MATCONT: A Matlab package for numerical bifurcation analysis of ODEs

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Software name: MATCONT

Short description: MATCONT is a graphical Matlab software package for the interactive numerical study of dynamical systems. It allows to compute curves of equilibria, limit points, Hopf points, limit cycles, period doubling bifurcation points of limit cycles, fold ,flip and torus bifurcation points of limit cycles.

The MATCONT GUI makes the standard Matlab ODE Suite interactively available and provides computational and visualization tools. MATCONT uses the Matlab symbolic toolbox whenever it is available; higher order derivatives are important e.g. in the computation of normal forms. The sparsity of the discretized systems for the computation of limit cycles and their bifurcation points is exploited by using the standard Matlab sparse matrix methods.

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Abstract

We consider generic parameterized autonomous ODEs of the form $\frac{dx}{dt} \equiv \dot{x} = f(x, \alpha)$, where $x \in \mathbb{R}^n$ is the vector of *state variables*, $\alpha \in \mathbb{R}^m$ represents *parameters*, and $f(x, \alpha) \in \mathbb{R}^n$. There are several interactive software packages for analysis of dynamical systems defined by ODEs. The most widely used are AUTO86/97[1], CONTENT[2] and XPPAUT.

The Matlab software package MATCONT provides an interactive environment for the continuation and normal form analysis of dynamical systems. This analysis is complementary to the simulation of the systems which is also included in the package and can be used in their identification, control, and optimization. MATCONT is designed to exploit the power of Matlab. It is developed in parallel with the continuation toolbox CL_MATCONT, a package of Matlab routines that can be used from the command line.

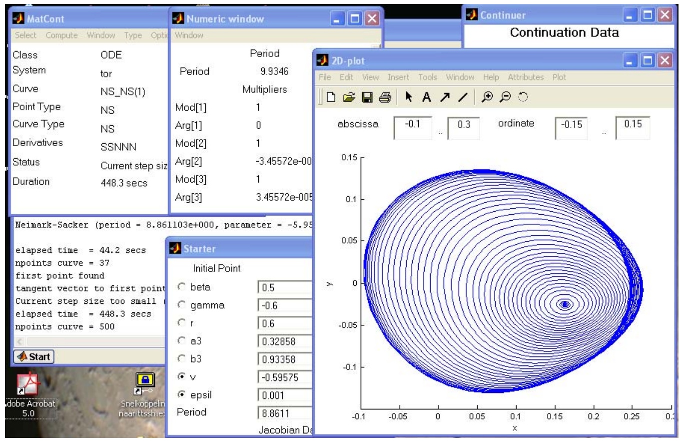

Figure 1: Torus bifurcation continuation in MatCont.

We consider the following model of an autonomous electronic circuit where x, y and z are state variables and $\beta, \gamma, \nu, r, a_3, b_3$ are parameters :

$$\begin{cases} \dot{x} &= (-(\beta+\nu)*x+\beta*y-a_3*x^3+b_3*(y-x)^3)/r \\ \dot{y} &= \beta*x-(\beta+\gamma)*y-z-b_3*(y-x)^3 \\ \dot{z} &= y \end{cases}$$

We compute a branch of equilibria with free parameter ν starting from the trivial solution $x = 0.00125$, $y = -0.001$, $z = 0.00052502$ at $\beta = 0.5$, $\gamma = -0.6$, $r = 0.6$, $a_3 = 0.32858$, $b_3 = 0.93358$, $\nu = -0.9$, $\epsilon = 0.001$. We start a curve of periodic orbits from a Hopf point on this curve choosing ν as the free parameter. We detect a torus bifurcation point at $\nu = -0.59575$. We continue the torus bifurcation in two parameters ν, ϵ and find that it shrinks to a single point for decreasing values of ν (Figure 1).

References

[1] E. J. Doedel, A. R. Champneys, T. F. Fairgrieve, Yu. A. Kuznetsov, B. Sandstede and X. J. Wang, AUTO97 : Continuation and Bifurcation Software for Ordinary Differential Equations (with HomCont), User's Guide, Concordia University, Montreal, Canada 1997. (`http://indy.cs.concordia.ca`).

[2] Yu. A. Kuznetsov and V.V. Levitin, CONTENT : A multiplatform environment for analyzing dynamical systems, Dynamical Systems Laboratory, CWI, Amsterdam 1995-1997 (`ftp.cwi.nl/pub/CONTENT`).