A Flexible Tool for the Visualization of Musical Mapping Networks

Master's Thesis Proposal; Music Technology
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Introduction

In a digital musical instrument (DMI) the physical control surface is separate from the sound synthesizer (Hunt, Wanderley, & Kirk, 2000), greatly differentiating it from its acoustical counterparts. Thus the mapping of control surface outputs to synthesizer inputs becomes a critical factor in the implementation of DMIs. It is often necessary for performers and composers with little programming expertise to quickly customize mappings for specific performances and pieces. Libmapper (Malloch, Sinclair, & Wanderley, 2008), an Open Sound Control (OSC) (Wright & Freed, 1997) based application programming interface (API), has been developed at the Input Devices for Music Interaction Laboratory (IDMIL) to help accomplish this task.

In the current graphical user interface (GUI) for libmapper, mappings are created by patching[1] together control and synthesis parameters from two lists. These lists are searchable and filterable to aid performances with many instruments. However, this approach is not scalable if many devices exist, as it gives no impression of the network's higher-order structure.

The goal of this research is to design and develop a flexible GUI for libmapper, with special emphasis on visualizing the large amount of hierarchical information inherent in a musical mapping network. The final interface will be capable of demonstrating the network's overall structure while also providing information about individual connections. The tool will allow the user to select which features of the network shall be associated with which dimensions of the visual interface in order to best communicate the state of the system and allow for greatest ease of manipulation.

Previous Work

The tremendous expansion of data set sizes in our information era (Tufte, 2006) has begotten a similar theoretical expansion for displaying said information. Grounded in Tukey's (Tuckey, 1965) assertion that we must be "approximately right, rather than exactly wrong," the works of Tufte (Tufte, 2006, 1990) expound upon the best practices for line diagrams, data labels, colors and layouts in evidence displays.

For pure visualization, Braun[2] gives users basic displays of OSC data flows. The Allosphere (Höllerer, Kuchera-Morin, & Amatriain, 2007) at the University of California is a building-sized, spherical display built for the navigation of large sets of data using auditory and visual cues.

On the interface side, many prior connection-type interfaces rely on a patching metaphor (Bullock, Beattie, & Turner, 2011)[3], while (Holten, 2006) describes mathematical ways of "bundling" connections to reveal a network's higher order structure. Simple list interfaces are also common (STEIM, 2004)[4], wherein users select control surface outputs and associated synthesizer inputs from drop down menus. Building upon the patching metaphor, (Booth, 2010) locates the network's inputs and outputs in space, and nests parameters within certain structures, such as instruments. The EaganMatrix[5] uses a distinctive connection metaphor built around a matrix of input and output parameters. Users make connections between parameters by placing a "pin" at their intersection on the matrix. (Rudraraju, 2011) describes an alternative GUI for libmapper, specifically designed for networks with an intensely hierarchical structure wherein instruments contain many nested layers of sub-devices and signals.

[1] Clicking and dragging between parameters, creating a visual connection analogous to patch bays in synthesizers.
[2] J. Bullock, "Braun." http://lists.create.ucsb.edu/pipermail/osc_dev/2008-March/001327.html
[3] David Robillard, "Patchage." http://drobilla.net/software/patchage/
[4] Wildora, "Osculator." http://www.osculator.net/
[5] http://www.hakenaudio.com/Continuum/eaganmatrixoverv.html

Working towards a standard for networked gestural communication in music, (Jensenius, Kvifte, & Godøy, 2006) details a standardized vocabulary and syntax for describing signals. Standards of OSC networking, both lexical and visual, are presented in (Place & Lossius, 2006; Baalman et al., 2010). (Wolek, 2010) describes a system for visualizing information sent over a musical network.

Proposed Research/Methodology

This project will be structured in three major parts: (i) a review of prior visualized mapping interfaces, (ii) the updating and integration of presently available GUIs for libmapper and (iii) extension of interface features.

I will begin part one by reviewing previous work in visualized mapping interfaces including (Rudraraju, 2011; Booth, 2010; STEIM, 2004), with special attention paid to visual features displaying the state of the system. Other connection-based interfaces (Bullock et al., 2011; Place & Lossius, 2006)[3] will also be reviewed for effective visual features.

Presently, three GUIs exist for libmapper: mapperGUI, webmapper and Vizmapper (Rudraraju, 2011). MapperGUI is built using the MaxMSP language. It is currently the most up-to-date and feature-rich of the GUIs, but has the disadvantage of not being cross-compatible and relies heavily on third party software. Webmapper is an Internet browser-based extension for the libmapper library, using a list-and-connection metaphor similar to mapperGUI. The user-interface side of the application operates upon JavaScript and HTML5, while it communicates with libmapper using a custom Python monitor. Though it is not presently as visually refined as the mapperGUI, the portable, cross-platform nature of webmapper is a more natural fit for a standard GUI for libmapper. In part two webmapper will be updated to include features currently present in mapperGUI. The main functionalities of Vizmapper will also be integrated as one of the possible view modes. Vizmapper excels at displaying networks with multilayered hierarchies, yet is less than ideal for networks with many instances of the same device, or devices with numerous signals. The end result will be a single, integrated user interface, containing the most effective features of the previous three based on feedback from long-term users.

During the third portion, extensions to the overall interface will be designed in JavaScript. They will include options for patching matrices, devices grouped by location on screen and hierarchical edge bundling[6] (Holten, 2006). Connected block diagrams as in (Bullock et al., 2011) and force diagrams will be explored. The current input/output list model will also be maintained. No single overall structure is to be forced upon users, as flexibility is key. What may be a good arrangement for certain networks may be overcomplicated, obscure or confusing for others. The power of configuration will be given to the user.

Within these visualization schemes, signal and device attributes, such as spatial position, update rate and device type, can be user-correlated to visual parameters like size, color, line-weight and position of objects. The goal is to create a sort of “meta-mapper,” where users are free to connect the devices and signal features with visual properties that are best suited to their network and creative style.

Contributions

Mapping is an essential feature of DMIs, and libmapper is an already widely-used open-source solution for performers and composers who wish to experiment with their mappings. The development of an intuitive, flexible interface for libmapper is an outstanding need for the library, due to the shortcomings of the user interfaces listed above. Not only will a visual tool help expert operators, it will also make libmapper more accessible for novice users of computer instruments.

Furthermore, this research will provide a review of data visualization literature with an emphasis on musical and mapping application displays. Such information will be useful to the designers of musical software as these tools continue to progress into a solidly multi-modal realm.

[6] A visualization technique in which connections are re-routed so that they are grouped according to the system’s structure.

References

Baalman, M., de Belleval, V., Salter, C. L., Malloch, J., Thibodeau, J., & Wanderley, M. M. (2010). Sense/stage - low cost, open source wireless sensor infrastructure for live performance and interactive, real-time environments. In *Proc. of linux audio conference* (p. 242-249).

Booth, G. (2010). *Inclusive interconnections: Towards open-ended parameter-sharing for laptop ensemble.* Unpublished master's thesis, University of Huddersfield, Huddersfield, England.

Bullock, J., Beattie, D., & Turner, J. (2011). Integra live: a new graphical user interface for live electronic music. In *Proc. of international conference on new interfaces for musical expression* (p. 387 - 392).

Höllerer, T., Kuchera-Morin, J., & Amatriain, X. (2007). The allosphere: A large-scale immersive surround-view instrument. In *Proc. of workshop on emerging displays technologies* (p. 21 - 28).

Holten, D. (2006, September/October). Hierarchical edge bundles: Visualization of adjacency relations in hierarchical data. *IEEE Transactions on Visualization and Computer Graphiscs*, *12*(5), 741-748.

Hunt, A., Wanderley, M. M., & Kirk, R. (2000). Towards a model for instrumental mapping in expert musical interaction. In *Proc. of international computer music conference (icmc 2000)* (p. 2-5).

Jensenius, A. R., Kvifte, T., & Godøy, R. I. (2006). Towards a gesture description interchange format. In *Proc. of the 2006 international conference on new interfaces for musical expression (nime06)* (p. 176-179).

Malloch, J., Sinclair, S., & Wanderley, M. M. (2008). A network-based framework for collaborative development and performance of digital musical instruments. *R. Kronland-Martinet, S. Ystad, and K Jensen. (Eds.): CMMR 2007, - Proc. of Computer Music Modeling and Retrieval 2007, Conference, LNCS 4969. Berlin Heidelberg: Springer-Verlag*, 401-425.

Place, T., & Lossius, T. (2006). Jamoma: A modular standard for structuring patches in max. In *Proc. of international computer music conference (icmc 2006).*

Rudraraju, V. (2011). *A tool for configuring mappings for musical systems using wireless sensor networks.* Unpublished master's thesis, McGill University, Montreal, Canada.

STEIM. (2004, Summer). Products of interest. *Computer Music Journal*, *28*(2), 105-107.

Tuckey, J. W. (1965, April). The technical tools of statistics. *The American Statistician*, *19*(2), 23-28.

Tufte, E. R. (1990). *Envisioning information.* Graphics Press.

Tufte, E. R. (2006). *Beautiful evidence.* Graphics Press.

Wolek, N. (2010). The mpg carepackage: coordinating collective improvisation in max/msp. In *Proc. of the society for electro-acoustic music in the united states (seamus 2010).*

Wright, M., & Freed, A. (1997). Open soundcontrol: A new protocol for communicating with sound synthesizers. In *Proc. of international computer music conference (icmc 1997)* (p. 101-104).