

Solving Constrained Differential-Algebraic Systems Using Projections

Abstract

This is a report on software additions to the Differential-Algebraic Equation (DAE) solver code **DASSL** made during our various researches of 2001-2008. The code modifications are made to deal with “constraint or invariant drift” for DAE systems. These terms are defined below. We also discuss the problem of computing consistent initial conditions for derivative values of DAE systems.

We have installed changes to the basic **DASSL** integration algorithm and provided a modified code **DDASLX**. Our expectation is that **DDASLX** expands the range of application models that can be solved with **DASSL**.

When constraints are present we perturb each step taken by the integrator using a projection algorithm. This change to a step is typically much smaller than the accepted error tolerance. It forces the solution back onto constraints or invariants that the mathematical solution must satisfy. Without this projection step, or some equivalent intervention, the numerical solution may become “non-physical” because certain natural constraints of the system are no longer satisfied. Our primary intent in this report is to give a description of the projection algorithm and draw attention to practical details and limitations.

We also discuss methods for getting started. This is primarily an issue for Index 1 systems where the initial values of the solution are given but the initial derivative values are unknown.