

## Abstract

• In current performance practice there is typically no physical connection between the human performer and the live electronics system, breaking the action-perception loop, which can render performers insecure.

• Leveraging recent work in the field of tactile notification we aim at closing this loop by communicating information from the live electronics system to the performer via the haptic channel.

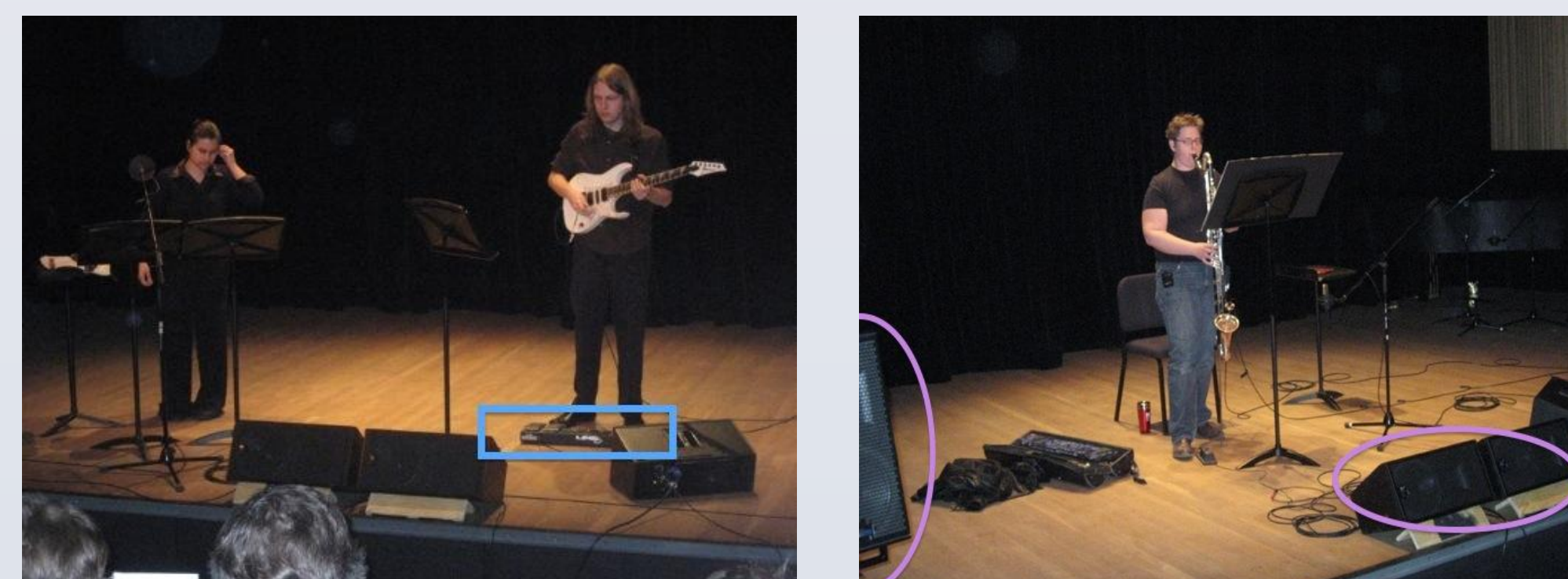
• We present a prototype tactile synthesizer, embedded in a Max-based modular software framework for live electronics, titled CLEF [1]. Tactile notifications can thus become an integral part of a musical score and communicate information to performers, allowing for tighter interaction with the live electronics system.

## The Problem

• A common problem in live-electronics performance is the lack of feedback to the performer about the state of the system, resulting in a sort of "limbo" in which s/he has no primary feedback

• Common practice to address this issue is providing auditory or visual feedback or the use of assistants in charge of the live-electronics system

• These solutions are often obtrusive and hinder the interaction between performer and system



## The Method

• Our approach is to use the haptic channel for communicating information

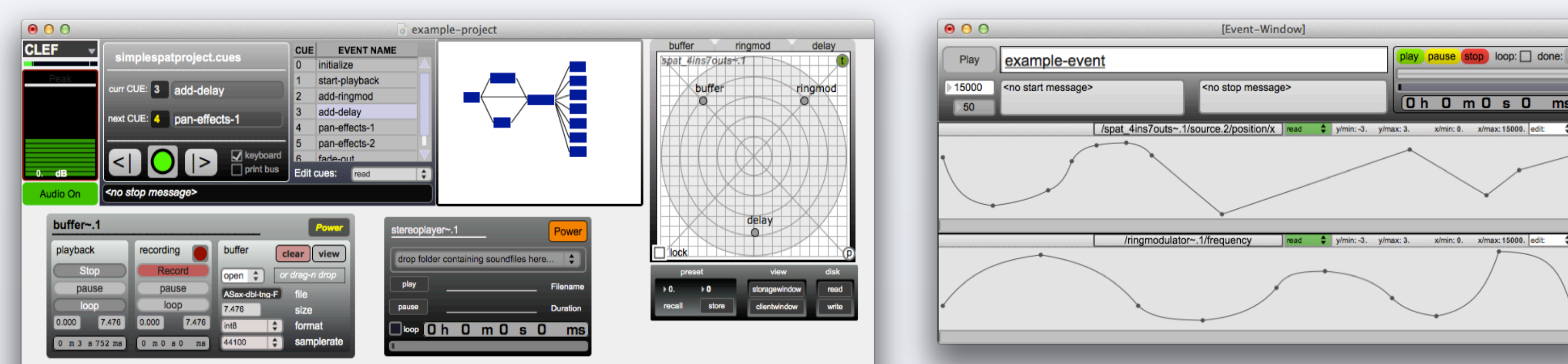
• Tactile Feedback has been used in various contexts of musical performance, mostly for performer-instrument interaction [2], [3]

• Our objective is to generalize this approach in order to convey both direct performance feedback and symbolic/abstract information (discrete, continuous)

• Aim is to implement a tactile synthesizer which allows tactile notifications to be treated as any other parameter of a live-electronics piece

## CIRMMT Live Electronics Framework

- CLEF is a modular framework for composition and performance with live-electronics in Max [1]
- Based on concept of Modules, organized in a hierarchical namespace in the OSC format [4]
- Score system based on *Events* (temporal data and programs) and *Cues*
- Graphical User Interface with *Views* and *Widgets*



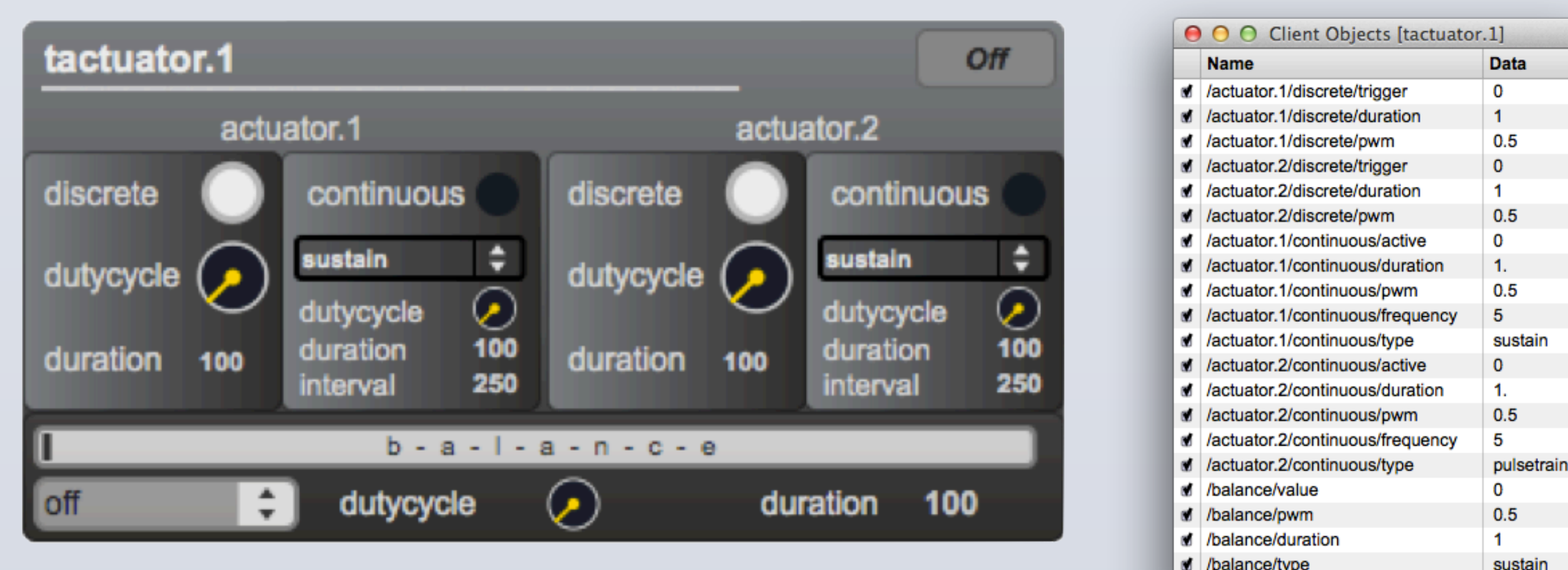
## Hardware Prototype

- Two vibrating discs driven by PWM from Arduino Nano
- Components have been chosen for inexpensiveness & availability
- Use of velcro band for to keep actuators in constant firm contact with skin
- Position of actuators on performer's back symmetrical about the spine: allows for easy discrimination between left vs. right side stimuli [5]



## Software Prototype

- Tactile Synth implemented as a CLEF synthesis Module
- Benefits from common functionalities and infrastructure: preset storage, interpolation, automations, mapping, etc.
- All parameters accessible through OSC namespace (MVC) or *patrr*
- 2 Modalities: Individual Mode vs. Balance Mode
- Parametric control of stimuli: discrete, continuous, etc. with adjustable intensity



## Preliminary Evaluation

• Design of 2 musical tasks for preliminary evaluation of effectiveness of the system to communicate temporal and spatial information:

- Task 1 (individual mode, discrete):  
rhythmic synchronization for loop-based overdub recording: *'haptic clicktrack'*
- Task 2 (balance mode, continuous):  
musical phrasing according to sound source position in a spatialization system: *'haptic intensity panning'*

## Conclusions

- Effectiveness of the display in conveying both temporal and spatial information was rated as very high by the performer
- Device was judged as unobtrusive and it did not hinder performer's movement and musical expressivity
- Tactile display was rated "second best" in conveying information, after visual feedback but before auditory feedback.

*"...in a situation where performers must focus their attention on the sheet music or difficult musical passages or when performers need to be in close visual contact with another performer, tactile feedback is the perfect solution to provide the necessary information to the performer."*

• Supports our hypothesis that communicating information via the haptic channel is less distracting than using visual/auditory sensory modalities

• Preliminary findings are suggestive that tactile notifications could effectively become a parameter included in live-electronic pieces

## References

- [1] <http://clef.sf.net>
- [2] Giordano, M., Wanderley, M.M.: Perceptual and technological issues in the design of vibrotactile-augmented interfaces for music technology and media. In: Haptic and Audio Interaction Design (HAID) 2013, Lecture Notes in Computer Science (LNCS). Springer (2013)
- [3] Michailidis, T., Berweck, S.: Tactile Feedback Tool : Approaching the Foot Pedal Problem in Live Electronic Music. In: Proceedings of the International Computer Music Conference (2011)
- [4] Wright, M., Freed, A., Momeni, A.: OpenSound control: state of the art 2003. In: Proceedings of the 2003 conference on New interfaces for musical expression. pp. 153-160. NIME (2003)
- [5] Jones, L.A., Kunkel, J., Piatieski, E.: Vibrotactile pattern recognition on the arm and back. Perception 38(1), 52-68 (2009)

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