Audio Environment for Emotional Imaging

Expanded Interface for the Emotional-Imaging Composer

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Funded by a Natural Sciences and Engineering Research Council (NSERC) Engage Grant

CIRMMT Centre for Interdisciplinary Research in Music Media and Technology

IDMIL

McGill

NSERC CRSNG

NSERC Engage Grant

- Gives a company access to the knowledge and expertise available at Canadian universities.
- Supports short term R&D projects to solve a problem specific to the company.

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Emotional Imaging, Inc.

"Emotional Imaging Incorporated specializes in giving realtime mediatic expression to how we are feeling."

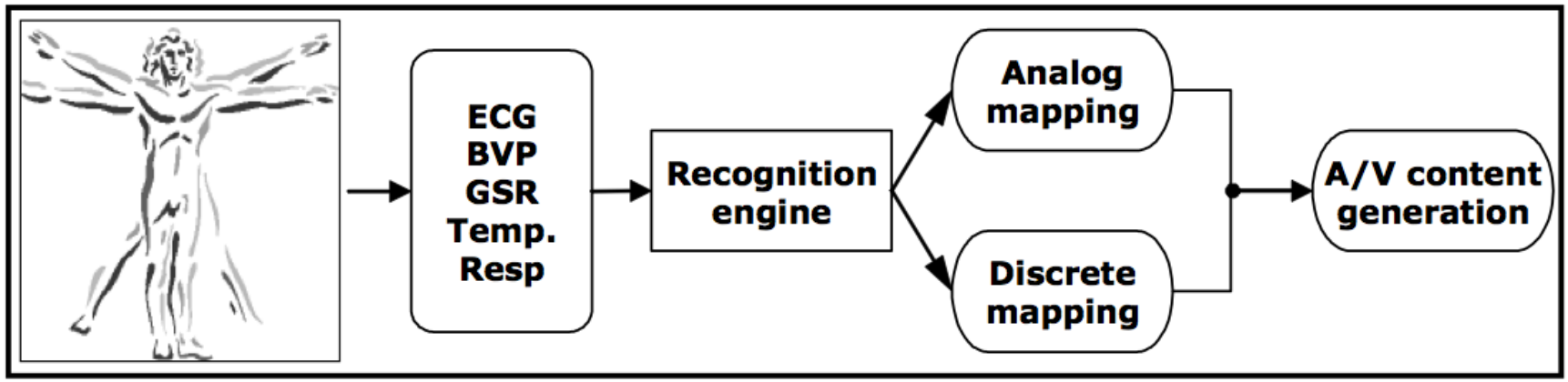
The Purpose of the Grant

The development of an extended interface for the Emotional Imaging Composer (EIC).

- Audio environment for real-time musical performance using emotional data
- Interactive sonification of human emotional states.
- Adds audio environment to EIC's current visual interface
- Broadens use to a music performance and data analysis context.

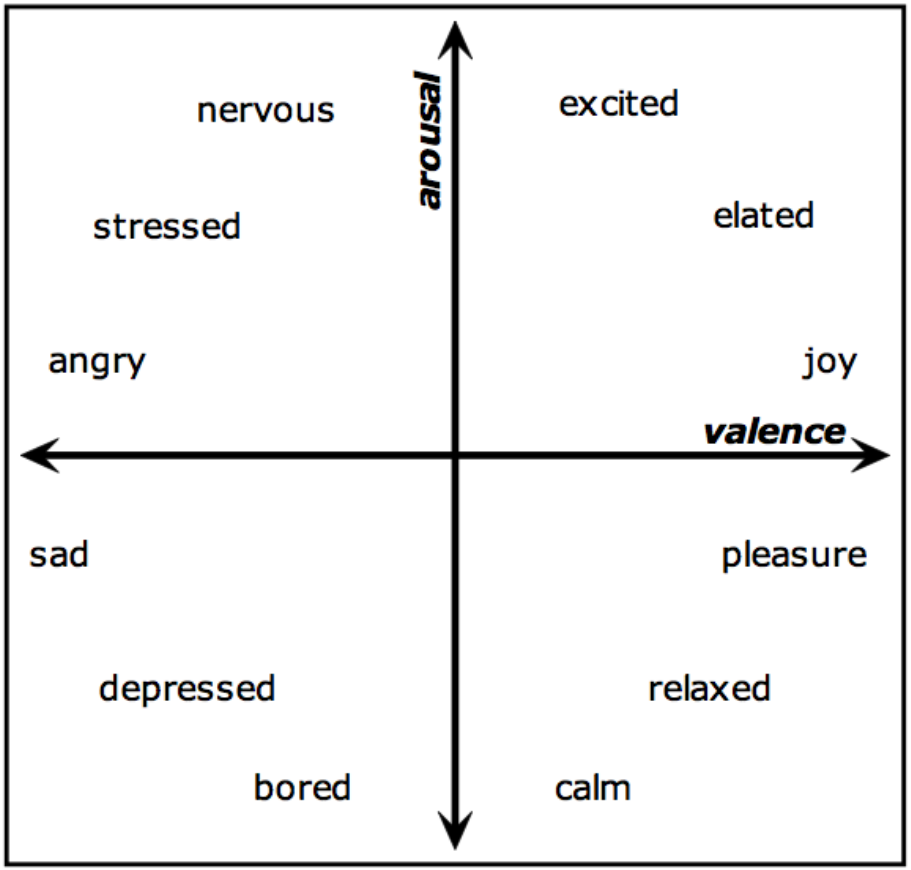
Emotional Imaging Composer

Biometrically Driven Multimedia Instrument



Benovoy, M., Deitcher, J., and Cooperstock, J. R. "Biosignals Analysis and its Application in a Performance Setting: Towards the development of an Emotional-Imaging Generator." In *IEEE International Conference on Bio-Inspired Systems and Signal Processing* (BIOSIGNALS), Madeira, Portugal, January 2008.

Russel's Arousal/Valence Circumplex



Posner J., Russell J.A., Peterson B.S., 2005. *The circumplex model of affect: an integrative approach to affective neuroscience, cognitive development, and psychopathology.* Development and Psychopathology, p. 715-734.

Emotional Imaging Composer

Hardware: Thought Technology ProComp Infiniti biofeedback system

Blood Volume Pulse (BVP) Sensor
SA9308M

Skin Conductance Sensor
SA9309M

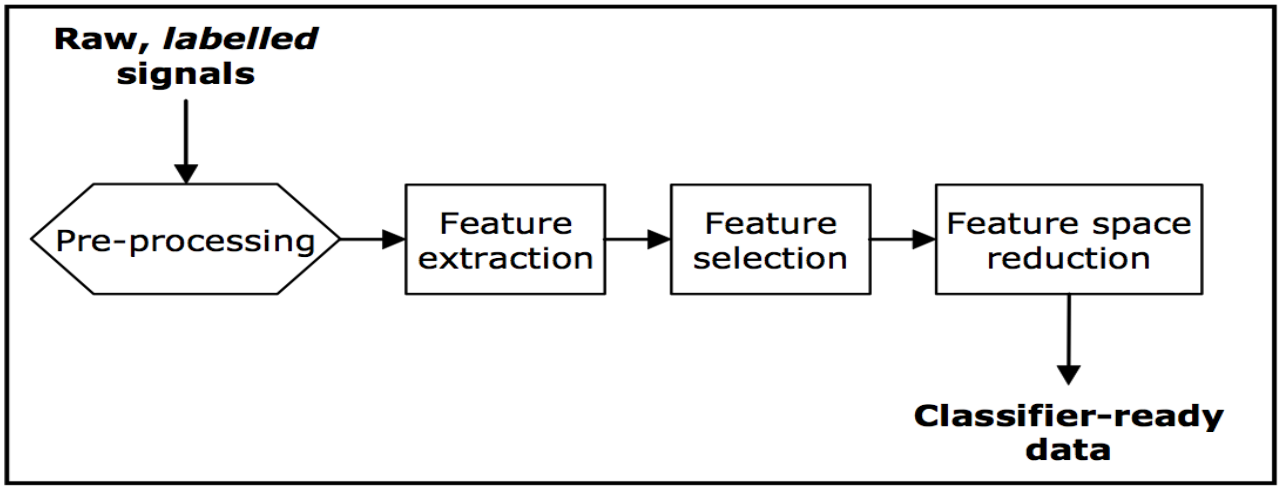
Temperature Sensor
SA9310M

Emotional Imaging Composer

Hardware: Thought Technology ProComp Infiniti biofeedback system

Respiration Sensor
SA9311M

EKG™ Sensor
T9306M or T9307M



Pre-processing: filtering noise, level adjustment

Feature Extraction: 225 features from five signals including: Mean of each signal and its first and second derivatives, heart rate mean, acceleration/deceleraton, etc.

Feature Selection: Removes redundant and irrelevant features

Feature Space Reduction: Reduces multi-dimensional feature space to 2 dimensions

Video used for this grant

"I Cast a Spell on You"

Sung by Laurence Dauphinais, method actress

Pre-recorded video w/arousal and valence data

Data sampled at 64hz

Studying Emotion

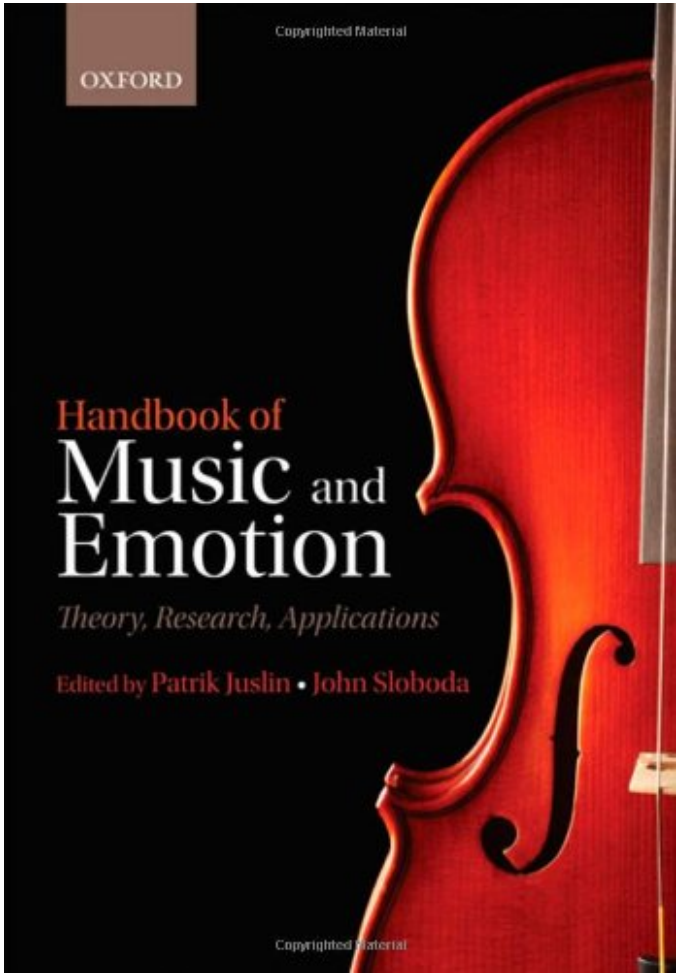
- Psychologically
- Biologically
- Neurologically
- Physiologically

Perceiving Emotion

- Facial Features and Gestures
- Emotional Speech
- Music

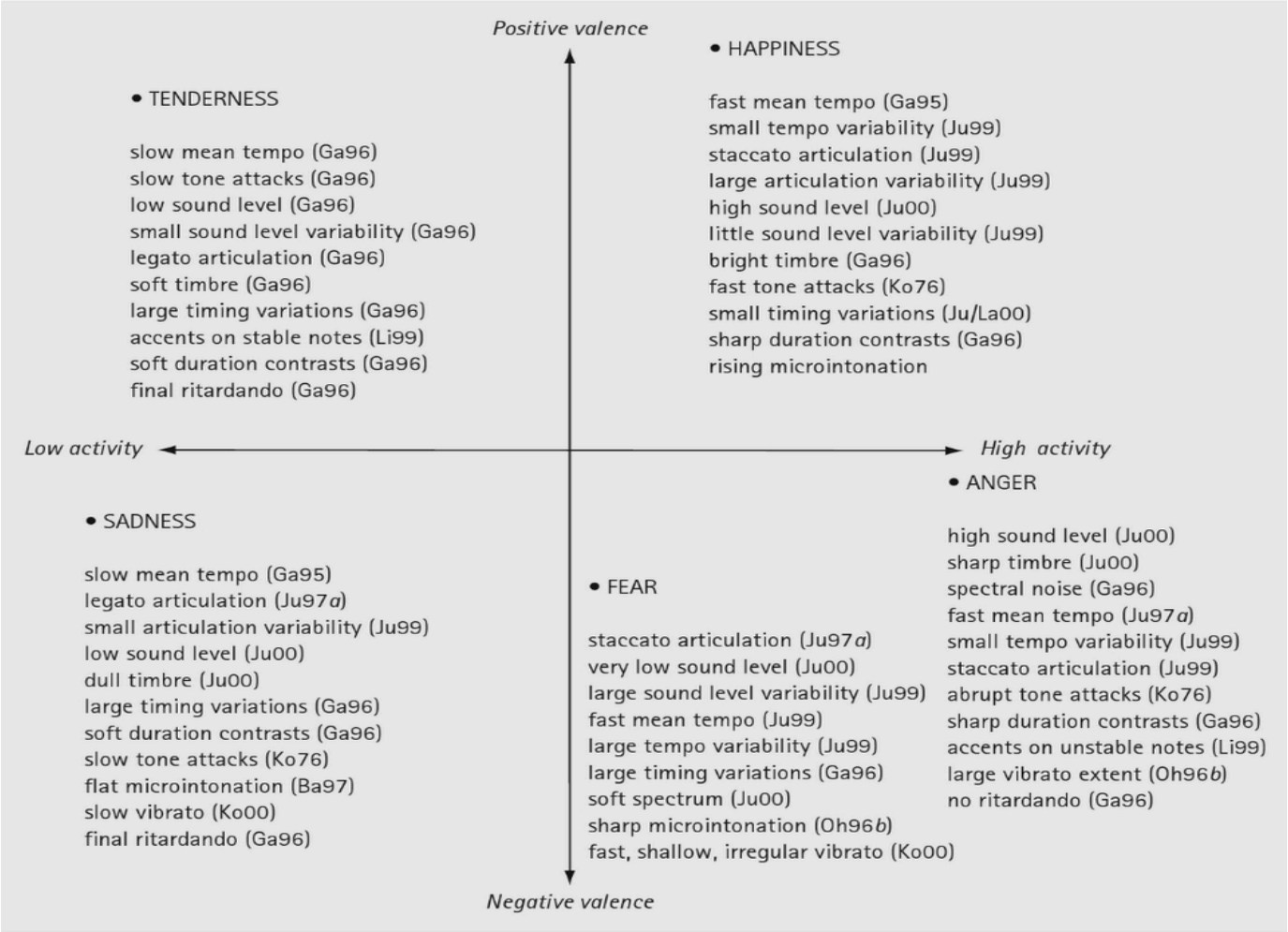
Music and Emotion

It has been proposed that music may express, reflect, or represent events/ situations, motion, dynamic forces, human character, personality, social conditions, religious faith, and—above all---emotions.



Gabrielsson, A. (2009). The relationship between musical structure and perceived expression. In S. Hallam, I. Cross, & M. Thaut (eds), *Oxford Handbook of Music Psychology* (pp. 141-50). Oxford: Oxford University Press.

Musical Structure and Emotion



Juslin, P. N. & Timmers, R. (2010). Expression and Communication of Emotion in Music. In P. N. Juslin, & J. A. Sloboda (eds), *Oxford Handbook of Music And Emotion: Theory, Research, and Applications*. (pp. 453-89). Oxford: Oxford University Press.

Our Work

- Sonification
  - Emotional Monitoring and Display

Affective Music Generation

- Performance Tool
  - 2 methods
    - From Biosignals
    - From 2D Emotional maps

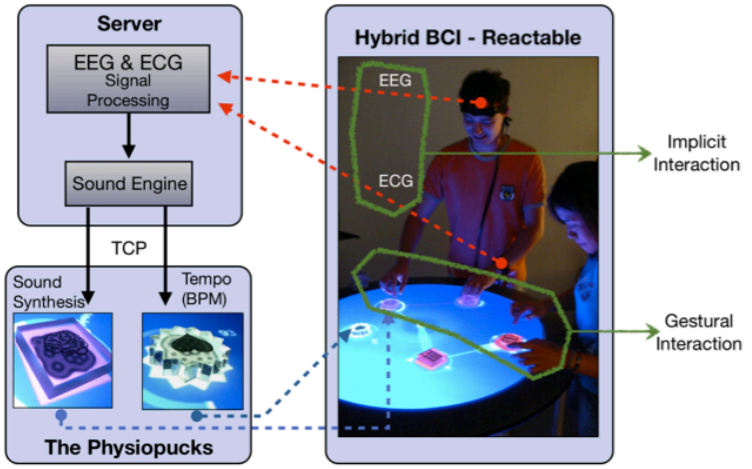
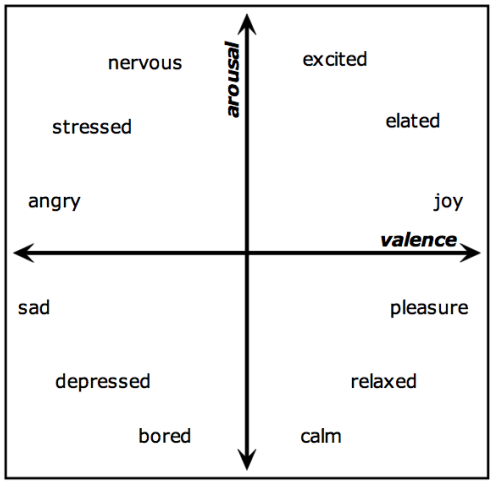


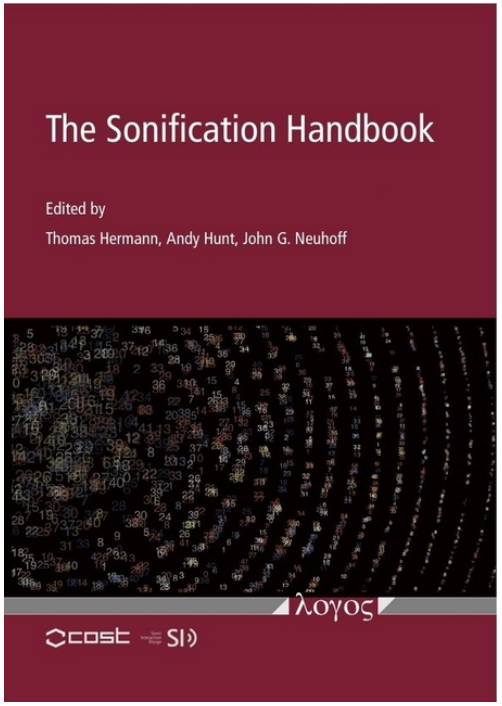
Figure 1: Multimodal Music System. Physiological signals (red dotted arrows) are wirelessly streamed to a server that applies a signal processing and sonification. EEG-based sound synthesis and tempo control through heart rate are integrated in the Reactable framework, and presented to performers as physiopucks (blue dotted arrows).



Mealla, S., A. Valjamae, M. Bosi, and S. Jorda. "Sonification of brain and body signals in collaborative tasks using a tabletop musical interface." In *International Conference on Auditory Display*. Budapest, Hungary. 2011.

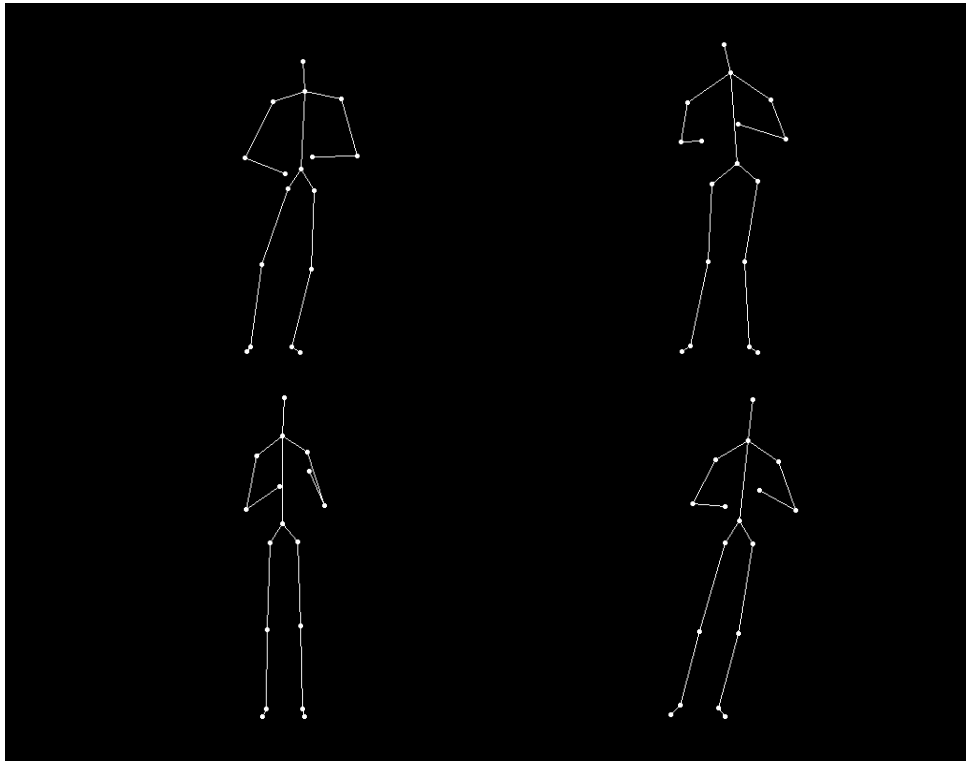
Introduction to Sonification

- "Use of sound to convey information"
  - E.g. Geiger counter
- *Systematic, objective, reproducible, data-dependent*
- Applied
  - Assistive technologies
  - Process monitoring
  - Auditory alarms
  - Navigation of data
  - Sports, leisure, movement



Sonification at the IDMIL

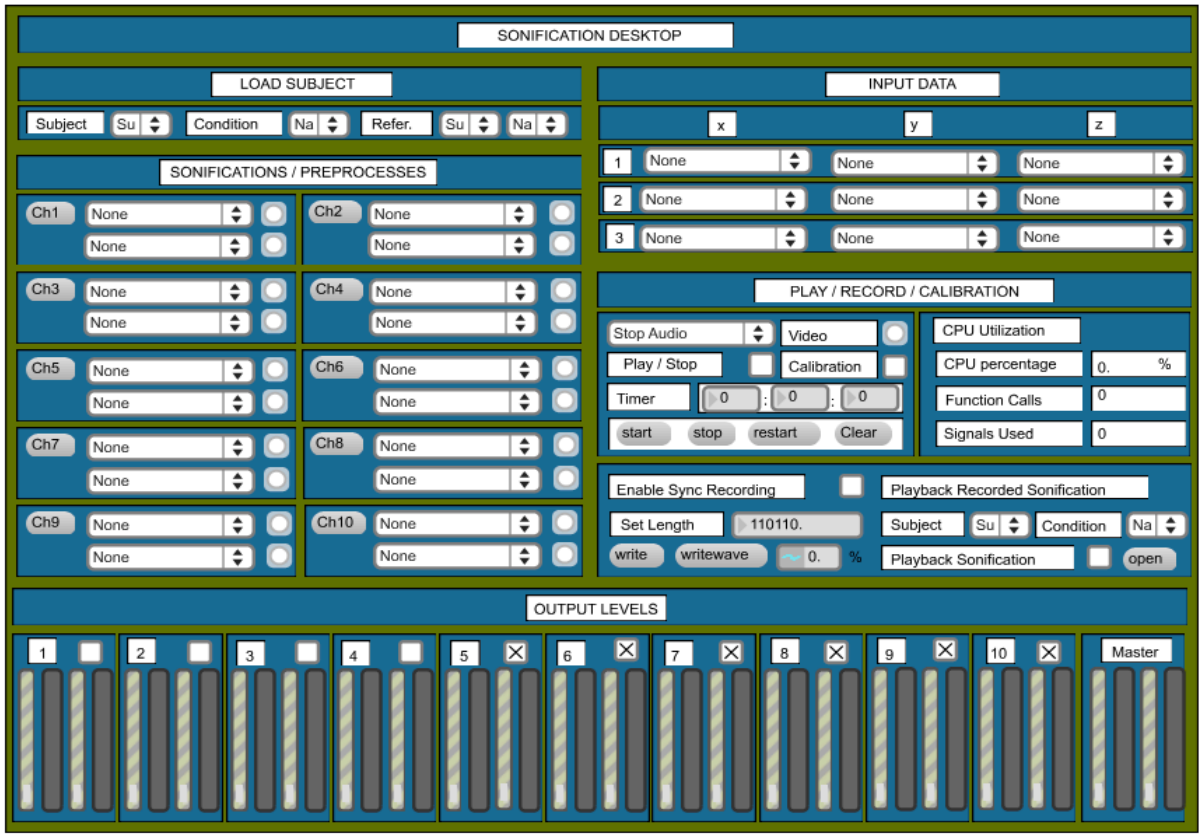
- Motion Capture of expressive movement
- Complement to visual analysis
  - Eases workflow
  - Flexibility in display
  - Hear things not seen



V. Verfaille, O. Quek, and M. M. Wanderley, "Sonification of Musicians' Ancillary Gestures," in *Proceedings of the International Conference on Auditory Display*, London, UK, 2006, pp. 194–197.

Sonification at the IDMIL

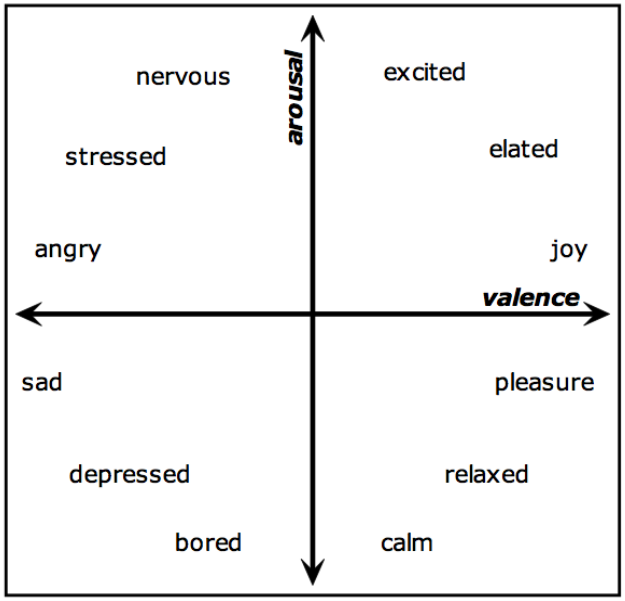
- Interactive Sonification
- Principle Component Analysis



R. Michael Winters, Marcelo M. Wanderley. "New Directions for the Sonification of Expressive Movement in Music Performance", In *Proceedings of the International Conference on Auditory Display*, Atlanta, Georgia, June 18-22, 2012.

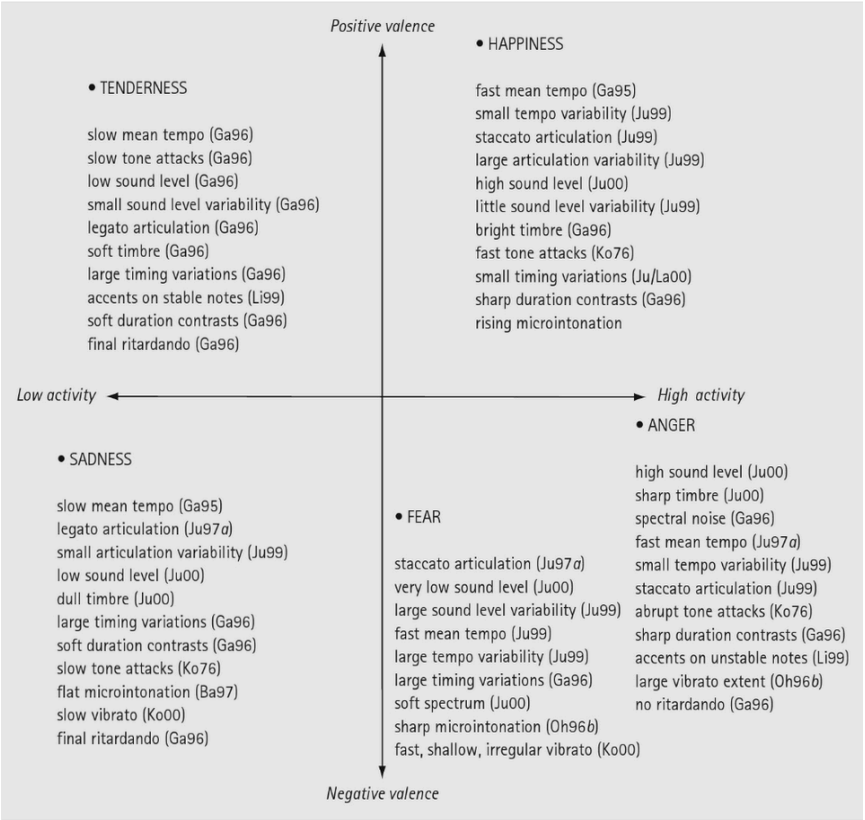
Sonification of Emotion

- Why is it useful?
  - "Eyes-free" monitoring
    - Therapist, wearable technology
  - Affective impact of sound
    - Benefits of multimodal strategy
      - *Closer* to the emotion itself



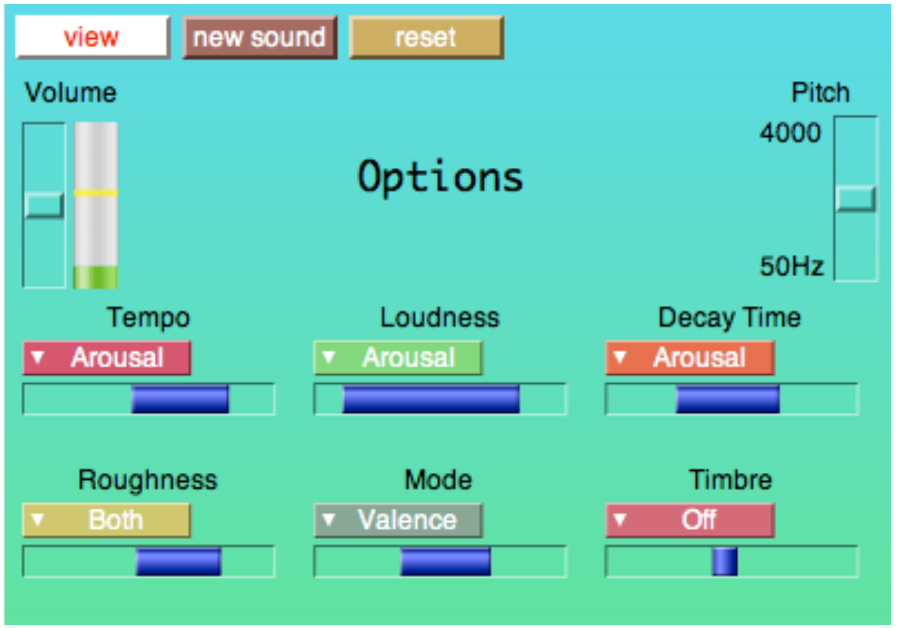
Mapping

- What has emotional impact?
  - Tempo
  - Mode
  - Loudness
  - Timbre
  - Pitch Height
  - Intervals
  - Melody
  - Harmony
  - Rhythm
  - Articulation
  - Amplitude Envelope
  - Pause/rest
  - Musical Form



Simplified Approach

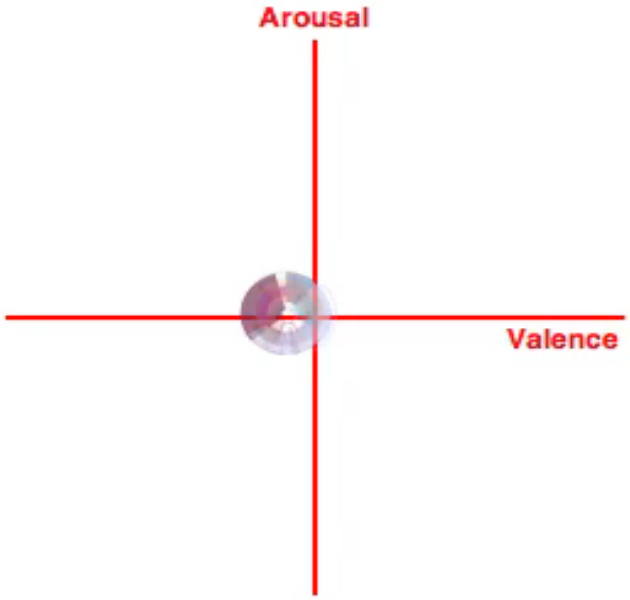
- Arousal
  - Tempo
  - Loudness
  - Decay
- Valence
  - Mode
  - Rougness



Feels

by R. Michael Winters

Input Devices and Music Interaction Labortory
CIRMMT, McGill University



McGill CIRMMT OML NSERC CRSNG Feelings, Illuminated.

Real-time music performance environment for the EIC

Goal:

"...as expressive and responsive as a fine musical instrument... rather than attempt to recognize and label human emotional states, our goal is to investigate the mapping of these states to expressive control over virtual environments and multimedia instruments."

Benovoy, M., Deitcher, J., and Cooperstock, J. R. "Biosignals Analysis and its Application in a Performance Setting: Towards the development of an Emotional-Imaging Generator." In *IEEE International Conference on Bio-Inspired Systems and Signal Processing* (BIOSIGNALS), Madeira, Portugal, January 2008.

Test-Case

Vocal performance of a traditional song

Constraints:

- Harmony/ Rhythm/Song Form
- EIC data part of soloist's performance
- Performance practice - vocal timbre

"The first (primary) factor is innate programmes for vocal expression of basic emotions." (p. 470)

Juslin, Patrik N and Sloboda, J. A. *The Handbook of Music and Emotion.* New York:Oxford University Press, 2010.

Spectral Delay

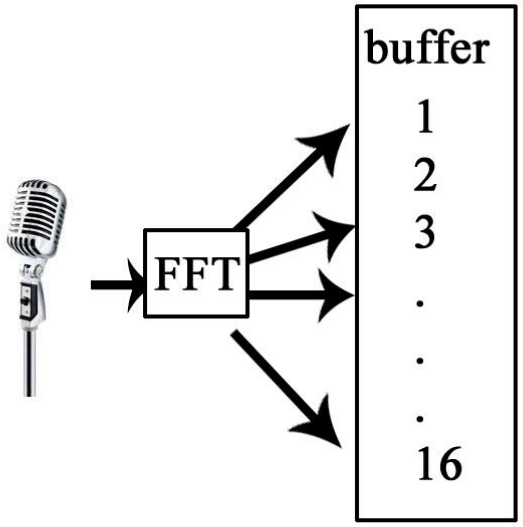
Provides detailed control over timing, delay, and feedback of individual frequency bands.

Charles, Jean-Francois. "A Tutorial on Spectral Sound Processing Using Max/MSP and Jitter." *Computer Music Journal* 32:3 (2008):87-102.

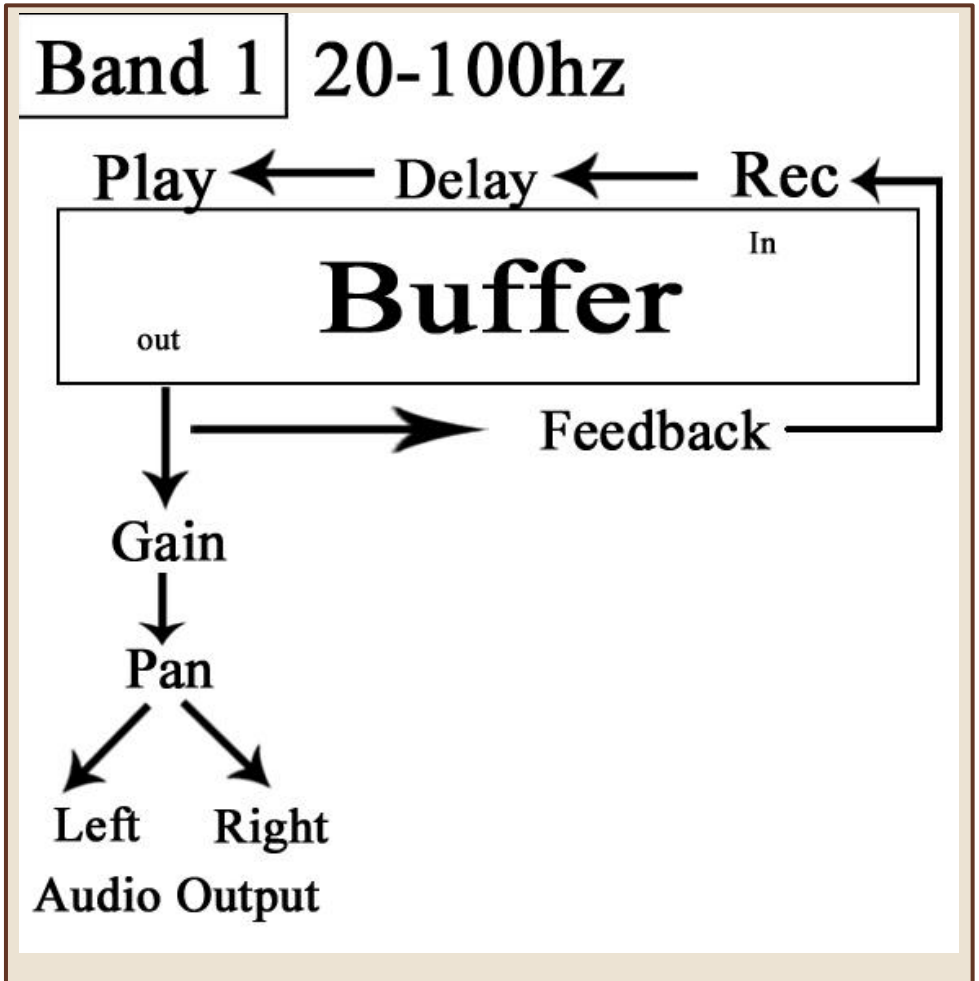
Gibson, John. "Spectral Delay as a Compositional Resource." *The Electronic Journal of Electroacoustics* 11:4 (2009): 9-12.

Basic Spectral Delay

Input:

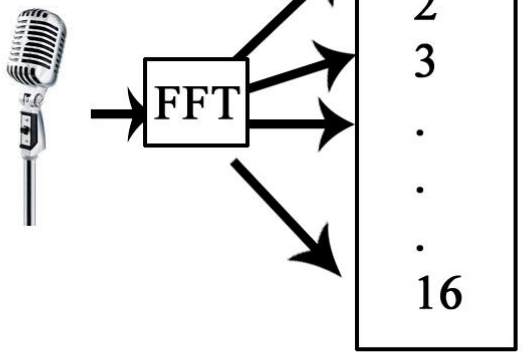


6:



Spectral Delay Sequencer

Input:



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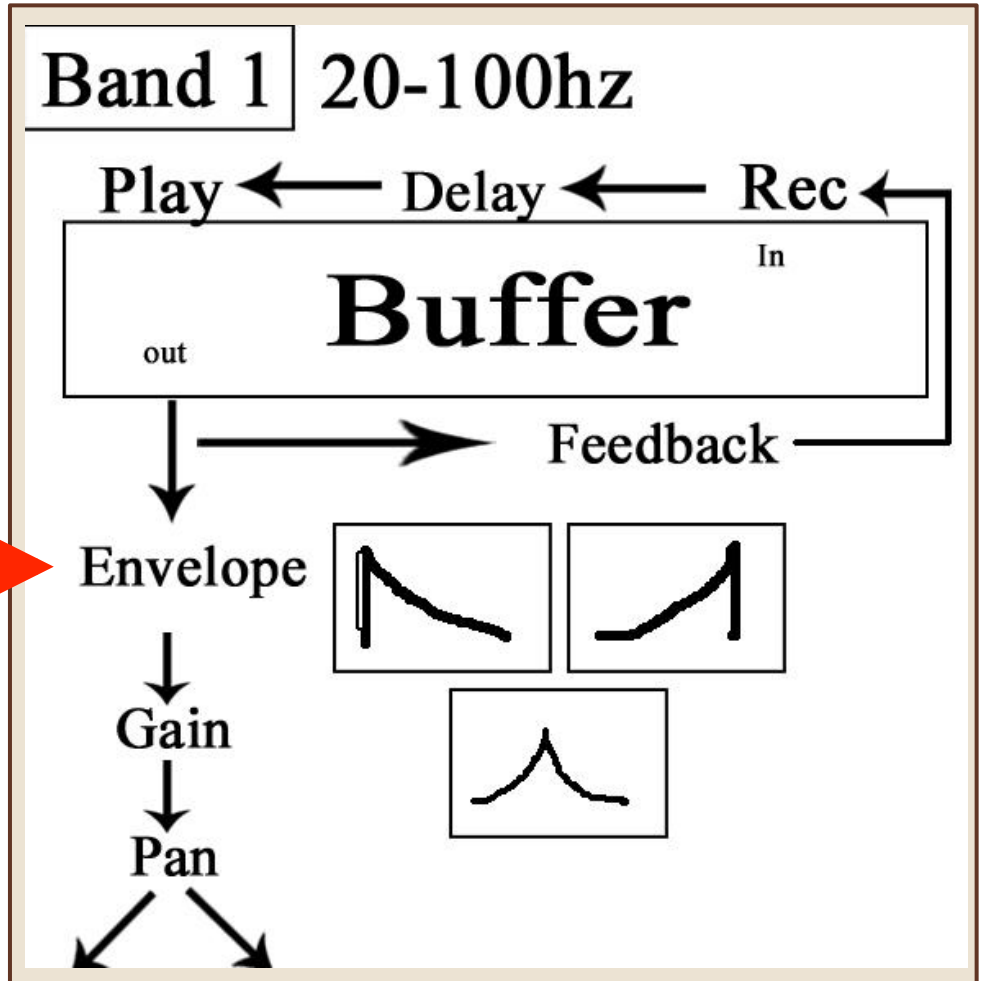

Correlation with Emotional Codes

Tenderness:

Slow mean tempo

slow tone attacks

low sound level

small sound level variability

legato articulation

soft timbre

large timing variations

accents on stable notes

soft duration contrasts

Spectral Delay:

Long delay time

Decreased sibilance (2-4k)

Low gain, feedback

uniform delay time of freq

high-frequency roll-off

Correlation with Emotional Codes

Anger:

high sound level

sharp timbre

spectral noise

fast mean tempo

small tempo variability

staccato articulation

abrupt tone attacks

sharp duration contrast

Spectral Delay:

increased gain

increased sibilance (2-4k)

non-uniform delay time

short delay

high-frequency roll-off

bright timbre