Blindsight: A Reactive Tool for Symbiotic Performance and Organic Signal Processing

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Abstract

Blindsight is a bespoke wearable I2C motion sensor device built for performance and organic signal processing, as well as the name of an accompanying live performance. This device allows for real-time wireless control of Ableton Live and Max/MSP parameters by the magnetic vector, acceleration, angular rate, and gravity of the device's sensors. The software component of *Blindsight* is a custom-built Max for Live device called *A0.gest*, which was developed to interface with a smartphone or I2C device to allow for the use of natural and unconscious body movements to manipulate audio, video, and data signals in real time and through complex customizable parameters. *A0.gest* can utilize up to 13 parameters from 5 discrete signals to map to and control Ableton Live, as well as any program capable of receiving OSC messages.

The *Blindsight* device allows its user to utilize their organic motion, gestures, and movement as an interface with digital signal processing and develop a reciprocal and symbiotic relationship between organic body and digital signal that models the relationship between musician and instrument that is seen in many acoustic instruments, such as the violin. The accompanying performance for violin and movement was created as a proof-of-concept to demonstrate this reciprocal theory. Strapped to the bow arm while playing the violin, *Blindsight* transmits the speed, position, acceleration, and direction as the performer plays and moves around the performance space. As the performer's movements manipulate and process the signals coming from the violin in real time, the resulting processing elicits direct feedback to the performer, forming a closed reciprocal loop.

Keywords

Performance, DSP, Digital Signal Processing, Motion Sensor, Audiovisual, Music, Electroacoustic, Max/MSP, Ableton Live

Introduction

Using the schematics for CNMAT's *MARGO* device as a starting point, the *Blindsight* device aims for with a larger degree of freedom, reliability, and stability, direct integration with Ableton Live, more sensor parameters, and eventual integration with other motion and biosensors.[2] Built using an ESP32, LSM6DS3, and LIS3MDL, the current iteration of the device features 10 degrees of freedom, wireless OSC transmission over Wi-Fi and Bluetooth, and 5-7 hours of battery life.

The accompanying Max for Live device, *A0.gest,* was developed to allow for direct mapping and advanced control of *Blindsight* within Ableton Live. The development of *A0.gest* evolved to focus on compatibility with any smartphone to allow for greater accessibility due to the ubiquity of smartphones, and has subsequently been released for free to allow for anyone to access similar capabilities without the cost or technical difficulty of assembling their own copy of *Blindsight*. The smartphone, which can be held or attached to any part of the body, connects wirelessly to *A0.gest* over Wi-Fi to transmit its motion sensor data in real-time. These parameters can be mapped to control any sound, video, or data signal with a single button press and a high degree of configurability. (Fig. 1).

Built with music and performance in mind, *Blindsight* allows its user to utilize their minute and unconscious movements, as well as more deliberate gestures, as an interface with their signal. As the user's movements dictate the processing of the signal, the user will naturally respond in turn, creating a symbiotic and reciprocal relationship between the user and their signals in which both have equal effect on the other, and effectively collapse the distance that lies between the musician and the digital processing of their instrument.

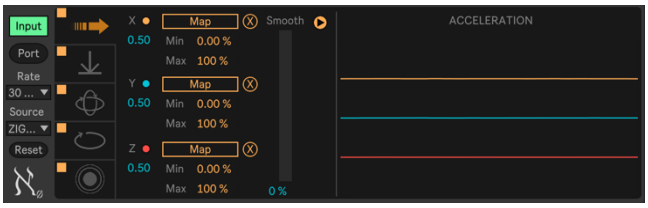

Fig. 1 The user interface of the *A0.gest* Max for Live device in Ableton Live 12. Here it is configured to utilize acceleration, gravity, gyroscope, quaternion, compass, and touch.

Correlation and Acoustic Symbiosis

Correlation describes the relationship between mental command and physical movement when a musician plays their instrument.[1] With traditional acoustic instruments such as the violin, correlation is bidirectional. The musician forms the mental command to move in a certain way to elicit a particular response from their instrument, and by receiving the physical feedback from their instrument, such as the strain on the strings or grip of the rosin on their bowstrings, the musician adjusts the mental commands they give to then elicit the best possible tone in response. In this way, the instrument itself affects the musician as much as the musician affects the instrument. This bidirectional correlation is interrupted in traditional electronic music interfaces such as laptops, pad controllers, and mixers. Without providing direct feedback to the subtle and unconscious movements of the player, these interfaces fail to capture the symbiotic relationship present in bidirectional correlation and thus lose an entire dimension of organic expression.

Sensors as Unique Identifiers

A unique by-product of developing *A0.gest* for smartphones is the ability to utilize the extensive body of research that has been conducted on the utilization of the minute and often unconscious movements of the body with the in-built motion sensors in smartphones for the purposes of personal identification. Like a fingerprint, each individual has characteristic movements and positions when using a smartphone that are unique to that individual. From gestures, touch pressure, angle preferences and more, the unique behavioral characteristics of every individual are an intrinsic part of their interaction with their phone.[3] Given these technological capabilities and the ubiquity of smartphones in the Western world, these in-built sensors are an ideal candidate for an accessible, precise, and sensitive way to capture movement. This can be harnessed to extend the dimension of bidirectional correlation to digital signal processing. In turn, this allows each user to translate the singular and distinct characteristics of their movement to the otherwise uniform realm of digital signal processing.

Unconscious Digital Signal Processing

With the symbiotic relationship of correlation and the capabilities of smartphone sensors to capture unique and unconscious movement in mind, *Blindsight* was created to amend the dimensional lack of typical interfaces for digital signal processing and allow for new possibilities of organic expression. *A0.gest* is the name for the software component of *Blindsight.* It is a Max for Live device that receives incoming OSC data from smartphone or I2C sensors over Wi-Fi and creates a mappable interface in which each axis of these signals can be assigned to parameters in Ableton Live through mappable buttons. By default, *A0.gest* can receive up to 13 mappable signals from 5 discrete sensors including acceleration, gravity, quaternion, compass, and touch. The device is easily configurable to use with any number of sensors from I2C or IoT devices capable of sending OSC. These parameters can be used to control audio, video, and data signals concurrently and in real time (Fig. 2). This device is envisioned to be used in both the context of performance and recording. Within the context of performance, *A0.gest* can be used with acoustic or digital instruments, dance, or other forms of physical performance, to create an immersive and reactive interaction with sound, signal processing, or live video (Fig. 3). Within the context of recording, *A0.gest* can be used in lieu of traditional knobs-slider-button interfaces to quickly and organically automate and modulate parameters or alter the tonal processing of live-input acoustic instruments to have a greater degree of control over the sound and ultimately allow for a more natural and organic mode of expression.

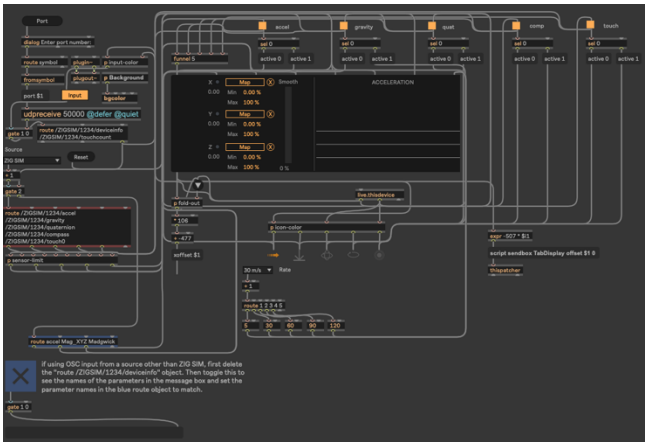

Fig. 2 A portion of the Max/MSP patch behind the user interface of *A0.gest*.

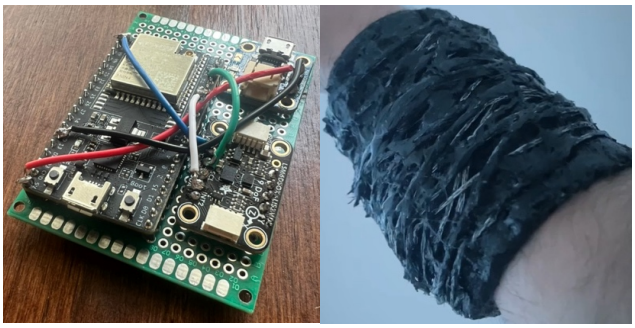

Fig. 3 *Left:* The *Blindsight* device's circuit, measuring 2cm x 3cm x 1cm. Not visible is the 1cm x 1cm x 0.5cm 1200mAh LiPol battery, attached to the back of the protoboard.
Right: The first custom housing developed for the *Blindsight* circuit (materials: elastic, pipe cement, steel braided cable).

References

[1] Galamian, Ivan. Principles of Violin: Playing & Teaching. Englewood Cliffs, NJ: Prentice-Hall, 1985.

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[3] Shen, Chao, Yuanxun Li, Yufei Chen, Xiaohong Guan, and Roy A. Maxion. “Performance Analysis of Multi-Motion Sensor Behavior for Active Smartphone Authen-tication.” IEEE Transactions on Information Forensics and Security 13, no. 1 (2018): 48– 62. https://doi.org/10.1109/tifs.2017.2737969.