Emotracking Digital Art

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Abstract. Art and emotions are intimately related. This work proposes the application to arts of Emotracker, a novel tool that mixes eye tracking technology and facial emotions detection to track user behaviour. This combination offers intuitive and highly visual possibilities of relating eye gaze, emotions and artistic contents. The results obtained after carrying out "5-second emotracking tests" over art illustrations and the use of the gathered information to create real-time artistic effects are presented.

Keywords: affect analysis, gaze, face analysis, digital arts.

1 Introduction

Affective Computing aims at developing intelligent systems able to provide a computer with the ability of recognizing, interpreting and processing human emotions [1]. Since the introduction of the term Affective Computing in the late 1990s, an increasing number of efforts towards automatic human affect extraction have been reported in the literature. Systems able to recognize human emotions from facial expressions, physiological signals, voice, text, etc. have been developed with high accuracy [2].

Independently of the channel -or channels- chosen to detect affect, most works still focus efforts on increasing the success rates in the emotion recognition task. However, other important issues have scarcely been studied, namely how to efficiently visualize the extracted affective information, how to process it to improve the user's experience in different applications or what is the best combination of channels depending on the information sought. In particular, the combination of user eye gaze and facial emotional information has been proved to have a great potential in measuring user perception, impact and/or engagement with digital contents [3].

One of the most subjective perceptual experiences is given by arts. Emotions and art are intimately related [4] and it is, perhaps, the unique and highly variable personal emotional perceptions elicited what makes art so attractive. The study of that perceptions require the interaction between art and science, two fields that, with few notable exceptions have grown in parallel with only counted interactions. In spite of the impact that the scientific study of art could have, it is somehow understandable that such enterprise is only starting to take off [5, 6, 7]. On the one hand, art perception is too subjective and challenging for rigorous scientific exploration. On the other hand,

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artists may fear that scientists could bring a misleading reductionism that would oversimplify all the aspects involved in the appreciation of art.

In an attempt to bridge these two fields, i.e., using scientific methods to study art, in this work we use Emotracker, a novel tool that mixes eye-tracking technology and facial emotions extraction to track user behaviour. This combination offers intuitive and highly visual possibilities of relating eye gaze, emotions and artistic contents. In particular, the results obtained after carrying out "5-second emotracking tests" over art illustrations and the use of the information gathered to create artistic effects will be shown.

The structure of the paper is the following. Section 2 analyzes the related state of the art. In section 3, the Emotracker tool is presented. Section 4 comprises the description of the "5-second emotracking tests", while section 5 focuses on real-time emotracking data-based artistic effects creation. Finally, in section 6 conclusions and future work are presented.

2 Background

This section explores issues related to the description of affective information, the analysis of eye-movements when looking to images and the use of user behavior data to artistically transform images.

2.1 Description of Affect

Despite the existence of various other models, the categorical and dimensional approaches are the most commonly used models for automatic analysis and prediction of affect.

The most long-standing way that affect has been described by psychologists is in terms of discrete categories, an approach that is rooted in the language of daily life. The most commonly used emotional categories are the six universal emotions proposed by Ekman [8] which include "happiness", "sadness", "fear", "anger", "disgust" and "surprise". The labeling scheme based on category is very intuitive and thus matches peoples' experience. However, human emotions are richer than simple emotional labels and may experiment strong complex variations over time. Those aspects of human affect (complexity and dynamics of emotions) should be captured and described by an ideal affect recognizer.

To overcome the problems cited above, some researchers, such as Whissell [9], Plutchik [10] or Russell [11], prefer to view affective states not independent of one another; rather, related to one another in a systematic manner. They consider emotions as a continuous 2D space whose dimensions are evaluation and activation. The evaluation (also called valence) dimension measures how a human feels, from positive to negative. The activation (also known as arousal) dimension measures whether humans are more or less likely to take an action under the emotional state, from active to passive. Unlike the categorical approach, the dimensional approach is attractive because it is able to deal with non-discrete emotions and variations in affective states

over time. However, given its continuous (i.e. numerical) nature, the main drawback of this approach is that it does not offer an intuitive understanding of affective information, since people is used to report emotions by means of words.

2.2 Gathering Information from Images: Eye Movements

The analysis of user eye gaze is a fundamental part when studying the impact of an art piece. There are several basic facts about how people look at (unchanging) images [12] that come from human vision studies:

- People can examine only a small part of an image at one time, and so understand images by scanning them using discrete, rapid movements of their eyes, called saccades. While saccades can be initiated voluntarily, they typically proceed in a goal-directed fashion. The motions are performed with remarkable precision and efficiency -the eyes seldom perform wasted motions, and typically land near the best place to gather the desired visual information.
- Saccades are punctuated by stabilizing motions called fixations, which allow the eye to dwell on a particular stationary object. The overwhelming majority of visual processing takes place during fixations. Under normal circumstances, the attention of the viewer is at the fixation location, for at least the bulk of its duration.
- In each individual glance, people look at something -the eyes do not wander randomly.
- In most tasks, the time spent fixating on a particular location or object indicates that processing on that object is taking place. More specifically, fixation duration provides a rough estimate on how much processing is expended in understanding that portion of the image.
- Many other types of movements are possible, such as those involved in smooth pursuit; but it is the saccades and fixations that play the largest role in gathering information from across a static image.

2.3 Using User Behaviour to Create Artistic Image Effects

There are a couple of very interesting works coming from the painterly rendering domain that have been exploring the use of user interaction data to modulate the stylization of images. The ultimate objective of painterly rendering is to create non-photorealistic images by placing brush strokes according to some goals.

Shugrina et al. [13] introduce the term “empathic painting”, an interactive painterly rendering whose appearance adapts in real-time to reflect the perceived emotional state of the viewer. They recognize users’ emotions from their facial expressions detecting facial action units by applying computer vision techniques; the facial action units are mapped to vectors within the 2D valence-arousal space. Then, applying a non-photorealistic painterly rendering algorithm they generate the frames of painterly animation from a source photograph.

Santella and DeCarlo [12] propose a new approach for the creation of painterly renderings that drives on a model of human perception and is driven by eye-tracking

data. The eye-tracking data is used to select and emphasize structures in the image that the user found important. They transform the original image by selecting those perceptual elements that people looked at extensively, using a model of people visual sensitivity. They display the image to the user, let the user look at the images several seconds and then perform meaningful abstraction based on the eye-tracking data (basically fixation points' data).

3 The Emotracker: A Tool for Advanced Human Affect Visualization

This section presents Emotracker, a novel and advanced visual tool able to dynamically relate eye gaze information, affect and contents.

3.1 System Description and Setup

Emotracker is based on the combination of an eye tracker and a facial emotions recognizer. It is built on the top of two commercial APIs we have been widely exploring in our user experience laboratory in the last years:

- Tobii Studio [14] is a software by Tobii© that offers tools for easily creating eye tracking tests and experiments, collecting eye gaze data and making graphical visualizations from them. It has an associated specific hardware, Tobii T60, which is a 17-inch TFT monitor with integrated IR diodes that enable the real-time detection of the user's pupil. The eye tracking process is unobtrusive, allowing natural and large degree of head movement, and any kind of ambient light conditions. Moreover, it doesn't lose robustness, accuracy and precision, regardless of a subject's ethnic background, age, use of glasses, etc.
- FaceReader [15] is a facial emotions recognition software by Noldus©. It is able to analyze in real-time the facial expressions of the user, captured by means of any ordinary webcam, and provide affective information both in categorical and dimensional description levels. FaceReader works with high accuracy and robustness, even in naturalistic settings with any kind of illumination and type of user.

Emotracker has been developed with the aim of going beyond traditional eye-tracking by indicating not only where the user is looking at, but also with which affective state. Figure 1 shows the Emotracker system's setup.

After a brief gaze calibration (see Figure 2), the user is allowed to interact with different types of contents: movies, pictures, web pages or applications. The output from this first analysis is: user's navigation information, user's gaze log and user's facial video. The latter video is then analysed by the FaceReader software to obtain a user's emotional log. This log, in addition to the three precedent ones, is then loaded into Emotracker, opening the door to advanced and meaningful visualizations as it is explained in the next section.

Fig. 1. Emotracker system setup

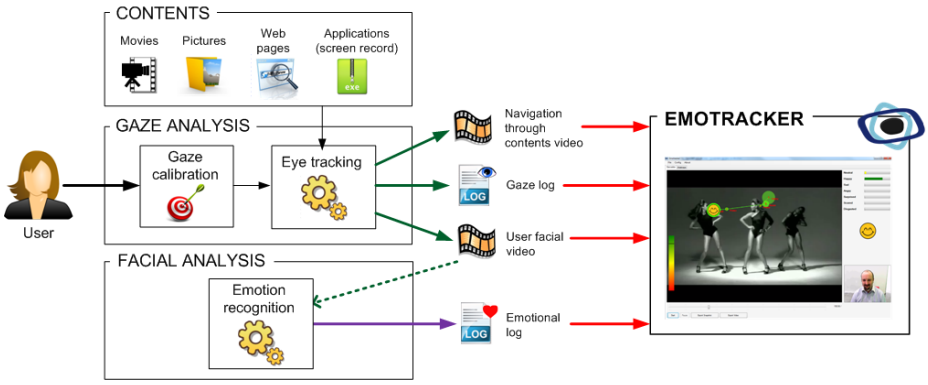

Fig. 2. Emotracker functioning: capturing user's gaze and emotional data

3.2 Emotracker Visualization Capabilities

Emotracker aims to visualize contents, gaze and emotional information at a glance, i.e. in an intuitive and clear way. To accomplish this, it builds visual reports in the form of "emotional heat maps" and "emotional saccade maps".

The "emotional heat map" is a direct unprocessed representation of the user's gaze data (of both eyes), enhanced with the possibility of working with "emotional layers". Each "emotional layer" represents the gaze data associated to a specific basic emotion, so that if a given "emotional layer" is selected only the gaze data associated to this emotion is shown and painted with its corresponding colour. If all the "emotional layers" are selected, the gaze data is filled-in with the colour of the most dominant emotion. This representation is particularly useful when checking whether a given content has elicited a particular emotion (even if non-dominant). The "emotional saccade map" is a dynamic processed representation of gaze data that shows the path

formed by the user fixation points: a fixation point is a point the user has been looking at for a minimum amount of time (in milliseconds, configurable).

The initial visualization configuration panel of the tool can be seen in Figure 3, while several examples of the visualization capabilities results obtained with the tool are shown in Figure 4. The main potential of tool is its wide range of customizable representation possibilities. Its interface allows to activate and deactivate different visualization options, both for "emotional saccade maps" and "emotional heat maps", such as: interest points numerical labels, discrete emotions text labels, drawing smileys inside the fixation points, discrete emotions coloured zones, valence graded colours, etc.

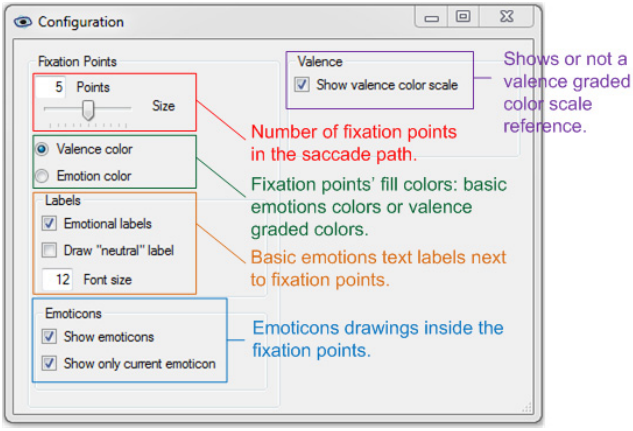

Fig. 3. Emotracker visualization configuration panel

3.3 Validation Issues

The Emotracker tool was validated through a pilot study with 14 naïve users exhaustively detailed in [3]. The objective of the study was investigating whether the emotional and gaze results visualized with the tool were similar with users' perception. Specifically, the users showed several emotional video sequences in the Emotracker device and then visualized their subsequent emotracking results. They were asked to classify the following statements between 1 (strongly disagree) and 5 (strongly agree):

- The information about the visual fixation points provided by Emotracker correctly represents the path followed by my gaze in the videos ("gaze accuracy").
- The emotional information provided by Emotracker correctly represents the emotions I felt watching the videos ("emotions accuracy").
- Emotracker's results are easy to understand ("intuitiveness").
- The visualization of the results presented by Emotracker is enough and appropriate ("visualization").
- During the emotracking session I could forget that I was being filmed and my behaviour was natural ("natural behaviour").

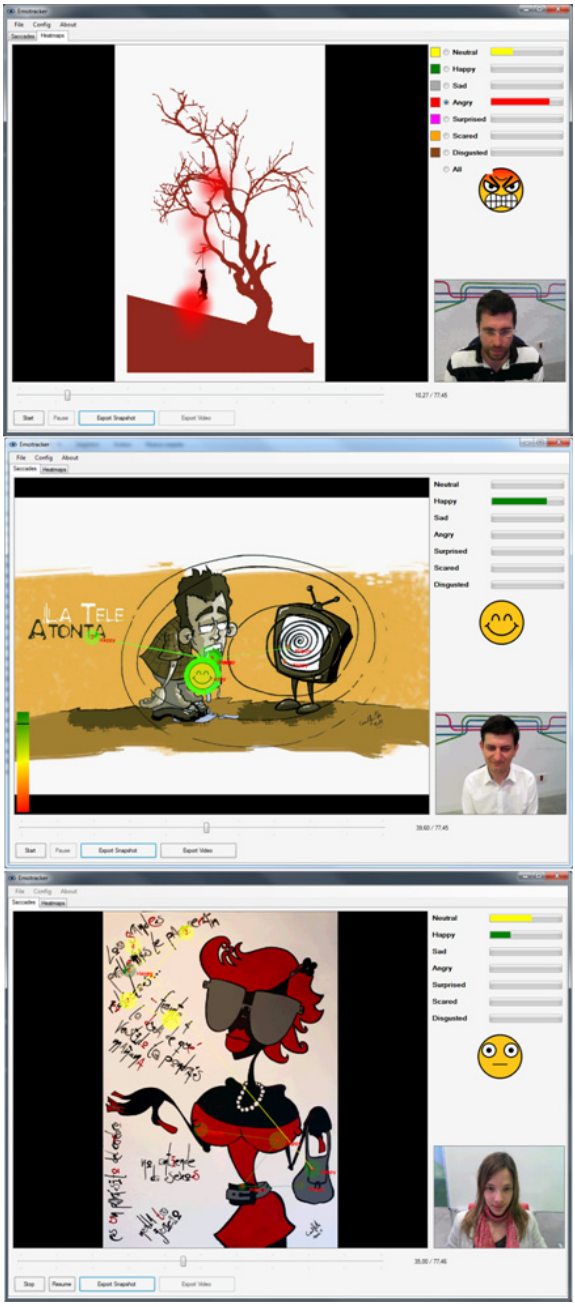

Fig. 4. Visualization capabilities of the Emotracker. Snapshots taken from "5-second emotracking tests" over artistic contents. Top: "emotional heat map" with the "angry layer" selected. Middle: "emotional saccade map" with valence colored fixation points, emoticons and emotions text labels. Bottom: "emotional saccade map" with basic emotions colored fixation points and emotions text labels. Illustrations by Rakel Goodféith.

Figure 5 summarizes the mean scores obtained for each statement. As can be seen, the intuitiveness and visualization capabilities of the tool really satisfied the users. Regarding the accuracy in gaze and emotion detection, users confirm that the visualization of the results in gaze detection are very accurate. However, the results regarding emotion detection vary a little: a greater dispersion in scores appears depending on each user and video sequence type (e.g. terror/tragedy/comedy clips). Finally, it is interesting to point out that most users couldn't completely forget they were being filmed while performing the tests.

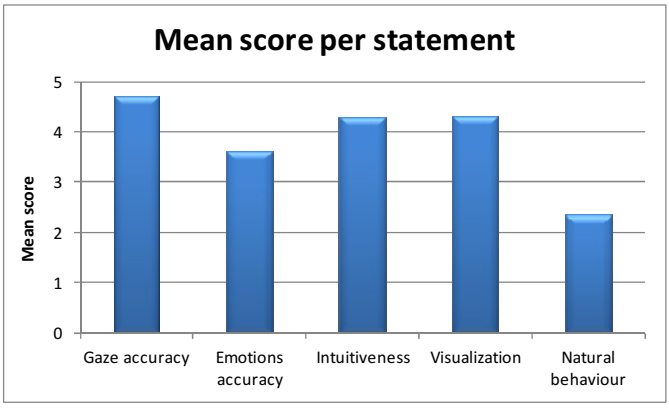

Fig. 5. Mean scores obtained in the pilot user study per evaluated statement

4 "5-Second Emotracking Tests" for Artistic Contents Impact Measurement

One of the most popular usability testing techniques is the so-called "5-second tests" [16]. As the name suggests, the "5-second test" involves showing users a single content, image or page-design for a quick 5 seconds to gather their initial -and therefore more salient- impressions. Five seconds may not seem like a lot of time, but users make important judgments in the first moments they see a content or visit a page. This technique has been traditionally mostly used for websites' usability analysis and users' judgments have generally been collected by directly asking them to write down everything they remember about the page. Eye trackers are a perfect tool to make this process more automatic, measurable and objective.

For that reason, and with the added value of affective information, we have used Emotracker to perform what we call "5-second emotracking tests". We presented a slideshow of 10 illustrations by the Spanish artist Rakel Goodféith to 5 naïve users and measured their reactions with Emotracker. The slideshow was organised so that each painting was shown during 5 seconds, and 10 seconds with black screen lapsed between two different drawings. Some snapshots of the "5-second emotracking tests" are presented in Figure 4.

Emotracking results where then shown to the artist who reported to "find the visualization very helpful and intuitive for understanding the first affective and visual impact of her illustrations on the users". She has also stated that she would be glad to reuse Emotracker, even in earlier stages of the creative process to predict the future impact of her artistic contents.

5 EmotrackingRT: Real-Time Affective Digital Art

As the initial aim when developing Emotracker has been to provide professionals (raging from marketing to psychology) with a flexible, intuitive tool to analyse the combined information of user's gaze and emotions when interacting with different kinds of content, special focus has not been put in achieving complete on-line real-time processing. But for other types of applications, such as arts, it could be interesting and it is perfectly possible.

In fact we have developed a real-time demo version of Emotracker, called EmotrackingRT, making use of Tobii SDK and FaceReader API. The demo does not account for all the types of visualization options the original off-line Emotracker has, but has been put into operation successfully. EmotrackingRT runs on a single PC with two output displays: the Tobii 17-inch TFT monitor, where the artistic contents themselves are shown to the users and their gaze is tracked, and a second standard monitor where emotracking information is visualized in real-time. In the latter screen, time-growing fixation points with associated emoticons or/and emotional colours are painted and a "new image" button is enabled to switch the artistic contents the user is viewing (Figure 6, middle).

This real-time functioning opens the door to new types of applications based, for example, in the interaction with digital illustrations that adapt colours, apply image filters or make any other kind of artistic effects depending on the user's gaze and emotional data obtained from our tool. To show its potential, we have added to the EmotrackingRT demo a third window, where an artistic effect is applied in real-time to the image being shown by the user: a radial motion blur effect is spread from the current fixation point and the global RGB histogram values of the image are modified depending on the current emotion colour (Figure 6, bottom).

6 Conclusions and Future Work

Art and affect are inherently related. This paper proposes the application of the tool Emotracker to the field of arts. Emotracker is a novel system based on the combination of a facial emotional recognizer and eye tracking technology that allows to plot gaze, emotions and contents in a single map. In this work we have successfully used Emotracker to carry out "5-second emotracking tests" over illustrations and to create real-time affective artistic effects depending on the current user's visual and emotional data. In a near future, we expect to acquire a wider range hardware-independent eye tracking system in order to analyze any kind of artistic contents (e.g. big size real paintings in museums) and create real-time digital interactive emotional art.

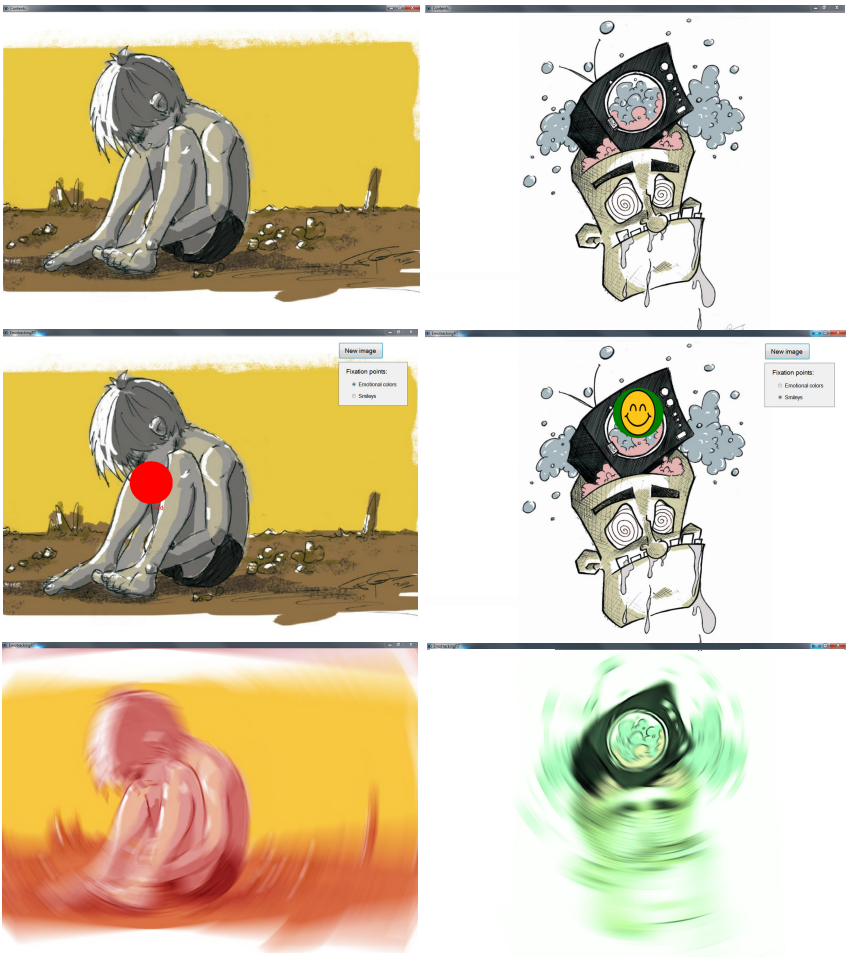

Fig. 6. EmotrackingRT results. Up: original illustrations by Rakel Goodféith the users are watching in the Tobii 17" TFT monitor. Middle: gaze and emotional information captured and displayed in real-time in a second standard monitor. Bottom: third window where an artistic radial motion blur effect spread from the current fixation point with global RGB histogram modified depending on the current emotion colour is applied.

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