COMPUTER INPUT DEVICE FOR POLYPHONIC STRINGED INSTRUMENTS

Keith A. McMillen
BEAM Foundation
970 Miller Ave
Berkeley, CA 94708
keith@beamfoundation.org

ABSTRACT
An interface device that is described that allows polyphonic stringed instruments to directly input audio via USB2 to a computer for feature extraction and signal processing.

1. INTRODUCTION
While the keyboard has been married to synthesis control since its inception, stringed instruments have basically had no entry method for computer interface appropriate for this instrument family. Bulky and expensive hardware devices have been available that reduce the nuance of a stringed instrument to keyboard like MIDI commands or rigid signal processing chains. This device (named StringPort) allows the direct entry of polyphonic string audio for feature extraction and signal processing.

2. Description of the StringPort Interface

2.1 Audio path to computer
The StringPort accepts polyphonic string audio through the industry standard Din 13 connector. This assumes a pickup system that has separate transducers per string such as the Zeta Violin family or Roland/Yamaha guitar systems. The Din 13 transfers up to six strings of audio as well as a monophonic summed audio signal. A second Din 13 is located on the rear panel and acts as a “pass through” for all signals presented to the input Din 13 (on the front) for use with legacy equipment. Front panel switches allow the user to pass the volume and switch data through to the pass through Din 13 connector. The StringPort conveys these seven audio signals and one auxiliary signal to eight high quality Delta Sigma ADCs. Audio is 24 bit at either 44.1KHz or 48 kHz sample rate. A custom IC extracts and formats the eight serial digital audio streams and conveys them efficiently to a USB2 transport PHY and connector. The audio signals show up as ASIO or CoreAudio signals depending on the computer’s OS. Presently drivers are available for Mac OSX and Windows OS. Linux Drivers are under development.

2.2 Other Conveyed Data
In addition to the polyphonic audio stream, three digital data paths are conveyed to the computer. MIDI in and out connectors allow users to add standard peripherals such as foot pedals and other controllers. The Din 13 connector often supplies analog control signals such as a volume pot and select switches from the instrument through the cable. These signals are converted and conveyed to the computer. A beefed up +V supply to the instrument with separate return path anticipates power needs for embedded processing. Finally, two separate serial data input streams are supplied with the intention of transferring fingerboard-tracking information (i.e. fret scanning as was used in the Zeta Mirror Six guitar) allowing a more rapid and robust pitch extractor. All four data paths are tagged then merged in the StringPort and appear to the OS as a single MIDI input.

Figure 1: Six string inputs and two hi-speed data lines connect to instrument.
2.3 Outputs
A pair of high quality audio outputs is provided. They are differential ¼” jacks with switchable -10 and +4 levels. A 3.5mm headphone jack and volume control are present on the front panel. The user available MIDI ports and the USB type B connector also appear on the rear of the unit.

2.4 Physical characteristics
The electronics are enclosed in an aluminum extruded chassis measuring roughly 4” x 1.5” x 5” (W x H x D). The StringPort is designed so up to four units can fit in a single 1U rack space (using the rack mount adapter accessory) anticipating compact portable stage-worthy support for string quartets.

Since power requirements approach the limits of USB powered devices, a rear mounted power jack and universal power supply are provided to ensure reliable operations.

2.5 Software support
The StringPort ships with a Host Application written in Max/MSP. Feature extraction such as continuous pitch, amplitude, centroid, even/odd and noise component are provided as well as trigger and articulation events in a format anticipating the HD Protocol for MIDI devices from the MMA. Users may modify the provided programs and or provide modules that comply with the processing framework. Much of the signal processing and control information is based on the work of Miller Puckette, Barry Threw and the author.

Certain commercial synthesis and notation packages will be supplied in a form modified for control by stringed instruments. These will be trial versions with durable versions available from the respective companies.

One of these applications will be the Synful Orchestra from Eric Lindemann. Synful is an attractive complement to the StringPort. It is based on an additive synthesis method (RPM) that supports realistic timbre manipulation that map directly to the output of the StringPort analysis methods.

3. ACKNOWLEDGMENTS
Our thanks to Barry Threw, Dennis Saputelli, Miller Puckette, Tom White, Eric Lindemann, Ashley Adams, Marriele Jakobsons, and the Creative ATC team: Michael Lee, Steve Waller, Chris Foster, Andrei Veltchev, David Beauchesne, and Joe Alig for their contributions to the project.

4. REFERENCES


Zeta Music Systems http://www.zetamusic.com

Synful Orchestra http://www.synful.com
