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The application of parallel processing techniques to computationally intensive biomedical imaging studies

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2013-07-19
http://hdl.handle.net/10539/12853

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Abstract

The landscape of modern computing is changing. While Moore's law is currently holding and the number of transistors that can be produced on a given area of a chip is still growing exponentially, the practice of improving performance by increasing the clock frequency of a single processor is reaching its limit. Instead, the focus has shifted to applying multiple processors to solving a single problem, a methodology known as parallel processing. Parallel processing has the potential to overcome many of the shortcomings of linear processing, but also presents a number of unique challenges. This dissertation explores the potential benefits of parallel processing by examining the application of a near-field coded aperture simulator on a parallel cluster and contrasting its implementation and performance with previously written simulators for serial processors. The platform used is a cluster of Sony PlayStation 3's; featuring the IBM developed Cell Broadband Engine Architecture. It was found that the PS3's were capable of producing performance gains of around forty times an equivalently priced conventional processor, with the capability of easily scaling the system by adding or removing nodes as required. However, this comes at the cost of a much increased burden on the developer. Apart from the core application, a great deal of code must be written to handle communication and synchronization between nodes, a task which can at times be very complex. In addition, a number of tools available for serial processors, such as highly efficient compilers, advanced development environments and many standardized libraries cannot be applied in a parallel environment. The main conclusions drawn from this research are that while the potential gains of parallel processing are enormous, allowing attainable solutions to problems that were previously too costly, the costs of development are prohibitive. Still, parallel processing is the natural next step in modern computing, and it is only a matter of time before its idiosyncrasies are solved.