our system, the background and related work of its development, the explanation of the concepts proposed and all the steps that composed our work. Also we propose an architecture and an implementation of the system, evaluate its usage and present some conclusions and future work.

II. AFFECTIVEWALL

We developed a system in which the user interacts by “painting on a canvas”, i.e. touching a vertical multi-touch surface, using its whole body. These movements are then captured and translated into emotions and affective states, based on the “affective eco-system interface” concept (later explained on this paper). Through these affective data read, the system composes music and generates abstract paintings in real-time that are projected on the canvas, always according to the affective features it reads. These contents consist on performer’s “augmented affective states”, related to the “extended expressive gestures” described in [2], which are perceived by spectators as multimodal stimuli composed by physical movements, audio and video contents. The name of this project is AffectiveWall and, in the end, our aim is developing a musical and visual instrument (and consequently a tool for performance) to be played in an organic and intuitive way (with the lowest possible learning curve), enabling its use not only in Arts, but also for educational and therapeutic purposes.

Explained the motivations and inspirations of our system, we will now begin to describe its development, starting on the kind of interaction related to affective expression.

III. AFFECTIVE ECOSYSTEM AS INTERFACE

Before In this concept of “ecosystem interface”, the system has the main role on the interaction, responding to a complex environment (which can be altered by users, but also by space conditions, noise, etc.) while users can indirectly interact with the system by actions on the environment. One example is AESI (Audible Eco-Systemic Interface) by Di Scipio [5], which is set as an automatic feedback cycle: sound from the environment is captured by microphones, passing on to controller, processing and synthesis steps, producing sound that comes back to the environment through speakers. So, in this case, sound is the interface and users can only interact with the system by acting on the environment. Therefore, AffectiveWall relates to this concept by having affective states as the interface, where the system has the role of interpreting the whole "affective ecosystem" and the user has the chance to change it (and therefore indirectly change the system output). This interaction is also related to gestural control of music, interactive music systems and the concept of digital or virtual instrument. Thus, it is mandatory to consider some characteristics about this topic [6]: immediate response to user’s movements, the non-limitation of interaction options (e.g. possible choices on a menu) leaving the interaction to a continuous sequence of controls, possibility of any audible sound as an output and, at last, the separation between the interface and the sound synthesis (both modules are independent and have a mapping of parameters between them). Regarding to this last point, Knapp and Cook [7] describe the potential of this abstraction, where this separation between musician and the object responsible for the sound generation increases the creation of an emotional interface instead of a physical interface (like guitar strings or piano keys) – one of the main concepts of AffectiveWall’s creative
process. This way, the user doesn't need to worry about using the instrument to produce low-level contents, like chords, but to convey a specific affective state, a high-level content. Moreover, it is necessary to connect this to the metaphor of painting. Its relevance cannot be overlooked because is the main help available to users, simplifying and providing them directives on how to use the system [8,9], avoiding the use of manuals or other external supports. According to Buxton, the most natural interaction language consists on non-verbal dialogues, enhancing gestures as phrases with their own meaning [10]. Therefore, the interface should be replaced by actions that naturally derive from the supported metaphor, rejecting the use of menus, buttons and windows (in the case of AffectiveWall there is only canvas, just like in painting). In terms of interface hardware, to maintain this metaphor is mandatory to preserve the traditional way of painting, i.e. the relationship between the artist and a physical and vertical medium. After talking about the users' interaction, it is time to explore the meanings of their expression: the emotions within the gestures.

IV. AFFECTIVE MODEL FOR GESTURAL EXPRESSIVITY

In the process of studying the link between emotions and gestures while painting, we found that is still a need for research in this area, mainly when considering the new opportunities that matter could provide on the emerging scene of multi-touch interaction. Some experiments have been made by Hiraga et al. [11] on the connection between emotions and drawings but mainly testing the recognition of emotions, not the production and interpretation themselves. Regarding gestures, Kipp and Martin [12] studied the expression of hands, while Fagerberg et al. [13], Camurri et al. [2], Castellano et al. [14] and Wallbott and Scherer [15] researched full body movements. Most researchers, however, do not consider the constraints of a medium on the gesture expression, such as when the subject is interacting with a surface, as in the case in our work. One of the researched systems is more closely related to our approach: EyesWeb by Camurri et al. [2], a framework for analysis of dance performances, producing audio-visual output related with the emotions conveyed by performer. However, in this system the gestures are not performed on a physical interface.

In terms of expression analysis, Izard claimed that are emotions with patterns that convey particular meaning or information [16]. In Laban Movement Analysis [17], human movement is studied and decomposed in body, space, effort, shape and relationship, defining a language for interpreting, describing, visualizing and notating all kinds of movements. In the same way, Wallbott and Scherer [15] defined six dimensions, namely overall activation (quantity of movements), spatial extent (amount of space occupied), temporal extent (duration of movements), fluidity (smoothness of the movements), power (dynamics of the movement) and repetition. Camurri et al. [18] reported how they measured the emotional expression of drawings made by users with a laser pointed to a wall (when listening to musical excerpts), and identify a collection of relevant features: angularity, rarefaction, spatial occupation, vertical symmetry, horizontal symmetry, central symmetry, compactness, lateral location, vertical location, angular tendency, and spatial extension. Although similar to our work in terms of classification, the expression here is performed using a single point in the wall, rather than the whole body.

Therefore, we adapted the model proposed in [15] to the performance of gestures on a surface. For instance, spatial extent on their model is represented by occupation of the canvas in our case. Also we use some descriptors proposed in [18], namely vertical location, compactness and spatial occupation. In addition, we considered the most frequent and distinguishable features we perceived in our evaluation, joining all together in the following metrics and measures: gesture length (punctual, short, medium, or long), area of touch (one fingertip, one fingertip of each hand, all fingertips, all fingertips of both hands, one hand, both hands, one arm, both arms, hands/arms and head, or whole body), quantity of gestures (one, some (two or three), or many), gesture speed (static, slow, medium, or fast), direction of the movement (none, downward, upward, inward, outward, sidewards, or random), shapes drawn (blob, straight line, curve, circle, or chaos), duration (sudden or sustained), location (low, medium or high height), and occupation of the canvas (confined, medium or expansive). Note that the purpose is to use the painting metaphor, thus gestures are only considered when touching the surface itself.

Relatively to the emotion range considered, we based ourselves on models from psychology, such as Russell's Circumplex Model [19] and OCC Model [20], and added aesthetic and artistic expression concerns, creating a group of, not only emotions, but more general affective states that are relevant when the matter is the expression on a canvas. For this work, the chosen affective states are: sadness, shame, anger, confusion, joy, freedom, melancholy, pride, pleasure, exaltation, tenderness, shyness, satisfaction, loneliness, hate, fear, relief, hope and disappointment. This selection was made with São Nunes¹, an action painting and performer expert, who works on painting in real-time accompanied by live music, exploring the emotional expression of her body and developing awareness to the problematic of interaction with a canvas.

V. GESTURES EVALUATION AND PATTERN RECOGNITION

Guided towards an affective model suitable to reality, we proceed with an experiment to find patterns of gestures related to each affective state, using the evaluation metrics presented on the last section. Is important to note that we are not aiming to find the perfect expression that will work for everyone (as we believe that would be an impossible task). We cannot forget that, as any other instrument, performers will have to discover their personal way of playing it (even in this case where the adaptation will be a lot lesser and looser than conventional instruments). In this way, we asked fifteen

¹ Info on: http://www.saonunes.com/ (accessed on 14-08-2011)
individuals to perform each affective state on a wall while we were recording video. Afterwards, we measured the gesture features from the video, aiming to find patterns in the subjects’ body language. We asked the subject to perform one expression for one affective state at a time, first using the most spontaneous gestures that came to their mind and then, after a pause to think about the best expression, using the subsequent reflective gestures. To remove any bias, affective states were presented in a random and different order for each subject, and tests were performed isolated without the user having previously seen other expressions. After each gesture, the subject was asked about her expression difficulty and her satisfaction/confidence, regarding the accuracy with which gesture represents the requested affective state. Due to the long process of this experiment (which includes several screenings of each video to make the feature analysis) and the duration of a single test (where we ask the user to perform nineteen different affective states twice), we decided that fifteen individuals would be a reasonable starting number to understand which affective states are likely to be “decomposed” into recognizable patterns and define how. To enrich and diversify the test group, the choice of individuals was made to cover a large range of ages (from 18 to 66) and backgrounds: with and without artistic background (and among artists, people from music, painting and dance), psychology, etc. Although, for the presentation of results we only considered subjects with artistic background those who have studies in acting, performance or dance, due to their potentially developed skills in expressing their emotions through the body (and awareness of expressive features involved).

The first conclusions that we took from the experiment, was the similarity on the ease/difficulty of expression between users with or without an artistic background (values on Fig. 2), and the fact that the majority of the group, independently on the background, revealed acceptable confidence rates in the expressed affective states. All of these suggest that it may be possible to create a universal instrument that everybody could play regardless of the existence of artistic background. Also, for the majority of features addressed, a statically significant difference between spontaneous and reflective expression was not found, suggesting us that an intuitive and organic instrument for affective expression is something that we can aim for.

Fig. 1. User performing affective states on the wall.

The results are:
- Sadness - One slow and sustained gesture drawing a downward line at medium height and with medium occupation;
- Anger - Punctual, static and sustained gestures (like punches) made with both hands, making blobs at medium height (fast movements as if they are ripping the canvas are also used);
- Joy - Many, long and sustained gestures at medium or high speed, performed at medium or high height and with expansive occupation;
- Tenderness - One long, sustained and slow gesture, drawing a line at medium height with medium occupation.

Due to being an issue with a large degree of subjectivity, and also because we are not aiming to find absolute expressions, our approach was to considered gestures that were performed by at least half of the group. In such manner, the model is appropriate to reality but also providing enough freedom and subjectivity to feed this kind of interaction interpreted by the system.

VI. ARCHITECTURE AND IMPLEMENTATION

Before thinking about an architecture, we came to a set of requirements that represent the *modus operandi* of AffectiveWall and guided us to the kind of instrument that we wanted to create, like:

- Be interesting and productive for performers and musicians and, at the same time, fun and intuitive to use for amateurs;
- Have a minimal learning curve, enabling is use by any person regardless of the background;
- Be an effective medium for electronic music composition;
— Make use of the visual feedback to help users composing and, at the same time, to allow and audience to better understand the content produced;
— Be controllable with the hands or other body parts, without the need of mouse, keyboard, controller, etc.;
— Always generate feedback, decreasing the users frustration;
— Be always prepared to receive input and create output, without distinguishing edit mode and execution mode;
— Enable an use that combines freedom, expression and creativity;
— Have a pedagogic nature but, at the same time, providing a fun experience;
— Increase the efficiency of the music instrument, like Jorda has defined it [21]:

\[
\text{Efficiency} = \frac{\text{MusicalOutputComplexity} \times \text{PlayerFreedom}}{\text{InstrumentInputComplexity}}
\]

Other more specific requirements can be enumerated that influence the implementation of all system:

— Modularity and extensibility, to allow the change of some part of the system;
— Real-time performance, i.e., low latency to prevent ruining the user experience;
— Use of standards, particularly in terms of communication protocols, to obtain the larger interconnectivity as possible;
— According to Human-Computer Interaction standards, always respect the chosen metaphor – painting – never using external controllers, interfaces with menus, options, buttons, etc.

Regarding the requirements of modularity and extensibility, we divided the project onto modules correlated with the different main tasks of AffectiveWall:

— Interaction Module (consisting on gesturesReader file in OpenFrameworks (OF), and Community Core Vision (CCV) software for tracking purposes) that updates an events list with the blobs on the surface (or simulated blobs when using TuioSimulator, a software that simulates the interaction without the actual multi-touch surface, using only the mouse for input);
— Interpretation Module (consisting on expressionInterpreter file in OF) that analyses the information on an events list and updates the current affectiveStates and mood vectors;
— Composition Module (consisting on musicComposer file in OF and server file in SuperCollider (SC)) that translates values from the current affectiveStates and mood vectors to sound parameters and send to all synths in SC;
— Painting Module (consisting on paintingsGenerator file in OF) that converts values from the current affectiveStates and mood vectors to colors, and apply them to the interaction and manipulation of a particle system to create visuals correlated to the users movements.

In terms of the core of AffectiveWall, the code in OF, it is divided on different files as stated above, and in two distinct threads. One to perform just the creation of visual feedback\(^2\) (that costs a large execution time) and the other one to all the other tasks (is important to notice that real-time performance is one of the main requirements of this system).

Lastly, the communication between different modules is mainly supported by the four vectors that maintain all the information that circulates on the system:

— events (list with information about the blobs that come from CCV, being each event filled with information about blob’s speed, position, direction, movement length, occupation on the canvas, etc.);
— deadEvents (list with basic information of events recently removed from the events list, namely removal time and movement length, that will be used later in some features analysis);

\(^2\) Being this thread the one that uses OpenGL to create the visuals, it was better to maintained it as the initial thread.
Explained the AffectiveWall architecture, we can review summarily how it works and how is implemented, from the moment in which the user touches the surface of the canvas until the appearance of visual and sound feedback.

In terms of hardware, AffectiveWall works by having a surface where the users perform their gestures, and behind is located a camera that captures all movements and send to a computer that hosts the system. Later, it outputs visual options, we built a LLP multitouch surface, as described on Nui Group website\(^3\), in order to maintain the lowest costs as possible, preserving the mindset of bring artistic performance closer to people.

Thus, we have a camera prepared to capture infrared light reflected by user’s body when touching the surface. In this manner, in terms of software we have CCV (Community Core Vision) which executes some image tweaks (like background subtraction, high pass filter, image threshold, etc.) and sends the information about the blobs to OF (identifiers, position, speed, movement length, canvas occupation, direction, etc.). In, OF, more precisely in expressionInterpreter, we run a never ending cycle that covers all the following tasks:

a) Update the events and deadEvents, the lists of current and recently finished events (by calling the functions getEvents and getDeadEvents of gesturesReader file);

b) Evaluate all the current events (updating the affectiveStates vector);

c) Update the mood vector using the data on affectiveStates vector;

d) Decay the values of current affective states (performed one time per second, to make all the non-expressed affective states on the present moment tend to zero);

e) Update the sound feedback (calling the function updateSynths of musicComposer file);

f) Update the visual feedback (calling the function updatePaintings of paintingGenerator file).

Regarding the musical composition, it can be divided in two parts: the synthesizers on SC and the control/conversion of sound parameters on OF (that will be send via Open Sound Control (OSC) to the SC server). Regarding to SC synths, they consist on independent “modules” of code (called SynthDef’s) that receive arguments and use them to control the production of sound and send the result to an output channel. In AffectiveWall this is done, for instance, receiving the mood value of a specific affective state and use it to control de volume of one synth, at the same time that receives the current affective state and links to the frequency of a sound wave or the speed that a sound event is triggered. Our approach was to create various synths associated with the different affective states and one for the general rhythm. The chosen parameters associated and their tuning were done through a large amount of experimentations to reach a solution that:

- Respects the aesthetical concerns considered for this kind of instrument;
- Takes into account the kind of sound production typically associated with experimental electronic music;
- Shows an innovative approach to the affective states addressed;
- Does not result on a huge amount of noise with the levels of all synths overlapping each other;
- Does not produce unintentional glitches or annoying noises;
- Provides an overall harmony between all sounds.

In relation to the generation of paintings, we use a particle system that calculates the movements of the “digital paint”, supported by MSAFluid\(^4\), a library for solving and displaying real-time fluid simulations based on Navier-Stokes equations and Stam’s work [22]. So, our paintingGenerator interacts with the fluidSolver from MSAFluid by giving data about the gestures and, after the calculation of fluid dynamics for each position of the visualization area, we use the information returned by fluidSolver to draw the visual output of AffectiveWall. The data treated by the particle system is composed by color, calculated according to Bresin’s studies [1], and force, that is equivalent to the velocity that gestures were performed and the entropy given by the affective states represented (i.e. the gesture’s arousal).

\(^3\) Info on: http://nuicode.com/attachments/download/115/Multi-Touch_Technologies_v1.01.pdf (accessed on 13-09-2011)

\(^4\) Available on: http://www.msavisuals.com/msafluid (accessed on 01-09-2011)
VII. AUGMENTED AFFECTIVE STATES AS OUTPUT, AN EVALUATION OF RECOGNITION

Finished Finished the first version of AffectiveWall (as we believe that whole system is a work-in-progress), we conducted an experiment to understand the current status of expression and recognition of affective states. Despite that, our concerns were not to simply evaluate how good the system is on converting gestures to music and sound which an audience can perceived all the affective states expressed. To achieve that, another approach should be followed, where many people would performed the expression on the system, testing the effectiveness of system’s feedback by how much spectators recognized each expression. This leads to a very time consuming test, because a large number of participants expressing themselves on the system would be needed, and all the videos recorded from these expressions would be viewed by many people as well, in order to avoid that some outliers in terms of gesture’s features used will disturb the whole experiment outcome. So, due to the complexity of a test like that, and regarding our initial motivations for this work, our approach was tried to answer the following questions:

— How much the performer influences the recognition of the expressed affective states by an audience?
— How much the spectator influences the recognition of the affective states expressed by a performer?
— Is it possible to have a universal instrument that anyone can play and an audience perceived there expression regardless their age, gender or kind of background?
— How much varies their confidence of recognition when answering, depending of their artistic background or not?
— There are some affective states easier to recognized comparing to others?
— How differently features of an affective expression, like arousal and valence, are perceived by an audience?

According to the metrics defined above, we divide the experiment in two phases: the expression and the recognition. The first one consisted on getting four subjects to use the system to express four affective states: anger, sadness, joy and tenderness. To remove any bias, affective states were asked in a random and different order for each subject, and tests were performed isolated without the user having previously seen other subject’s expression. We recorded video taking into account the appearance of all AffectiveWall outputs: music, sound and physical gestures of the subject.

The second phase of the experiment was to show all the sixteen videos to spectators. This was done through online questionnaires where we asked the following data:

— Gender, age and country (where the subject spent most of his/her life);
— If the subject have artistic background (and in which area: paintings/drawings, music, theatre/performative arts or other);
— For each video, which affective state is being expressed (from one of the following possible answers: anger, disgust, fear, joy, sadness, surprise, tenderness or don’t know);
— The confidence on the given answer;
— Comments, suggestions, etc. (optional).

Again, to remove any bias or restriction to the participant’s answer, in the “don’t know” answer we gave the opportunity to participants to freely write the affective state that best suits the video. In order to enlarge the diversity of the test group, this test was performed by 84 participants with a wide range of ages, countries and backgrounds.

![Fig. 6 Subjects using the system to express affective states while being recorded on video to be later showed to other participants for recognition.](image)

![Fig. 7 Expression recognition rate by (a) gender and (b) kind of background of the spectator (note that the bars related to recognition of valence and arousal correspond only to situations where participants do not recognized successfully the affective state).](image)

By non-parametric Wilcoxon signed-rank tests, the difference on the recognition rate between participants from the both genders is 0.357, and between people with artistic and non-artistic background is 0.109 (both tests with a significance level of $P = 0.05$).
As we can see from the variety of participants and the results shown above, the output of AffectiveWall can be considered as universal. i.e. regardless of gender, age and, mainly, the existence or not of an artistic background, an audience can understand the system outcome in a statistically similar way. Also the confidence that participants felt when given an answer for each video did not show a statistically significant difference between people with and without artistic background (0.646 for a $P = 0.05$).

Is also interesting evaluate if the performer had influence on the overall recognition of the affective states expressed, being the results presented on Fig. 9.

In the process of testing if the differences of recognition rate between the expressions of the four performers are statistically significant, i.e. how much the person who uses the system influences the overall recognition of an audience, we ran the non-parametric Friedman test. As a result we get a $\chi^2(3) = 83,654$ with a significance level of $P = 0.05$. As there was overall statistically significant difference, we had to perform a post-hoc analysis with a Wilcoxon signed-rank test and using the Bonferroni adjustment to discover which groups this difference happened. This test evaluates the possible combinations between the videos of the four performers, showing us that all combinations except between subject 2 and 3 have significant differences. So, in almost all cases the performer had a huge influence on how the audience perceives and decodes the affective states addressed. As we can see in Fig. 9, the recognition of each subject performance goes from almost twenty to sixty percent of successfully recognitions. In fact, what we did noticed was a great disruption between the gestures’ features that we are expecting from our affective model (which were an average of the behaviors of fifteen people) and what we notice in this experiment. This explains the clearly difference between the performance of subject no.4 and the other ones. So, a more extensive evaluation should be done to statistically prove this statement, including the viewing and annotation of features of these sixteen videos to later compute the statistical difference between them and the results from the evaluation conducted for the affective model definition. This could be a seminal future work, due to being a too overwhelming task to perform on this phase of our work. Besides this, we consider that the results obtained this time where not unsatisfied at all regarding this conditions, suggesting us that will be possible to create a system where the “augmented affective states” really helps an audience to better understand the performer’s expression even if a wide variety of expressive cues (that the system was not expecting) were used.

As in the case above, for testing the recognition rate between the four affective states addressed, we ran the non-parametric test Friedman test. As a result we get a $\chi^2(3) = 32,643$ with a significance level of $P = 0.05$. Again, due to the overall statistically significant difference, we performed a post-hoc analysis with a Wilcoxon signed-rank test using the Bonferroni adjustment to discover which groups this
difference happened (showing us that joy was the most perceived affective state on this evaluation).

Some conclusions about the recognition in general can be taken, like the fact that the arousal of affective states is the most perceived characteristic perceived by an audience (as shown on Fig. 11).

![Fig. 11. Number and type of recognitions (in a total of 336 visualizations for each affective state).]

**VIII. CONCLUSIONS AND FUTURE WORK**

Thus, the AffectiveWall, an intermedia instrument where music is created without the typical instruments paradigm like vibrating a string or pressing a key, and painting does not need to be defined as separate entities. Regarding the quality of expression, the system can directly change the input by providing actions to the environment; and the “augmented affective states as the output”, a multimodal stimulus that is perceived by the audience as a composition of physical movements, audio and video.

In terms of future work, it would be rather important to evaluate how the quality of expression and the confidence of the performer changes with the system (comparing to the kind of expression done in the first evaluation for gestural patterns). Also, to test the recognition rate in a correct manner, a longer and with a larger number of participants interacting with the system could be. In addition, many developments can be done to the visual feedback, including new kinds of shapes and movement effects that express better the affective states addressed, and to the sound feedback, adding more synthesizers and extending it to other kinds of music. Also in terms of gestures reading, other input methods and new features can be incorporated, like sensitivity/power of the touch (e.g. using piezos to capture the sound made by performer when hitting the surface), and with mental disabilities to study their reaction to the system. Adapting the affective model to the specificities of each possible user group, positive outcomes can emerge from the use of the system in a therapeutically context, mainly due to its direct contact with the music and visual creation (joining...
together two seminal fields in this area: therapy with music and therapy with paintings).

So we talked about emotions and affective states, and the way we can expressed them, specially linking different artistic fields in a creative process that involves a physical medium: a wall or canvas. Thus, as in the paper which resulted from this dissertation, we choose “Another Thrill in the Wall” as the leitmotif for our work, in which the word “thrill” refers to the physical manifestation of an emotion through the whole body. We want to continue to explore this kind of intermediary instrument, using the vast and growing world of multi-touch interfaces. Jefferson Han 5 said “Multi-touch-sensing was designed to allow non-techies to do masterful things while allowing power users to be even more virtuosistic”. We want to subvert his words and apply them to Arts, in order to simplify them to one the most universal languages known to everyone: emotions. Because, all in all, it’s just another thrill in the wall.

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