

# zjam: A Platform for Gestural Musical Control and Multi-User Improvisation

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**Abstract - zjam is a low power experimental platform for real-time gestural control and user collaboration in a networked musical environment. The device is powered by 2XAAA batteries and features a PIC18F microcontroller, a 3 axis accelerometer, an 802.15.4 radio (zigbee), and several buttons. The device has extensive sleep capabilities for long operational life. The network is controlled by an interface running in max/msp. The protocol is converted to midi data and can be used in a variety of applications, including Ableton Live for real time composition and performance.**

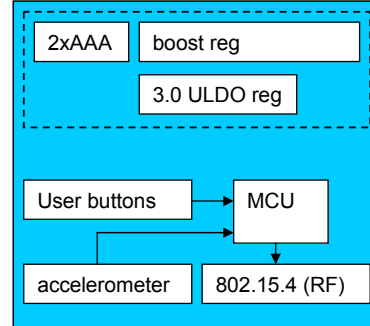


Figure 1 – Device Block Diagram

## I. INTRODUCTION

Consumer devices often employ some type of sensor or sensors to collect and process data from the users' environment. The collected data is used to provide some sort of feedback. Sometimes the feedback may be subtle, as the sensors prevent noticeable interruption of the device's operation. Other times, the sensors provide direct feedback of the user's actions, and occasionally, the system may make decisions based on patterns or thresholds.

zjam is experimental platform that responds to user movements and input in the context of a musical device or electronic musical controller. Additionally, the interface allows for wireless collaboration, so that many users can participate at once. The role and purpose of each device is open ended and can be configured as needed. This allows for multiple collaborative scenarios: devices can influence and control aspects of other devices data, or simply act as another independent controller and compliment the performance.

The platform and user interface allows for end user creativity; with some programming, the user can quickly reassign the functions of zjam. Therefore, the possibilities of how the device may be used are limited only by the user. In a group setting for example, zjammers may independently control audio and visuals making for a personal, yet highly collaborative, multimedia exposition.

## II. THE ZJAM PLATFORM

The user device is a portable, low power, wireless device. The electronics are powered from 2xAAA batteries and device lifetimes have been measured at > 72 hours with continuous packet sending. The block diagram for the user device is given in figure 1.

The power stage of the device consists of a switching boost regulator and an ultra low drop out linear regulator. The 2xAAA are regulated by Texas Instruments TPS61016, a low input voltage synchronous boost converter. The TPS61016 can sense the load current and vary its internal PWM frequency to further reduce power consumption. The switched 3.3V output is passed into a LP2985, a low noise ultra low-dropout regulator which provides a stable 3.0V operating and sampling reference. The LP2985 is a low noise regulator, and its ripple rejection at 3.0V and 60mA is sufficient to reject the high switching frequencies and ripple of the TPS61016 when the device transitions out of sleep mode into normal operation. Furthermore, the linear regulator must have a sufficient transient response yet a ripple output that is less than 1lsb of resolution so that DAC measurements are not corrupted. To further compensate for AC ripple on the TPS61016, several ferrite beads were added in series with VCC and GND to attenuate high frequency noise.

The MCU on board is a PIC18F2525. The processor runs at 8Mhz utilizing an internal crystal for significant savings in power consumption. As a tradeoff, reliable data rates are limited to 19.2Kbaud. The address of the device is user settable and this is read by the MCU during operation. MCU samples the x, y, z axis of the ADXL330. The sample and hold ADC has a 10b resolution, but only 7b of resolution is needed. In addition, 4 user buttons exist. The wireless link is 802.15.4 (zigbee) compliant. The Maxstream Xbee transceiver module was selected. The module interfaces to the MCU by a UART and has a sleep pin available when the device is not used to transmit or receive data. The inputs and accelerometer data are formatted into a packet (non ASCII) and sent to a receiver connected to a PC. The device features a timeout in which the electronics are put in a sleep mode when the device is not being

used. The user can wake the device by pressing one of the four buttons. Sleep current is  $< 10 \mu\text{A}$  and typical peak current is 60mA during radio usage. Figure 2 is the platform prototype.



Figure 2 – zjam prototype

### III. USER INTERFACE AND CONTROL

The data from each device enters the PC via the serial port, or some emulation of the serial port. The current interface is designed in Max/MSP for rapid prototyping and quick sketching of ideas. Accelerometer calibration is currently implemented in Max and a separate file for each device is stored on the computer. Each user device has a specific address and this allows for incoming data to represent a unique user device.

Raw accelerometer readings are passed into Max. Calibrating the device yields the correct sensitivity (mv/g) and the arcsin of the raw x and y axis readings are also converted into roll and pitch, respectively. The roll and pitch measurements describe the position of the device. The range of roll and pitch is -1g to 1g and the raw data range is -3g to 3g. Roll and pitch data can be used to control various MIDI parameters or to specify certain operational modes within the program. In addition, by comparing raw readings to threshold specified in the program, users can toggle events and actions. The data acquisition portion is shown in figure 3.

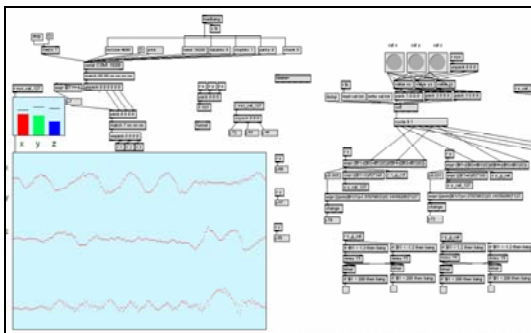


Figure 3 – Max Interface

### IV. APPLICATIONS AND PERFORMANCE

Loop based audio and video are acceptable forms for performance and exhibition of digital music and art. Many exhibitions and performances rely on traditional forms of input and control such as the computer to control the performance. The zjam platform seeks to remove the traditional boundaries of performance control by allowing the user to be free from wires and battery life.

Visually, a loop based performance is not as interesting as a live performance. A platform that allows the user to hold, move, and press a device to control many aspects at once makes for a visually stimulating performance. Audio programs such as Ableton Live simplify the use of audio loops for live performance. To demonstrate the capabilities of the zjam device, a demo incorporating a max/msp interface and Ableton Live was tested. In the demo, two zjam devices allow for live and performance of music and manipulation of audio effects.

Loop based performance requires a low learning curve for performance yet teaches the users about improvisation, composition, and musical performance. For example, with 12 devices, a musical ensemble can be created, where each of the 12 users represents a different instrument. The number of loops or sounds, is limited only by the zjam platform, current tests have used 8 loops per instrument.

Another interesting application of the device is its roll in the control and manipulation of digital audio. For example, in the context of a DJ mixer, pitch or roll can be used as a “virtual cross fader” to mix between two separate audio tracks. To test the feasibility of a wireless platform for “scratching” digital audio, another interface was created in Max to perform scratching effects similar to DJ’s performance on a turntable. With additional work, it is possible to create a virtual platform to mix, scratch, and control music.

The flexibility of the interface and widespread acceptance of max/msp make it possible for users expand the uses of the device. For example, technically savvy VJs may integrate the zjam with Cycling 74’s jitter; the intent being zjam is used for real time video control and effects. Furthermore, multiple users could also participate in a video and audio performance and push the boundaries of an interactive audio/visual installation.

### V. CONCLUSIONS

In its simplest sense, the zjam is a wireless controller capable of sensing user movement and user button presses. The possibilities of the device are numerous however, the accelerometer will be the limiting factor in most applications. The drift (mv/g) of the ADXL330 and its low sensitivity make it impractical to derive velocity and position information from. Therefore, to improve device performance either a mid range MEMs gyroscope or compass should be added.

Further work includes the advanced development of the communication architecture. For example, the host zigbee device (at the PC) can act as a router passing along data packets to other users. Movements and keystrokes from other devices can then be used to control and influence the output of other devices.

Additionally, to simplify the mechanical aspects of the device, capacitive based buttons can be added to the final device. A Quantum qprox sensor can be added for a wheel, slider, and button type functions quickly expanding the capabilities and usefulness of the device as a musical controller.

In terms of gestural control, advanced algorithms are needed to learn, compute, and categorize user movements. The algorithms must either learn from user training, or search for possible programmed solutions. The likely candidates are either neural or genetic based.

#### ABOUT

**Matt Aldrich** currently works as an electrical engineer for Renaissance Lighting, a small start up specializing in solid state lighting. He received his B.S. in electrical engineering from Yale University in 2004. He enjoys designing electronics and musical interfaces. More projects and work can be seen at [www.visiphon.com](http://www.visiphon.com)

