Embedded Audio Without Beeps

Synthesis and Sound Effects From Cheap to Steep

Overholt, Daniel; Møbius, Nikolaj Friis

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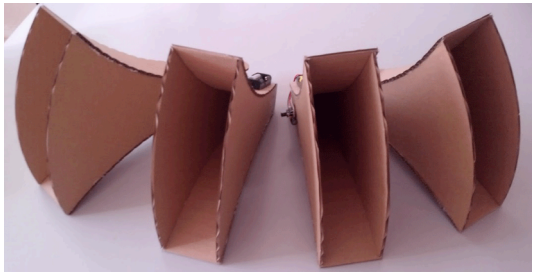
Embedded Audio Without Beeps: Synthesis and Sound Effects From Cheap to Steep

Dan Overholt
Aalborg University Copenhagen
A.C. Meyers Vænge 15
2450 Copenhagen, Denmark
dano@create.aau.dk

Nikolaj "DZL" Møbius
Roskilde University / Illutron
Universitetsvej 1
4000 Roskilde, Denmark
nimo@ruc.dk



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Abstract

Can your microwave be musical? What does it take to design devices that produce better sounds than the prototypical square wave beeps we are accustomed to hearing today? The authors have developed several prototyping toolkits for the rapid creation – sketching in hardware – of sonic and tangible interaction designs focusing on audio for interactive devices; specifically, producing higher-quality sound than the typical beeps so commonly heard from many digital devices today. Participants will learn how to create both completely self-contained devices for embedding into various objects or clothing, and wireless devices for the control of sound or music generated remotely. For example, studio creations can synthesize sound directly with an Arduino or a more powerful "Create USB Interface" board via Direct Digital Synthesis. Alternatively, they can control a program such as Pure Data (or other common software environments for audio processing) via innovative interfaces that send real-time inputs to such software running on a laptop, mobile device, or small Linux board (e.g., Raspberry Pi or Beagleboard). Basic hardware will be provided, but participants are also encouraged to bring related equipment they may already own.

Keywords
Music Interaction Design, Microcontroller, Wiring language / Arduino compatible, StickOS BASIC, Open Sound Control, Microchip PIC32, Wireless, Zigflea, Wifi, 802.11, Bluetooth, Create USB Interface, CUI32Stem.

ACM Classification Keywords
Design, Experimentation, Human Factors.

Introduction

One of the core toolkits to be used in the studio is an updated version of the *Create USB Interface* called the CUI32Stem[1], which was designed to work together with Seeed Studio's GROVE system [2]. The aim of the toolkit is to make it easy to build tangible devices as electronic 'sketches', and develop interactive sonic behaviors in C, Arduino, or BASIC languages. It is therefore versatile not just in terms of development languages, but also in terms of usage scenarios, whether the desired functionality is mobile or static location-based. The theme of the studio at TEI 2014 will focus on the development of interactive sound and music experiences using various toolkits, including the GROVE system as well as standard Arduinos (and ATtiny chips), plus hardware control of common audio synthesis software packages. Participants will develop their own input devices that control expressive sonic outputs.

The studio structure is broken down into several phases: participants will have an opportunity to open the CUI32Stem GROVE electronics kits, build simple test setups using the various sensors and actuators, program the board in different languages, and pair up with fellow participants to explore how the combination of the GROVE System and audio synthesis can allow people to create interactive sonic and tangible devices from their imagination. The end of the day will feature a show-and-tell in the form of a semi-formal "concert" performance, and will also include a round table discussion as an opportunity to learn the particular aspects of building tangible embedded and embodied sonic interfaces enabled by the presented toolkits.

Studio Proposal

The overall goal of the studio is to provide better accessibility to high-quality sonic interaction tools to as many embedded designers as possible. As such, the GROVE elements (as well as the CUI32Stem itself) are only one way of approaching the problem. Other methods of design will also be addressed (albeit the hands-on portions will rely only on the GROVE system for practical reasons). Some of the methods to be presented range from very cheap alternatives such as Direct Digital Synthesis for polyphonic waveform generation on 8-bit microcontrollers (Arduino, ATTiny, etc.), to more expensive alternatives such as Android or iOS based options, and of course likely the simplest method for quick prototyping of sonic interaction designs: control of sound synthesis software on a laptop. While the workshop will focus on sound and audio hardware and software, no prior skills are required in these areas. However, participants are welcome to bring related ideas and skills to the table.

SeeedStudio, Inc. is the purveyor of the GROVE system for prototyping electronic interfaces. SeeedStudio is an 'open hardware facilitator' based in China, but design

[1] CUI32Stem Create USB Interface board for GROVE, http://www.seeedstudio.com/depot/cui32stem-p-1100.html

contributions are encouraged from all around the world to add to the increasing collection of GROVE elements [2]. These include a wide range of sensors and actuators that may be useful in various fields of research, but our primary interest here is in the sonic aspects of interaction design. Participants may prototype music interfaces (for both listeners and players), as well as audio for any device or interface that needs to incorporate sonic feedback to the user. Imagine a kitchen stove that plays a different pitch for each setting of heat level, and a different timbre (tone quality) for each of the burners, for example. This might allow for a more intuitive user experience. Quite a few human input sensors are available as GROVE elements, and environmental sensors (or other types) may also be interesting for certain projects.

Studio Topics to be Covered

Examples for direct audio synthesis and/or control protocols such as Open Sound Control (OSC) will be presented on various platforms. One of the platforms, the GROVE toolkit with a CUI32Stem is shown in figure 1. The CUI32Stem functions primarily as a simple breakout board for the Microchip® PIC32 processor – a PIC32MX795F512H, which is a 32-bit microcontroller running at 80MHz. In addition, the use of a free RTOS (Real-Time Operating System) called StickOS makes the system easy to use for quick sketching in hardware. By default, the CUI32Stem boots into StickOS, but it can also be programmed in Arduino or C-languages. StickOS was created by Rich Testardi [9], and includes an on-chip compiler for simple BASIC-language programs, providing ease of use for beginners or even advanced users who are interested in quick prototyping with the system.In addition to sonic device prototypes using StickOS and audio software on their laptops, workshop participants will learn how to make stand-alone polyphonic sampling synthesizers that they can load with their own sounds, using the CUI32Stem board and various GROVE sensors, via an example by Philip Burgess, as shown online [1]. They will also learn about Direct Digital Synthesis for Arduino and related 8-bit microcontroller platforms.

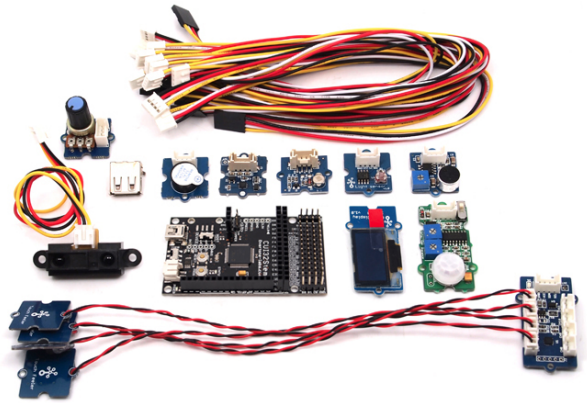

Figure 1. A GROVE toolkit with CUI32Stem (black, middle) - various sensors and actuators can be attached via cables shown at top

The CUI32Stem has several options for wireless: ZigFlea, Bluetooth, and WiFi. A 'Serial Bluetooth' module is available as part of the GROVE system. A 'ZigFlea' add-on board for the CUI32Stem is also available from Seeed Studio[2]. It was designed to plug

[2] ZigFlea, http://www.seeedstudio.com/depot/zigflea-p-1146.html

on top of the CUI32Stem without conflicting with any of the GROVE headers. Finally, WiFi connectivity is accomplished via a GROVE element allowing the connection of a WiFly RN-XV 802.11 module [8]. This module can be configured to broadcast its own 'AdHoc' 802.11 base-station, or join existing WiFi networks. It allows the CUI32Stem to send raw UDP and/or TCP-based packets, and communicate easily with any software that supports the Open Sound Control (OSC) protocol. One of the strengths of this approach is that the CUI32Stem can be used directly with any iOS or Android device, without having to use a laptop as a 'bridge'. This means that sensors attached to the CUI32Stem (GROVE or otherwise) can be used to control parameters of real-time synthesis processes running on a mobile device, such as audio synthesis or effects algorithms in mobile apps (via MobMuPlat [7], LibPd [3], SuperCollider [4], or similar).

Expected Outcomes

The learning objectives of this workshop focus on the use of various toolkits for sonic interaction design, including the GROVE system and the CUI32Stem microcontroller for quick sketching in hardware, Direct Digital Synthesis of sound on smaller microcontrollers, and more expensive options including laptop-based software prototyping environments and apps for mobile devices such as smartphones or tablets. Participants should get a feel for what is possible with each toolkit, and come to understand the design space from 'cheap' to 'steep'. The studio focuses on both music-related and common household devices with respect to applications. Participants are expected to explore, discuss, and discover the new capabilities with the discussed toolkits. It is important for researchers to stay abreast of current technologies in the world of Tangible Embedded and Embodied Interfaces, and in this sense, it is expected that the studio will contribute to the overall discourse while emphasizing the audio-related dimensions of interaction.

Studio Supporting Web Documents

Additional online materials in the form of workshop activities will be posted online prior to the event, and follow-up discussions can continue after the studio has finished in the form of an online-forum at the Overtone labs website http://www.overtone-labs.com/ or one of the author's blogs http://dzlsevilgeniuslair.blogspot.dk/

References

[1] Burgess, Philip, "chipKIT Simple Synth Demo", last accessed August 7, 2013: http://youtu.be/hdpQ8LEku90

[2] GROVE system, from SeeedStudio Inc., http://www.seeedstudio.com/wiki/GROVE_System#Grove_elements accessed February 7, 2012.

[3] LibPd, http://gitorious.org/pdlib/ accessed February 7, 2012.

[4] McCartney, J. Rethinking the Computer Music Language: SuperCollider. *Computer Music Journal, 26(4), 61-68.* 2002

[5] MPIDE, from ChipKIT, http://www.chipkit.cc/wiki/index.php?title=MPIDE_Installation accessed February 7, 2012.

[6] Overholt, D. Musical interaction design with the CREATE USB Interface: Teaching HCI with CUIs instead of GUIs. *Proc. of the 2006 International Computer Music Conference*, New Orleans, 2006.

[7] MobMuPlat, http://www.mobmuplat.com/ accessed August 7, 2013.

[8] Roving Networks (WiFly GSX module), http://rovingnetworks.com/ accessed January 29, 2012.

[9] Testardi, R. (StickOS), http://cpustick.com/stickos.htm accessed January 29, 2011.