Differential Algebraic Equations by Taylor Series (DAETS) - Mac OS X Version

Published date: June 5, 2009

Technology description

DAETS is a C++ package that solves numerically initial value problems for differential algebraic equation (DAE) systems. It uses a recently developed approach that is able to solve DAEs of high index. DAETS is especially effective at high accuracies, and on very nonlinear problems. The equations can be formulated explicitly or implicitly, and derivatives need not actually be present. Thus DAETS can solve explicit ordinary differential equations (ODEs) y'=f(t,y), implicit ODEs f(t,y,y')=0, and purely algebraic (continuation) problems f(t,y)=0.

Description

Developed jointly by Ned Nedialkov at McMaster University, Canada, and John Pryce at Cranfield University, UK, DAETS is based on Pryce's method for the structural analysis of DAEs. This is a powerful way to determine the index of the system, its number of degrees of freedom, and exactly which components should be given initial values. The results of the structural analysis can be printed out by the user's program as a useful aid to understanding a DAE problem.
A DAE can be encoded in a form very close to its mathematical description. There is no need to convert it to a form that involves only first derivatives, nor to use index-reduction techniques.
Finding an initial consistent point for a DAE is often difficult, especially for nonlinear problems. DAETS has a robust and reliable method for doing so automatically.
DAETS has been used to solve a range of nontrivial problems, including chemical, mechanical and electrical system examples from the "ODE/DAE Test Set for Initial Value Problem Solvers", DAEs of index up to 47, and difficult continuation problems. It has been found easy to use by students in a graduate course on scientific computing.

Limitations

There are no theoretical limitations on the size of the problems DAETS can solve. Computationally, it is efficient on systems of up to a few hundred equations. DAETS is suitable for nonstiff to mildly stiff problems, and may not be efficient on very stiff systems.
The structural analysis, on which the code relies, is guaranteed to work for many common forms of

DAE. However, there are some DAEs for which it gets the wrong results. In our experience this difficulty can always be overcome by simple manipulation of the equations.

Institution

McMaster University