The Emotion in Motion Experiment: Using an Interactive Installation as a Means for Understanding Emotional Response to Music

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ABSTRACT
In order to further understand our emotional reaction to music, a museum-based installation was designed to collect physiological and self-report data from people listening to music. This demo will describe the technical implementation of this installation as a tool for collecting large samples of data in public spaces. The Emotion in Motion terminal is built upon a standard desktop computer running Max/MSP and using sensors that measure physiological indicators of emotion that are connected to an Arduino. The terminal has been installed in museums and galleries in Europe and the USA, helping create the largest database of physiology and self-report data while listening to music.

Keywords
Biosignals, EDA, SC, GSR, HR, POX, Self-Report, Database, Physiological Signals, Max/MSP, FTM, SAM, GEMS

1. INTRODUCTION
In music and emotion research, the design of bio-inspired algorithms and their ultimate calibration has previously been based on testing with a small number of individuals - in fact usually the performer themselves. In this demo, we will describe how we created a public space computer terminal to record data from visitors in order to create an extensive user database.

One of the many problems in dealing with physiological correlates of emotion in general is the high degree of variability within the signals. There are many factors that influence the measurement of the Autonomic Nervous System (ANS), emotion being only one of them. Other factors include physical context and cognitive state [7].

We are interested in understanding audience's emotional reaction to music, and even though measurement during concerts has shown very promising results [3], we have not previously been able to arrive at conclusive results due to the difficulty of implementing experiments with large audiences. For this reason, the 'Emotion in Motion' experiment terminal was designed and has been running in public spaces since 2010.

This paper will describe the technical design of such a terminal, detailing the hardware and software implementations. For the reader interested in the first results from these experiments, please refer to [4].

NIME'12, May 21-23, 2012, University of Michigan, Ann Arbor.

2. THE EMOTION IN MOTION EXPERIMENT
Emotion in Motion[1] is an experiment designed to understand the physiological reaction of people to music. Our main research question is to see if we can detect the emotional content of the music from the physiology, and also understand what specific characteristics of the music trigger or generate a particular physiological response.

In order to achieve this, participants (visitors to science galleries or museums) are asked to listen to different song excerpts while we record their ANS response, as measured through features extracted from electrodermal activity (EDA) and heart rate (HR) [5,6] (see Figure 1). These two signals were chosen because of their capability to measure physiological indicators of emotion while still being relatively unobtrusive. The songs are chosen randomly from a pool of over 50 excerpts (approximately 90 seconds per excerpt), which are selected to have an overall balanced emotional content from happy to sad (high to low valence), and from high to low arousal. In addition to this, special attention is made in order to include songs from different genres and styles. The excerpts from each song were chosen to be representative of the song in question and edits made at musically sensible points e.g. end of chorus or bar. At the end of each excerpt, participants are asked to respond a simple questionnaire regarding their assessment of the song, as well as how it made them feel.

Figure 1. Heart Rate and EDA sensors (left). Participants at the Emotion in Motion terminal (right)

This experiment and its terminal have been installed in the Science Gallery Dublin, Casa Paganini research centre in Genoa, the EyeBeam Gallery in NYC and is currently running in VilVite Science Centre in Bergen, allowing us to have data of over 5000 participants and nearly 16000 listening samples.

[1] http://www.musicsensorsemotion.com/tag/emotion-in-motion/

3. SENSORS AND DATA CAPTURE

MediAid POX-OEM M15HP[2] is used to measure heart rate using pulse oximetry (POX). This sensor is fitted by clipping on to the participant's fingertip, as shown in Figure 1 (left).

To record EDA, a sensor developed by BioControl Systems is utilized[3]. This provides a continuous measurement of changes in skin conductivity. Due to the large number of participants, we developed a 'modular' electrode system that allows for easy replacement of failed electrodes.

In order to acquire the data from the sensors, two Arduino microcontrollers[4] were used to sample the analogue data at 250 Hz and to send via serial over USB communication to the Max/MSP patch. The code from SARCduino[5] was used for this purpose. For safety purposes the EDA sensor is connected via an Olimex USB isolator[6], to eliminate any direct connection to ground. Because the POX circuit requires external power, it has to be connected with a separate Arduino, to avoid any electrical connection with the EDA sensor. Full frequency response closed-cup headphones with a high degree of acoustic isolation are used at each terminal, with the volume set at a fixed level.

4. SOFTWARE

The experiment is implemented as a modular Max/MSP patch. The software was inspired by Michael Zbyszyński's CNMAT spectral tutorials [9]. It consists of a main patch that manages each session, records the physiological signals and plays the songs for each participant. The questions and feedback for the participant consist of independent patches that are dynamically loaded for each session. This allows great flexibility and makes it easy to change the questions, the number of songs to be played and even the language of the experiment without altering the main code.

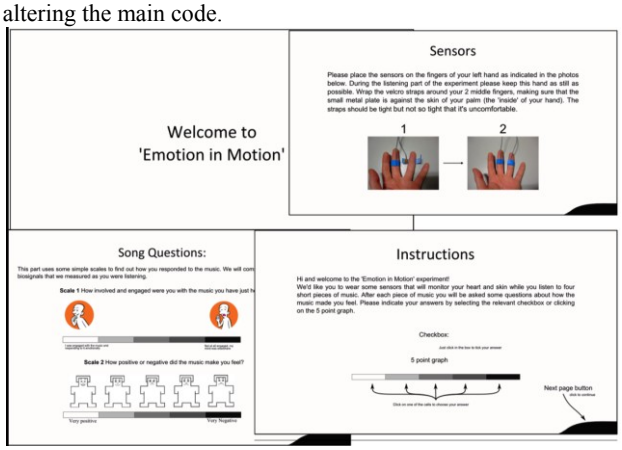

Figure 2. Emotion in Motion slides.

The software records the participants' answers and physiological data into files on the computer, as well as some extra information about the session (e.g. date and time, selected songs, state of sensors, etc.). All these files are linked with a unique session ID number, which is later used to build the database. A scheduled script copies the experiment files to a server at the end of each day, which are then downloaded at our lab for analysis. Figure 2 shows examples of the different slides used during the experiment.

The physiological data is processed in Max/MSP to present preliminary results to the participant at the end of the session. HR is extracted from the POX signal, and the EDA signal is filtered to remove any electrical noise. Both signals are evaluated for artefacts and anomalies in real-time, and a confidence index is recorded among them.

5. QUESTIONNAIRE

A variety of psychometric tools were used across different versions of the experiment to gather self-report information from the participants, mostly based on 5-point Likert scales [8]. These ranged from basic demographic questions related to age, musical preference and experience etc. to measures specifically assessing emotional response such as the Self Assessment Mannekin (SAM) [1], the 9-point version of the Geneva Emotional Music Scale (GEMS) [10], The LEMtool [2] and questions regarding the participants' enjoyment of and engagement with each excerpt as well as which excerpts they found *most* enjoyable and engaging. The different versions allow the comparison of the different measures used, as well as the effect of the questionnaire on the participants' responses.

6. FINAL REMARKS

We have presented an installation that automatically collects self-report and physiological data in an ecological setting for understanding the relationship between human physiology and emotion. This terminal could serve as a foundation for a new method for large-scale data collection in the arts.

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