Physics Department Senior Design Project Proposal

Project Mentor: Prof. Mark Coffey, 303-273-3818, mcoffey@mines.edu
(Name, phone, email)

Project Title Image enhancement by parallel diffusion processing

Project Type: [x] Team; Number of students_2-4____ [ ] Honors

Objective
(What is the science and/or engineering in this project?)
Diffusion processing is a very useful method for practical image enhancement, wherein the visual quality of an image is improved. The primary objective of this project is to implement diffusion processing for image enhancement in a parallel computing environment. Secondary objectives are to understand and apply concepts of classical and quantum lattice gases.

Prior Background
(What is the history of your involvement with this topic, including previous student projects?)
Previously the feasibility of using classical and quantum lattice gases to efficiently simulate diffusion processes for selective image smoothing was investigated and demonstrated. A related student project lead to a joint publication that is listed below. This type of project provides an introduction to the subjects of image processing, including image enhancement, and classical and quantum lattice gases. Some high-level code in Matlab and Mathematica is available as a starting point.

Student Expectations
(What do you anticipate the student(s) will be able to accomplish during the academic year?)
Gain an introductory understanding of the quantum lattice gas algorithms, of a local parallel computing environment, of image enhancement, and image entropy. The fall semester will largely consist of that, together with implementing, debugging, and testing simple parallel algorithms. In the spring semester the students should be able to modify, port, and extend as necessary the existing Mathematica programs for two dimensional diffusion processing. Useful monitors of the diffusion processing are entropy measures, that could also be incorporated into the programs. The student team is expected to assign roles and responsibilities, to establish early on a tentative working timeline, and to identity campus software and hardware resources. The team is expected to provide documentation of the parallel software by the end of the spring semester.

Supervision Plan
(Who will be directly interacting with the student(s), you, a post-doc, grad students, or others?)
I will initially directly work with the students, and there will likely be meetings where another research student(s) will join the discussion. A weekly meeting will provide status and an opportunity for discussing difficulties and approaches for their resolution.

Resources
(What equipment, algorithms, and facilities are available, and what will be assembled as part of the project?)
Part of the team's start up activity will be to identify and 'reserve'/coordinate time on a suitable physics (or other) department cluster computing facility. My understanding is that a 20-machine cluster is currently available. Successful preparation in the fall semester should improve the likelihood of obtaining time on the new Ra supercluster. A related start up activity is to identify

suitable MPI (message passing interface) or other software manuals to complement the MPI references given below.

Technical References

(Identify a few key starting points for the student(s); journal citations, prior reports, instruction manuals, etc.)

J. Yepez, Int. J. Mod. Phys. C **12**, 1285 (2001).
M. W. Coffey and G. G. Colburn, Proc. Royal Soc. A **463,** 2241 (2007).
W. Gropp, E. Lusk, and A. Skjellum, Using MPI: Portable parallel programming with the Message-Passing Interface, MIT Press (1999).
P. Pacheco, Parallel programming with MPI, Morgan Kaufmann Publ. (1997).
http://www.netlib.org/utk/papers/mpi-book/mpi-book.html