Digital Analog Simulation of Uniform Motion in Representations of Physical n-Space by Lattice-Work MIMD Computer Architectures

Anil M. Shende

Abstract

This doctoral dissertation is part of an ongoing research project with John Case, Dayanand S. Rajan and myself. We are investigating the possibility of solving problems in scientific computing involving the motion of objects in a bounded region of physical n-space by (a) representing points in the region of space by processors in a lattice-work mesh of processors with local connections for inter-processor communication, and (b) *literally, analogically* simulating the motion of objects by representing the particles of these objects by algorithms which move themselves about in the lattice-work of processors, much as the motion in real space of the particles making up real objects, in effect, constitutes the motion of those objects.

The main contributions of this dissertation are (i) two provably correct algorithms to generate *virtually perfectly shaped* spherical wavefronts emanating from a point source at virtually constant radial speed, (ii) a provably correct algorithm template for simulating the uniform-speed traversal of certain curves by a single particle, and (iii) for the two algorithms of (i) and the template of (ii), the specification of classes of meshes which are excellent discrete approximations to bounded regions of euclidean n-space, and on which these algorithms can be executed. Algorithms for the simulation of uniform-speed translation and uniform angular speed revolution of single particles are presented as specific instances of the algorithm template. A *crucial* aspect of *all* the algorithms in this dissertation is that, in spite of the discreteness of the representation of physical n-space, the *speed* of the simulations, using these algorithms, is approximately *linearly proportional* to the speed of the phenomenon being simulated. Furthermore, all decisions made by processors running these algorithms are based only on *local* information, such as messages from neighboring processors.