Impetus Cascading Chaos

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Abstract: When working with computer generated sound I have the past couple of years been very interested in exploring waveforms created through iteration of mathematical algorithms such as it is done within chaos and fractals.

Chaos has over the past century become a vast topic within mathematics, so I will in this context simplify the notion of chaos to a time function system with orbits which has a sensitive dependence on the initial condition and when mapped to waveforms produce waveforms of a very high or infinite period.

Till now I have just looked at a few things within that field. Iterating a 'simple' transcendental function like e.g. k*sin(x) already has chaotic properties for most values of k. I looked at several maps which in some ways are extensions of this fact — Standard/Chirikov — Henon — Ikeda — CurlicueFractal. There will be an almost endless possibility to design new algorithms out of this basis.

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The particular work, which will be presented at xCoAx2013, is based on an algorithm twisting the Standard map to something surely different, and then cascading versions of it to look for something one could call 'harmonically related chaotic and high-period orbits... ' Also the notion of cascading chaotic systems has many aspects to it and offer of course many diverse possibilities to be explored further in the future. This particular work is done in MaxMsp.

My concept for including voice alongside with these autonomous and happily unpredictable algorithms has been to use the intuition of the voice, the physical action which comes before thought. After all the human body, being nature in some sense, is acting as the most sophisticated calculator and possibly beyond that. Very importantly the intuitive possibilities of the human mind-body has always been a central topic for me, and from I first started working with computer-music the relation between mind-intuition and computer has been a root question. Recently I listened to an interview with physicist Russell Targ who has been a part of the US military program for 'remote viewing'. An espionage program which aimed at a systematic development of extrasensory perception, ESP. Targ has recently written an iPhone application with which one can train ESP. The idea is that the mind can be trained to fathom the outcome of the pseudo random algorithm in an instant. Targ very much expressed some possibilities which are of great interest to me when working with chaotic algorithms...

Back to Impetus — in order to make the details of the piece unpredictable for the rational mind the interaction between calculation-flow and human is done by letting the person decide on the moments of change from one phase of the piece to the next. Since we are in a realm of 'sensitive dependence of initial condition' it will create different paths to initiate this change just 1 sample sooner or later.

Along the way I have as well looked at a few algebraic algorithms like the Mandelbrot set and the wide notion of Möbius transformations which with suitable parameters can produce chaotic orbits. Here I have till now spent most time with the Mandelbrot set. (MaxMSP-patch can be found at http://antidelusionmechanism.org/vilbjorg.html) — spending days on end slowly scrolling towards to boundary in many different places has been an universal sound- and space-travel in the infinitesimal. When arriving from the 'outside' one gets an almost physical feel for what number precision means. When approaching 'the boundary' it takes still more iterations before the point escapes/blows up. It can sound periodic but then suddenly after ever so many million iterations the point escapes and proves that the waveform produced never was completely periodic — it seems like the boundary itself is wrapped in infinity — that is the fractal one must agree.

How much chaos can a computer in theory generate from a chaotic map? — here is one simple way to look at it: due to finite bit-rate the period will be finite, but the period might be longer than the concert, even much longer than your life. One could think about an algorithm that in continuous form would produce *absolute chaos* = infinite period if dealing with some ideal infinite number-precision. When iterating at every sample by 44.1kHz sample rate and working in 64 bits then the maximum possible period (with maximum rounding luck) could simply be considered to be 2^64 samples (if you return

to exactly same number-value you start over) which is about = 1.84467441e19 which very roughly corresponds to 1.16e10 hours or 1.3 million years. My computer and I will most likely not be there at the end that 'ultimate' period... And I mostly do not iterate at every sample, so that I can hear whats going on, I do a minimum iteration-period of 2 samples and often much larger to fully enjoy the waveforms — in 32 bits the same calculation goes to roughly 27 hours, quite a difference! — in 128 bits the time-span goes somewhat beyond my imagination.

Something which looks to me to be standing central today — when working with algorithms and computers — is the interplay between the mathematical idea on the one side and the computation on the other. I keep remembering Benoit Mandelbrot telling about the moments (1980) when he and a programmer from IBM saw the first prints of the Mandelbrot set. They thought something had gone very wrong, they just did not believe what they saw. No one had ever been able (or had the time in one life) to do those calculations and no one had previously seen those rich — one could be lured to say non-linear — consequences of mathematics. I believe this is a true paradigm shift — the more I look into the various fields of mathematics the more it becomes clear that centuries of excellent mathematical ideas still need to be explored in computational arts. Most is at this moment undone. Out of such material we will perhaps see a bridge being enforced between artistic and scientific practices.