ACCELERATED WAVE-REFLECTION SOLVER FOR TRAVELING-WAVE-TUBE SIMULATIONS*

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We present our progress on an accelerated algorithm for resolving wave reflections in the parametric, multi-frequency, TWT simulation code CHRISTINE[1]. On the average, it achieves a speedup factor of at least 10 compared with the previously used Newton-type iterative algorithm.

Wave reflections in CHRISTINE are modeled by the coupled wave equations for the forward and backward wave complex amplitudes of the associated Fourier modes. These equations must be solved subject to appropriate boundary conditions imposed at the ends of the interaction space, z=0 and z=L. Since CHRISTINE integrates the wave equations and the equations of motion of the beam in z from z=0 to z=L, the solutions for the forward and backward wave amplitudes may be obtained iteratively. One way to do this is to employ a multi-dimensional Newton's method to find the initial amplitudes. The convergence of this method is very slow, however, when the number of Fourier modes is large.

By expressing the reflected wave equations as a nonlinear fixed-point problem we were able to implement a much faster and more robust algorithm via an iterative, multi-dimensional, fixed point solver, based on the modified Powell's hybrid method[2]. For instance, using this new algorithm to resolve reflections for an input waveform with 64 Fourier modes, we have observed a speedup factor of about 10 compared to the previous version of CHRISTINE.

We are currently investigating the numerical aspects of utilizing this approach to resolve wave reflections in the 3-dimensional code CHRISTINE 3D. In this case we anticipate even larger speedup factors, given the increased runtime complexity of the 3D version.

1. T. Antonsen, Jr. and B. Levush, "CHRISTINE: A multi-frequency parametric simulation code for traveling-wave tube amplifiers", U.S. Naval Research Laboratory, Washington DC, Tech. Rep. NRL-FR-9845, May 1997
2. J. J. More, B. S. Garbow, and K. E. Hillstrom, "User guide for MINPACK-1," Report ANL-80-74, 1980

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