Numerics and Visualization on Mobile Devices

Manfred Liebmann

Institute for Mathematics and Scientific Computing
University of Graz, Austria

March 25, 2005

Abstract

Mobile devices like cell phones and personal digital assistants are in widespread use today. These devices feature powerful processing units and have enough memory to run complex applications. The aim of this work is to exploit these capabilities for quantum mechanical simulations and advanced data visualization using a novel 3D graphics pipeline.

The time evolution of a non-relativistic quantum mechanical system is governed by Schrödinger's equation. To calculate the time-dependant complex wave function a fractal approximation scheme for the unitary evolution operator is used. The fractal approximation scheme is a very efficient and robust method, introduced by the author, that allows the numerical solution of initial value problems using only fixed point arithmetic. Simulations with a complexity of over 100.000 equations can be handled in real time on PocketPC devices.

Data visualization using 3D graphics is a popular means to explore complex data sets. A novel approach to the design of a 3D graphics pipeline is presented, that allows the implementation of advanced rendering features in software on the ARM processor architecture. The implementation uses a space-filling fractal curve for rasterization and does not require a z-buffer for visibility determination. The graphics pipeline architecture also enables an efficient integration of complex vertex and pixel shaders. Rendering virtual environments and animated characters from popular games is used as a performance benchmark and demonstrates the capabilities of the graphics engine.