6 Solver PSIDE

6.1 General information

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first version:	November 28 1997 (version 1.0)
last update:	November 25 1998 (version 1.3)
language:	Fortran 77
availability:	the code PSIDE is freely available (in the public domain)
official link:	http://www.cwi.nl/cwi/projects/PSIDE/
problem type:	IDEs/DAEs of index upto at least 3
IVPtestset files:	solver: pside.f
	driver: psided.f
	auxiliary files: psidea.f (auxiliary linear algebra routines)

6.2 Numerical method

The code uses the four-stage Radau IIA method.

6.3 Implementation details

PSIDE is a Parallel Software for Implicit Differential Equations [SLV97a, SLV97b]. It has been designed for working on shared memory parallel computers, using the OPENMP parallel tools.

The nonlinear systems are solved by a modified Newton process, in which every Newton iterate itself is computed by means of the Parallel Iterative Linear system Solver for Runge-Kutta (PILSRK) proposed in [HS97]. This process is constructed such that the four stage values can be computed simultaneously, thereby making PSIDE suitable for execution on four processors. Full details about the algorithmic choices and the implementation of PSIDE can be found in [SLV97c].

6.4 How to solve test problems with PSIDE

Compiling

```
f90  -o dotest  psided.f  problem.f  pside.f  psidea.f  report.f,
```

will yield an executable `dotest` that solves the problem, of which the Fortran routines in the format described in Section IV.3 are in the file `problem.f`. In order to have the correct solution, before the compilation, change the auxiliary routine I1MACH and D1MACH, in the file `dassla.f` because they are machine dependent.

As an example, we perform a test run, in which we solve problem HIRES. Figure I.6.1 shows what one has to do.

References

[HS97] P.J. van der Houwen and J.J.B. de Swart. Parallel linear system solvers for Runge–Kutta methods. *Advances in Computational Mathematics*, 7:157–181, 1997.

[SLV97a] J.J.B. de Swart, W.M. Lioen, and W.A. van der Veen. *PSIDE*, December 1997. Available at http://www.cwi.nl/cwi/projects/PSIDE/.

[SLV97b] J.J.B. de Swart, W.M. Lioen, and W.A. van der Veen. *PSIDE Users' Guide*, 1997. Available at http://www.cwi.nl/cwi/projects/PSIDE/.

```
$ f90 -O5 -o dotest psided.f hires.f pside.f psidea.f report.f
$ ./dotest

  Test Set for IVP Solvers (release 2.3)

  Solving Problem HIRES using PSIDE

 User input:

 give relative error tolerance:
1d-4
 give absolute error tolerance:
1d-4

 Numerical solution:

                                              scd
       solution component              ----------------------------     ignore
                                       mixed       abs        rel    mix - abs,rel
 ----------------------------------    -----      -----      -----   -------------
 y(  1) =  0.7371770832059414E-003      7.34       7.34       4.21
 y(  2) =  0.1442575715381605E-003      8.05       8.05       4.20
 y(  3) =  0.5889602259243881E-004      8.06       8.06       3.83
 y(  4) =  0.1175734704403569E-002      7.08       7.08       4.15
 y(  5) =  0.2387823243162753E-002      5.83       5.83       3.21
 y(  6) =  0.6244778711349675E-002      5.24       5.24       3.03
 y(  7) =  0.2850043711924880E-002      7.34       7.34       4.80
 y(  8) =  0.2849956288075124E-002      7.34       7.34       4.80

 used components for  scd                  8          8          8
 scd of Y (maximum norm)                5.24       5.24       3.03


 using mixed error yields mescd         5.24
 using relative error yields scd                                3.03


 Integration characteristics:

    number of integration steps         43
    number of accepted steps            37
    number of f evaluations            665
    number of Jacobian evaluations      20
    number of LU decompositions        168

 CPU-time used:                        0.0029 sec
```

FIGURE I.6.1: *Example of performing a test run, in which we solve problem HIRES with PSIDE. The experiment was done on an ALPHAserver DS20E, with a 667MHz EV67 processor. We used the Fortran 90 compiler* `f90` *with the optimization flag* `-O5`.

[SLV97c] J.J.B. de Swart, W.M. Lioen, and W.A. van der Veen. *Specification of PSIDE*. CWI, 1997. Available at http://www.cwi.nl/cwi/projects/PSIDE/.