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Digital Audio Processing II
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ETOM (Electron Trapping Optical Memory)

ETOM is a completely new approach to digital data storage. The basic advantage of this technique is that it allows coding of signals with more than the two on/off states of binary. Historically, this system of data storage is mainly being pioneered by a company called Optex Corp. who have approximately $2.5 million dollars in funding to research this project. Most of the money is coming from an agency known as the Advanced Technology Program. The project itself has been under work since the early 1990's, but only received full finding until about 1995.

To understand the basic mechanism of ETOM, one needs to remember some basic facts from high school chemistry. In atoms, the electrons can exist at different energy levels. The electrons spin around the atom in patterns known as orbitals and can shift into different patterns. These different orbitals, known as valence levels, exist at varying distances from the nucleus of the atom. The further the electron orbits from the nucleus of the atom, the more energy it requires due to the larger surface area of its trajectory. As electrons move from one valence level to another, they release or absorb energy in the form of light. By absorbing light, electrons can move to higher orbital levels. Conversely, when electrons fall to lower energy orbital patterns, they release light.

Digital audio makes use of these different orbital levels to encode information. ETOM is a method of storing information by exciting and trapping electrons to a higher orbital and then reading the information in the form of emitted light by returning the electrons to their ground state. Since more than two valence levels exist in higher atomic number elements, a high number of combinations can be encoded with just one electron. Because of these combinations, a high density of information can be encoded in a small space. For information theorists, this is good news. Unfortunately, in practice, this storage system has met with little acceptance. If ETOM techniques become practical, however, it will mean a large increase in data density storage possibilities. For example, 10 GB could be stored on a mere 130mm optical disk. Also, 2 hours of video could be captured on the same disk. Transfer characteristics of this information would be increasingly quick, as well. Supposedly, 120 MB/second of information could be accessed with ETOM storage techniques. All in all, it appears that there are continuing methods on the horizon to challenge and increase the density and ease of access to digital information.

Research Status Report #4

This week I spent most of my time working on the noise shaping graphs that I would use in my poster report presentation. I think I've got enough graphs to really prove the workings of noise shaping, although in hindsight, I think one more may be necessary (an example past the Nyquist frequency) to really bring the concept home for most people. Nevertheless, I think the graphs themselves require a little explanation in class. From a research standpoint, investigating converter design or even such a thing as noise shaping is a tricky process since most explanations either verge on too simple or too technical.

One of the main points I want to emphasize with noise shaping is that it moves most of the quantization noise to the upper end of the sampling spectrum. I think this theory is easy enough to grasp, but one does not automatically see the ramifications of such a technique. Combined with oversampling, noise shaping can not only move noise to higher frequencies but also effectively reduce the total amount of noise in the system. This power duo of oversampling and noise shaping is the true strength of both systems. It is a synergy of sorts. Sometimes, according to Watkinson, the two terms are often used in the loose sense as if they were synonymous. In fact, oversampling without noise shaping is a waste of technological potential. True, the less sharp curve to the anti-aliasing filter is an advantage, but the reduction of the noise floor by 1/16 for a 4x oversampler (i.e. the inverse of the oversampling frequency squared) is a far greater reason to implement oversampling in converter design.

One area of noise shaping and converter technology is still a little unclear to me, and it is that of filtering. I understand anti-alias filtering, but not the complete potential of both analog and digital filters, both on the A/D and D/A side of things. For example, the quantization graphs for noise shaping, while conceptually resembling that of dither, actually look in some ways noiser than a straight quantization of the signal. Watkinson chalks the increase in fidelity up to filtering, but I am as of yet unclear on how this process works. For my next poster project, I would like to investigate that area.

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