CLAMS - The Quest for Portability and Audio

Forth Day 2024

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Previously on CLAMS

The original concept - early 2022

- Forth for the Electro-Smith Daisy Seed (Electrosmith 2024)
  - Microcontroller board designed for digital music
  - ARM Cortex-M7 MCU, running at 480MHz
  - Hardware floating point and DSP instructions
  - 64MB of SDRAM for up to 10 minute long audio buffers
  - 8MB external flash
  - Stereo audio IO - 96kHz / 24-bit audio hardware
  - No WiFi or Bluetooth
  - $29.95US quantity one
  - Available in various packaged modules
  - Control logic and synthesis both done in Forth

Revised concept - early 2023

- Forth for the Raspberry Pi Pico (WH)
  - Microcontroller board designed for general applications
  - Dual-core ARM Cortex-M0+, running at 133 Mhz
  - Co-processor for division, interpolation and I/O
  - No floating point or DSP instructions
  - 262KB RAM
  - 2 MB flash
  - No SD card
  - No audio hardware
  - 2.4 GHz WiFi and Bluetooth
  - $7.00 US
  - Audio expansion packs available
  - Control logic and synthesis both done in Forth

Stepping up a level - what does a digital synthesizer need?

- A way of reliably generating accurately-timed pulse-code
- A way of converting those samples to analog voltages for
- An interface for the composer / performer

So what was wrong with the previous two concepts?

1. Portability - Forth needs to be hand-ported to individual MCUs.
   - Other desirable boards: Teensy 4.1 and ESP32-S3, C3 and C6
2. Only I2S audio was realistically supportable
   - USB audio and Bluetooth audio cannot be realistically done in Forth

CLAMS - the New Design

Arduino for portability

- All target boards (Daisy, Teensy, ESP32 and Pico / Pico 2) have Arduino support
- I2S audio is supported on all test boards
- Bluetooth audio is supported if the board has the hardware
- USB audio is in alpha testing

C3 Forth for Arduino (Christopher Curl Accessed 2024-11-13)

- Token-threaded Forth written in C/C++
- Runs on Linux (native), Raspberry Pi Pico and Teensy 4.1 (Arduino)
- Under active development
- Well-documented

CLAMS architecture

- a domain-specific language implemented in Forth
- conceptually, ChucK (https://chuck.cs.princeton.edu), (Salazar et al. 2014) semantics with Forth syntax
  - low-level words: digital synthesis and microcontroller audio
  - mid-level words: construct signal flow graph
  - high-level words: algorithmic composition and live performance

Forth base: C3

Road map

Target audio hardware

- Pimoroni Pico Audio Pack
  - ~ $16US plus shipping
  - requires an expander board for UART connection (~ $9US)
- Waveshare Pico Audio Expansion Module
  - ~ $20US plus shipping
  - includes speakers
- Waveshare Overall Evaluation Board
  - ~ $50US plus shipping
  - includes 3.5 inch resistive touch screen
  - includes serial-to-USB adapter
  - includes microSD card adapter

CLAMS on the web

- GitHub: https://github.com/AlgoCompSynth/CLAMS
- blog: https://www.algocompsynth.com/#category:CLAMS
- this presentation: https://github.com/AlgoCompSynth/CLAMS/blob/main/presentations/CLAMS-intro.pdf

Me on the web

- Mastodon: https://ravenation.club/@AlgoCompSynth
- LinkedIn: https://www.linkedin.com/in/znmeb
- Bandcamp: https://algocompsynth.bandcamp.com

References

Christopher Curl. Accessed 2024-11-13. “C3 on GitHub.” https://github.com/CCurl/c3/; Christopher Curl.

Electrosmith. 2024. “Electrosmith Daisy.” Electrosmith. https://electro-smith.com/products/daisy-seed.

Salazar, S., A. Kapur, G. Wang, and P. Cook. 2014. *Programming for Musicians and Digital Artists: Creating Music with ChucK*. Manning.