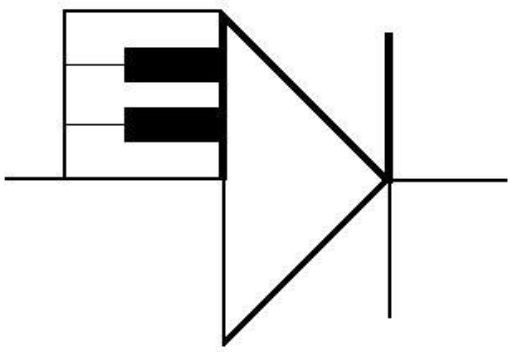


ELECTRONOTES

WEBNOTE 08/17/2009

RECALLING WALSH FUNCTIONS

The topic of Walsh functions in music synthesis comes up from time to time – every few years it seems. This is a fact. One conclusion you might draw from this fact is that possibly they are not particularly useful for this purpose - since periodic reappearance suggests periodic abandonment. Probably this is also true.

"LOCAL HISTORY"

I believe the first discussion of Walsh functions for music synthesis was in a paper I wrote in 1973 [1], followed by one on a real-time Hadamard transform [2]. As I have acknowledged, the real idea of using Walsh functions for electronic music came to me from Carl Frederick who was working in Space Sciences, a few hundred feet from my lab in Applied Physics, both at Cornell, about 1972-73. I remember walking over (mostly up!) to his office to chat since we were both doing electronic music stuff – and as I walked in he said "I want to see you!" as he opened a book (Harmuth) which discussed Walsh functions.

In going to Carl's office, I had escaped my supervision, but Carl had not, of course. His "supervisor" at that time was Tommy Gold. No one in the entire world was more receptive to new ideas than (sometimes gadfly!) Tommy Gold, but for the moment at least, Tommy thought it was more urgent that Carl did the work he was supposed to do. Well, the Walsh work did get done eventually.

RESULTS AS SEEN FROM TODAY'S PERSPECTIVE

I learned a lot from doing the Walsh work.

(1) Periodic waveforms are all (about equally) boring.

(2) A dynamically changing (Fourier or Walsh) spectrum is essential.

(3) Unless you made a special effort, a "typical" Walsh-generated sound was rough and pulse-like – not mellow.

Another thing working against the Walsh approach was the loss of the original advantage: they were much easier to generate than sine waves. They still are, but sinewaves are no longer uneconomically hard.

One thing that people tend to miss is that sine waves can be generated iteratively by a very simple recursion (see also Fig. 1, and reference [3]):

$$x(n) = 2\,\mathrm{Cos}(\Theta)\,x(n-1) - x(n-2)$$

which is just a digital filter with poles on the unit circle. Here Θ is the angle of the poles on the unit circle. The frequency of the oscillator is Θ/2π times the sampling frequency.

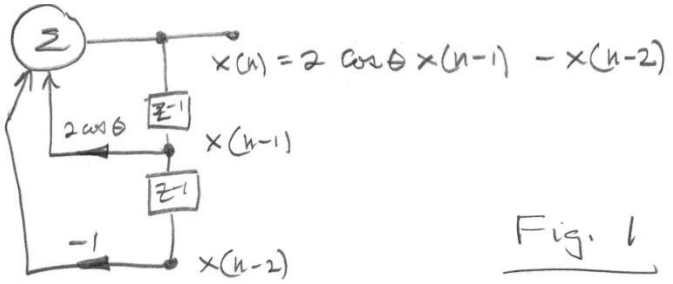
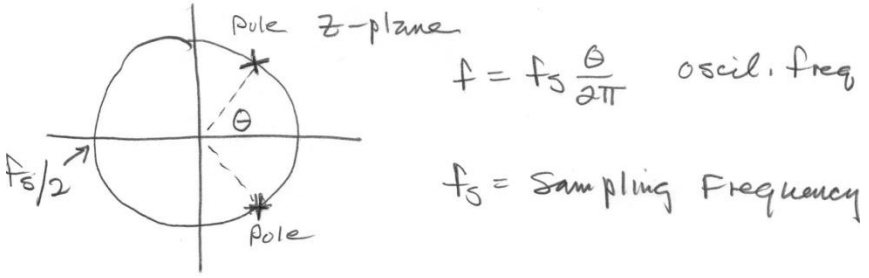


Fig. 1



MORE ABOUT CARL FREDERICK

Incidentally, Tommy Gold was one of my heroes, and Carl still is. Carl is today, among other things, a successful science fiction writer [4]. One thing that he did, which is astounding, was to convert genetic code to sound. That he could do this is not the astounding part. What is astounding is that the result is music. He took some genetic code from a fruit fly, and out came The Little March of the Fruitflies [5]. **LISTEN TO IT!** Carl denies that there was any "editorial input" (composing on his part) in the march. The DNA code is structured – not random. Imagine that!

REFERENCES - See News and Specials for Direct Links

[1] http://electronotes.netfirms.com/AES1.PDF

[2] http://electronotes.netfirms.com/AES2.PDF

[3] http://electronotes.netfirms.com/AN349.pdf

[4] http://www.darkzoo.net/

[5] http://www.darkzoo.net/clfsite/march.wav.mp3