Research at The University of Akron

Parallel Computation of the Fast Fourier Transform

The speed at which a computer can perform a task is very important to a user. Nobody wants to sit and wait at their computer while it finishes loading a screen or does a certain kind of computation. However, modern technology is coming close to the theoretical limits on how fast computations can be done on a single chip. A solution to this problem is to have multiple processors operating in parallel, doing different parts of a computation that are then combined at the end. Divide and conquer, in a modern computer-oriented way, allows a process to be done faster.
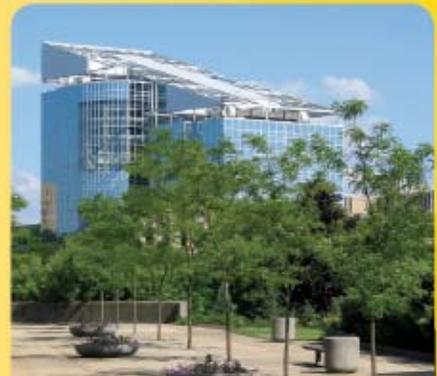
Although most personal computers are currently shipped today with either "dual core" or "quad core" (i.e. 2 or 4) processors, the algorithms in computer codes are primarily still those that have been constructed to be done in the old serial way. This is especially true for scientific computations, so that engineers and scientists are working to reformulate algorithms so as to benefit from the parallelism in computer hardware. The Fast Fourier Transform (FFT) is an especially important scientific computation that can be done much faster with parallel processing.

The FFT computation is pervasive in scientific analysis and modern communication. Although the patient is unaware of it, the two-dimensional inverse FFT is used for the production of every MRI and CT image. It is used for communications to eliminate noise. It is used in X-ray crystallography to reconstruct a protein's structure from its diffraction pattern. The following quote is from David H. Bailey (in *SIAM Review*, March 1993): "...the FFT has found application in almost every field of modern science, including fields as diverse as astronomy, acoustics, image processing, fluid dynamics, petroleum exploration, medicine and quantum physics, among many others. It is not an exercise in hyperbole to say that the world as we know it would be different without the FFT."

In general, the more processors available for a computation, the higher the potential speed of that computation. UA has a cluster consisting of more than fifty processors, and the Ohio Supercomputer Center (OSC) has a cluster containing nearly 1,000 processors. How to reformulate the FFT, widely popularized in 1965, so as to take advantage of this large number of processors, is the research project currently underway at UA. If the speed of the algorithm could be increased 1,000 times, the many applications of the FFT discussed above would all be improved, and new applications, such as molecular modeling, would be opened for new discoveries as well.

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Faculty Inventions and Patents at UA

- Polymer science (88)
- Medical (50)
- Information technology (24)
- Nanotechnology (23)
- Advanced materials (19)
- Biotechnology (7)
- Chemical technology (6)
- Environmental (6)
- Energy (3)
- Security (3)

Research at UA

As the public research university of northern Ohio, The University of Akron is connected to the community and to industry, using research as the driver for finding meaningful solutions to advance the region.

162 – number of active UA patents
6,300,000 – 2007 licensing revenue, leading to a statewide first place ranking in rate of return for technology commercialization
1 – worldwide ranking in patents issued per research dollar spent, according to a five year study by the Milken Institute
24,800 – number of UA students, under the tutelage of 735 full-time faculty members
16 – percentage of UA's $51.7 million 2007 research expenditures funded by industry, the national average is 5 percent

For more information on The University of Akron's research, inventions, and technology, visit www.uakron.edu/research.

About The Faculty Inventor

Dr. Dale Mugler is Professor of Biomedical Engineering and Applied Mathematics at The University of Akron. He also serves as Dean of the Honors College. Dr. Mugler's research interests include computational methods related to **signal and image processing**, particularly applications of wavelets and Fourier analysis involving numerical methods directed towards biomedical or bioinformatic applications. The methods include signal processing algorithms, such as parallel FFT techniques. Also, methods related to medical imaging techniques such as magnetic resonance imaging (MRI) and computerized tomography (CT).

His co-inventor, Mr. Nilimb Misal, is a former Biomedical Engineering graduate student working in his research group.

Invention Information

Title: Interleaved Method for Parallel Implementation of the Fast Fourier Transform

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