Concept Tahoe: Microphone Midi Control

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ABSTRACT

We have developed a prototype wireless microphone that provides vocalists with control over their vocal effects directly from the body of the microphone. A wireless microphone has been augmented with six momentary switches, one fader, and three axes of motion and position sensors, all of which provide MIDI output from the wireless receiver. The MIDI data is used to control external vocal effects units such as live loopers, reverbs, distortion pedals, etc. The goal was to to provide dramatically increased expressive control to vocal performances, and address some of the shortcomings of pedal-controlled effects. The addition of gestural controls from the motion sensors opens up new performance possibilities such as panning the voice simply by pointing the microphone in one direction or another. The result is a hybrid microphone-musical instrument which has recieved extremely positive results from vocalists in numerous informal workshops.

Keywords

NIME, Sennheiser, Concept Tahoe, MIDI, control, microphone

1. INTRODUCTION

The microphone industry sometimes refers to the microphone as the "vocalist's instrument[1]". While a vocal teacher might disagree with this designation, there are many ways in which an ordinary microphone can be manipulated for expressive control just like a woodwind or brass instrument. For example, vocalists can expressively alter the angle of the microphone and distance to the mouth in ways that, depending on the proximity effect and polar response of the microphone, can strongly vary the timbre of their voice. In this way a microphone has much in common with a traditional musical instrument. And when you add interactive effects such as live looping into the signal chain, the entire signal chain becomes a type of musical instrument.

1.1 Vocal Effects as a Paradigm Shift

A growing number of vocalists are using effects pedals. Although some effects such as the phase vocoder [8] have been used by a few vocalists for decades, the effects pedal has primarily been a tool for guitarists. However, in the last few years this has been changing, and there are now companies such as TC Helicon devoted solely to effects for vocalists. One extremely popular effect pedal for vocalists is the live looper, which allows vocalists (and instrumentalists) to loop and overdub their voice or instrument over and over to achieve highly orchestrated songs. This is becoming increasingly popular, with new live looping hardware available every year (for example the Boss RC50, Digitech Jamman, and Looperlative LP1, just to name a few) and multiple worldwide festivals dedicated to this practice. Live looping pedals are typically operated by foot, and they require a great deal of interaction in order to start, stop, and play different tracks on the fly. In this way a live looping pedal could be considered an instrument on its own.

1.2 Concept Tahoe

In order to improve the interaction with loopers and other effects pedals, we have developed what we call the Concept Tahoe prototype microphone (figure 1). We have augmented a wireless microphone with buttons, faders, and motion/position sensors in order to give users obvious, intuitive and intimate control over their sound and looping effects.

Figure 1: Concept Tahoe: A wireless microphone augmented with buttons, faders, and motion sensors.

2. BACKGROUND

There are many examples of what Miranda and Wanderley refer to as "augmented instruments" [10], where sensors are placed onto existing musical instruments to enhance musical interactivity. Examples of this phenomenon are Cook/Morrill's augmented trumpet and Tod Machover's hyper-violin[10]. There has also been much recent work

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done in the field of motion controlled gestures over musical performance, again detailed by Wanderley and Miranda [10]. Due to the recent ubiquity of accelerometers and other motion sensors, there have been many recent implementation of gestural musical control, from mobile phones [7] [11] to commercial devices such as the Source Hot Hand MIDI-EXP. [4]

2.1 Other Examples of Mic Control

We are not the first people to put buttons on a microphone. Many microphones made for karaoke systems, for example, have buttons located on the microphone body for navigating through different songs. To our knowledge karaoke machines are the earliest instance of microphone control.

In the mid 1990's John Popper, the lead singer and harmonica player for the band Blues Traveler, used duct tape to fasten buttons to his microphone in order to turn his effects pedals with his hand while playing harmonica [9].

As we were developing the Tahoe microphone, two more examples of microphone control cropped up. The I am TPain microphone [2] (2011) uses buttons to control an autotune effect. Also, in 2011 TC Helicon released the MP-75, a wirebound microphone with a button on it used for controlling parameters of TC Helicon effects pedals [5].

2.2 Problems with pedal control

For the project we interviewed and observed multiple vocalists who use live loopers or other interactive effects and thus were able to identify what many vocalists describe as shortcomings of foot-to-pedal interaction. The three most common issues we observed were lack of eye contact, poor expressive control, and sight-to-sound connection.

2.2.1 Pedal Issue 1: Eye Contact

The first primary problem with pedal control is that it pulls the audience's focus onto the user's feet, instead of their face. As one of our vocal workshoppers put it, if the performer is looking at their feet, the audience is looking at their feet. Users reported that this can really distract from the performance, especially if there is a great deal of interaction with the pedal.

2.2.2 Pedal Issue 2: Expressive Control

Another problem with pedal control is the lack of accurate expressive control over the sound. Continuous expression pedals, such as those used for volume sweeps or wah-wah effects, are difficult to control with your feet simply due to the mechanics of moving one's feet.

2.2.3 Pedal Issue 3: Sight-Sound Connection

Another issue with pedal interaction is the difficulty for audience members to connect what they see with what they hear. When a violinist pulls the bow across the violin strings, the audience members can connect the bow gesture with the sound of the violin and more easily understand what the artist is doing to produce the sound. This connection between what the the audience members see and what they hear is an important part of the performance, and most pedal interaction that we observed was too difficult to see to make these connections.

3. CONCEPT TAHOE

The Concept Tahoe microphone addresses the problems with pedal control by offering controls that you operate right on the microphone. The prototype microphone is based on the Sennheiser Evolution Wireless 500 series microphone, with modifications made to extend the length of the body to allow for the added electronics. In this prototype the data line is communicated over a 2.4ghz signal. The overall flow of control can be seen in figure 2. The audio and sensor states are sent wirelessly to the receiver, which converts the sensor data to MIDI signals. Audio and MIDI data are then sent into an effects processor.

3.1 Buttons

We placed five buttons on the front panel mic (see figure 3) in order to solve the eye contact problem. The buttons function just as buttons on a pedalboard would. Users can start, stop, and overdub their loops, toggle their reverb or distortion on and off, toggle through full effect presets and jump to the next section of a song. The buttons are particularly effective for live looping, as well as for controlling section-based software such as Ableton Live.

Figure 3: Buttons On Front Panel: Five buttons on the front panel substitute for buttons on a pedal. They offer on-off, toggle, or other instantaneous control over effects.

The buttons were placed mid-way down the mic so that the vocalist can hold the mic in one hand and works the button controls with the other, maximizing agility. Three of the buttons are located lengthwise along the mic, with two smaller buttons that can be operated by the pinky finger. There are also LEDs beneath each button to provide visual feedback. These are controlled by MIDI in signals from the effects processor, and the mappings are entirely configurable.

Figure 4: Continuous Control: Fader on back panel allows for continuous control over volume levels, wah-wah, etc.

3.2 Continuous Control

To address the expressive control issue we added a fader to the back panel of the microphone (see figure 4). The fader is operated with the user's thumb, and feels very similar to the fader on a mixer. Using the fader for even simple controls

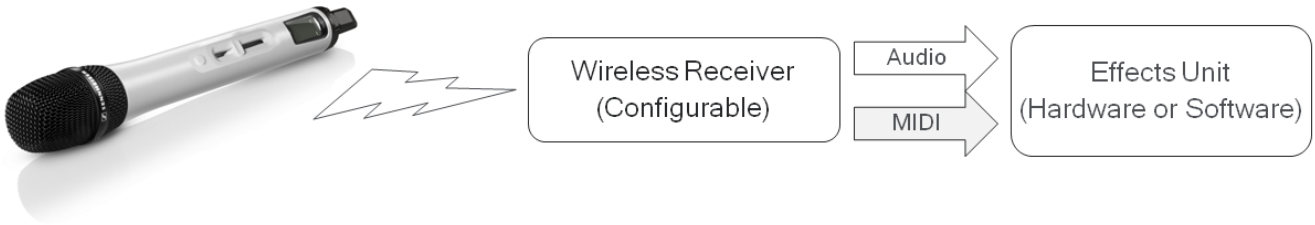
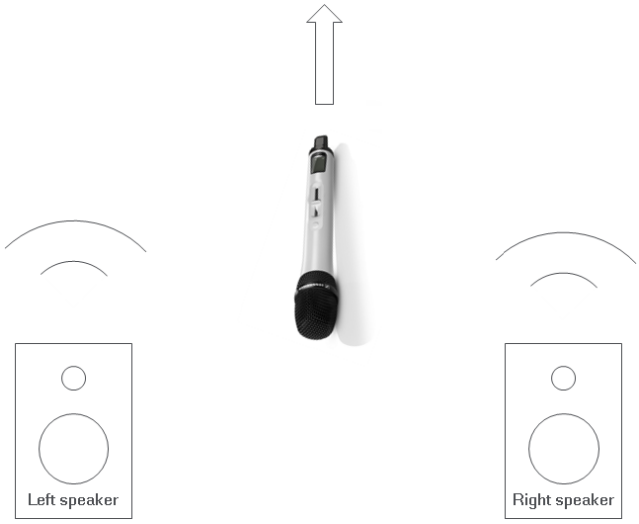


Figure 2: Concept Tahoe Data Flow: Audio and sensor information is sent wirelessly to the receiver, which sends the audio to the effects unit and translates the sensor data into MIDI. This allows the sensor information to be configured flexibly.

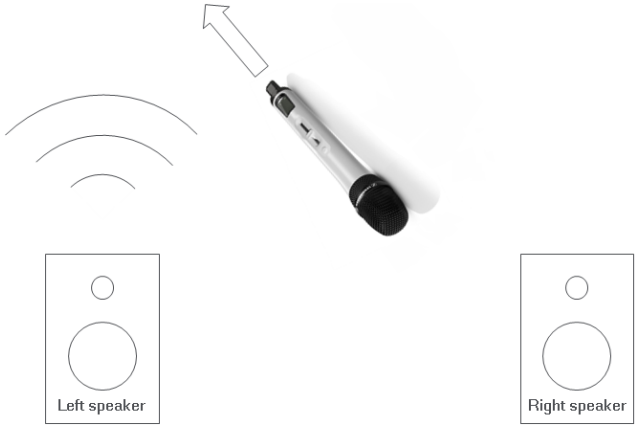
such as volume can be surprisingly expressive and effective. It can also be used for wah-wah effects, pitch shifting, or any other effect that uses MIDI continuous control messages.

3.3 Gestural Control

For improved connection between sight and sound, we have added motion and rotational position sensors to the Tahoe microphone, in the form of a 3-axis gyro and 3-axis accelerometer. Computations are made on the gyro sensors in the form of quaternion rotations [6] to allow the microphone to calculate which direction it is facing and send this data in the form of configurable continuous control messages. In order to avoid unintentional gestures we placed a sixth button called an activation button, on the back of the mic near the fader (see figure 4). The position and acceleration data is only sent when the button is depressed. Typically the activation button is operated by the user's thumb of either hand. The gestural control really opens up new possibilities for vocal performance. For example, the user could map the vertical direction to a pitch bending effect, so that sweeping pitch changes can be communicated by lowering and raising the mic. A very popular implementation of gestural control is the ventriloquist, or panning effect. In the ventriloquist effect, the user can pan the location of their voice simply by pointing the mic. So, as in figure 5(a), if the vocalist is pointing directly forward and there are 2 stereo speakers, his/her voice is projected forward equally by the two speakers. But if the vocalist wants to "move" their voice to one side of the room, he (or she) just depresses the activation button and points to the left as in figure 5(b). Many of the vocalists who tested the mic identified this as his/her favorite effect.



(a) When the user is pointing the mic to the center, the sound is panned equally between the speakers.



(b) When the microphone is pointed to one side the sound can be panned in that direction.

Figure 5: Gestural Panning: The rotational sensors inside the microphone turn simple panning into a gestural effect.

4. DEVELOPMENT

For the early design stages, we created an ultra-rapid prototyping system consisting of a microphone extension with sensors and related PCBs attached with movable putty (see figure 6) in order to allow artists to quickly try out different sensors in a variety of different positions. The sensors were connected to an Arduino microcontroller which communicated the sensor states with Max/ MSP for instant implementation of simple effects control. We then workshopped these prototypes with a variety of different artists and had them experiment with effects and move the sensors to where they were most comfortable. We tried many different sensors, including buttons, sliders, squeeze/force sensors, proximity sensors, accelerometers, rotary dials, capacitive touch sensors, gyros, accelerometers, LEDs, and touchscreens for visual feedback.

4.1 Initial Design Results

In general the users gravitated towards a clarinet-like layout, as implemented in our later prototype. Users with wind

instrument experience were (not surprisingly) faster at developing agility with the prototype. Most artists prefered simple buttons over other sensors, although enough people wanted an easy continuous controller that we went with the single-fader design.

We found that while people loved the gestural control, users found it intimidating to suddenly be concerned with the way that they were holding the mic. The use of a dedicated activation button alleviated user fears of accidentally triggering effects.

Overall, response has been extremely positive, and most of our test users were eager to add the Tahoe mic to their arsenal of musical tools.

Figure 6: Early Tahoe Prototype: Early prototypes of the Tahoe mic were tested using sensors attached to the mic with blue putty, allowing for rapid prototype iterations and mutability, even during user testing.

4.2 Effects Mapping

Choosing what each sensor should control has been a major challenge of this project, since every user has different needs, and every pedal has different functions. Thus, choosing the mappings is an ongoing process, and there is no one-size-fits-all setting, which is why we opted to use a MIDI output instead of dedicated effects. For later testing we patched the audio and MIDI output of the microphone into a Muse Receptor [3] which hosted many configurable VST effect plugins, and had the users specify how they wanted the various sensors to be operated. We have found that there are a few types of functionality that are popular. When optimizing for loopers, for example, we settled on a 4-button, three track looping setup (see figure 4.2). When configuring the system for a more generalized audience users, we settled on using 2 buttons for looping and the rest for reverb, pitch bend, or other interesting effects. The panning/gestural mapping has also proven to be very popular.

4.3 Video

We demonstrated the microphone at the NAMM conference in January 2011, and video of this can be found at `http://www.youtube.com/watch?v=9dYdWrbhUNI`. We have video footage of master beatboxer Ekips (figure 8) at `http://www.youtube.com/watch?v=C1WY3jkw4js`.

4.4 Conclusion / Next Steps

By adding buttons, a fader, and motion sensors to a wireless mic, we feel we have created a new instrument which allows vocalists more performative, intimate, and connective control over their effects. We should stress that Concept Tahoe is not a product on the market yet, but rather a patent-pending proof-of-concept. There is much work left

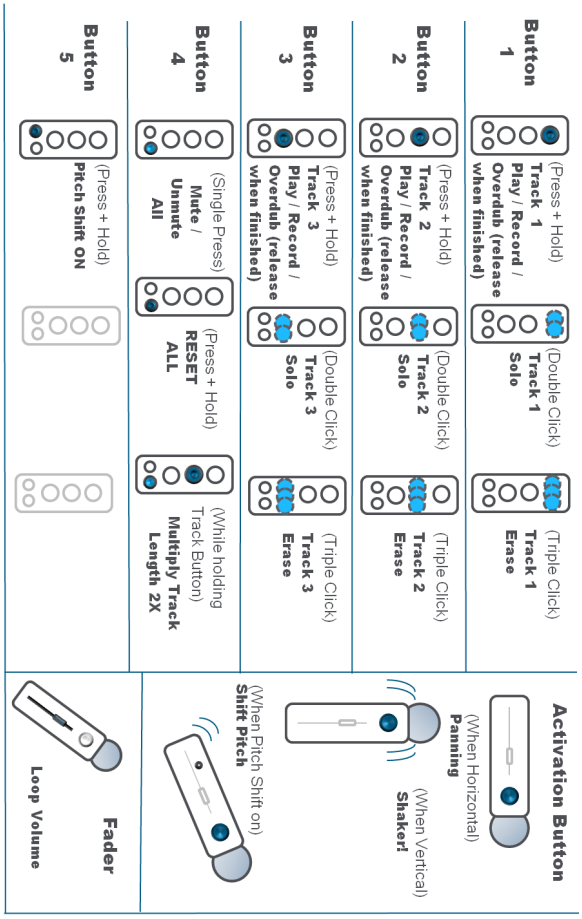


Figure 7: Effects Mapping: An example of multitrack-looping mappings, using buttons 1, 2, and 3 as general track buttons and button 4 for mute, multiply, undo, and reset. The fifth button is still reserved for effects changes.

Figure 8: Eklips With Tahoe: Master French beatboxer Eklips provided great feedback on the specific needs of looping beatboxers.

to do, and we are continuing to refine the Tahoe mic as we get more feedback. We are hoping to continue shaping it into a tool that can be used by vocalists and musicians of all kinds.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Based on conversations with achim gleissner and the sennheiser microphone team.

[2] I am t-pain review. `http://www.iamt-painmic.com/`. [Online; accessed 03-Feb-2012].

[3] Muse receptor. `http://www.museresearch.com/products/index.php/`. [Online; accessed 16-Apr-2012].

[4] Source hot hand midi exp controller. `http://www.sourceaudio.net/products/hothand/midi_exp.php`. [Online; accessed 015-Apr-2012].

[5] Tc helicon mp 75. `http://www.tc-helicon.com/products/mp-75/`. [Online; accessed 03-Feb-2012].

[6] E. R. Bachmann. *Inertial and Magnetic Tracking of Limb Segment Orientation for Inserting Humans into Synthetic Environments*. PhD thesis, Defense Technical Information Center OAI-PMH Repository [http://stinet.dtic.mil/oai/oai] (United States), 1998.

[7] G. Essl, D. T. Laboratories, and M. Rohs. Shamus – a sensor-based integrated mobile phone instrument. In *Proceedings ofthe International Computer Music Conference*, volume 40, pages 1–4. Citeseer, 2007.

[8] J. L. Flanagan and R. M. Golden. Phase vocoder. *Bell System Technical Journal*, 45:1493–1509, 1966.

[9] D. Gershuny. John popper and blues traveler, til death do us part...? *Gig Magazine, National*, December 1999. [Online; accessed 02-Feb-2012].

[10] E. Miranda and M. Wanderley. *New Digital Musical Instruments: Control And Interaction Beyond the Keyboard*. A-R EDITIONS, INC., Middleton, WI, 2004.

[11] G. Wang, G. Essl, and H. Penttinen. Do mobile phones dream of electric orchestras? In *Proceedings ofthe International Computer Music Conference*. Ann Arbor, MI: Scholarly Publishing Office, University of Michigan Library, 2008.