In this paper, we present a way of extending the blowup method, in the formulation of Krupa and Szomolyan, to flat slow manifolds that lose hyperbolicity beyond any algebraic order. Although these manifolds have infinite co-dimensions, they do appear naturally in certain settings; for example, in (a) the regularization of piecewise smooth systems by tanh, (b) a particular aircraft landing dynamics model, and finally (c) in a model of earthquake faulting. We demonstrate the approach using a simple model system and the examples (a) and (b).
Canards in stiction: on solutions of a friction oscillator by regularization

We study the solutions of a friction oscillator subject to stiction. This discontinuous model is nonFilippov, and the concept of Filippov solution cannot be used. Furthermore some Carathéodory solutions are unphysical. Therefore we introduce the concept of stiction solutions: these are the Carathéodory solutions that are physically relevant, i.e. the ones that follow the stiction law. However, we find that some of the stiction solutions are forward non-unique in subregions of the slip onset. We call these solutions singular, in contrast to the regular stiction solutions that are forward unique. In order to further the understanding of the non-unique dynamics, we introduce a regularization of the model. This gives a singularly perturbed problem that captures the main features of the original discontinuous problem. We identify a repelling slow manifold that separates the forward slipping to forward sticking solutions, leading to a high sensitivity to the initial conditions. On this slow manifold we find canard trajectories, that have the physical interpretation of delaying the slip onset. We show with numerics that the regularized problem has a family of periodic orbits interacting with the canards. We observe that this family has a saddle stability and that it connects, in the rigid body limit, the two regular, slip-stick branches of the discontinuous problem, that were otherwise disconnected.

General information
State: Accepted/In press
Organisations: Department of Applied Mathematics and Computer Science, Mathematics
Authors: Bossolini, E. (Intern), Brøns, M. (Intern), Kristiansen, K. U. (Intern)
Number of pages: 27
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Main Research Area: Technical/natural sciences

Publication information
Journal: SIAM Journal on Applied Dynamical Systems
ISSN (Print): 1536-0040
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.88 SJR 1.256 SNIP 1.297
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.358 SNIP 1.389 CiteScore 1.89
Web of Science (2015): Indexed yes
This thesis is concerned with the application of geometric singular perturbation theory to mechanical systems with friction. The mathematical background on geometric singular perturbation theory, on the blow-up method, on non-smooth dynamical systems and on regularization is presented. Thereafter, two mechanical problems with two different formulations of the friction force are introduced and analysed. The first mechanical problem is a one-dimensional spring-block model describing earthquake faulting. The dynamics of earthquakes is naturally a multiple timescale problem: the timescale of earthquake ruptures is very short, when compared to the time interval between two consecutive ruptures. We identify a small parameter $\varepsilon$ that describes the separation between the timescales, so that $\varepsilon = 0$ idealises the complete timescale separation. Earthquake faulting problems also have multiple spatial scales. The action of friction is generally explained as the loss and restoration of linkages between the surface asperities at the molecular scale. However, the consequences of friction are noticeable at much larger scales, like hundreds of kilometers. By using geometric singular perturbation theory and the blow-up method, we provide a detailed description of the periodicity of the earthquake episodes. In particular, we show that attracting limit cycles arise from a degenerate Hopf bifurcation, whose degeneracy is due to an underlying Hamiltonian structure that leads to large amplitude oscillations. We use a Poincaré compactification to study the system near infinity. At infinity, the critical manifold loses hyperbolicity with an exponential rate. We use an adaptation of the blow-up method to recover the hyperbolicity. This enables the identification of a new attracting manifold, that organises the dynamics at infinity for $\varepsilon = 0$. This in turn leads to the formulation of a conjecture on the behaviour of the limit cycles as the timescale separation increases for $0 < \varepsilon < 1$. We illustrate our findings with numerics, and outline the proof of the conjecture. We also discuss how our results can be used to study a similar class of problems. The second mechanical problem is a friction oscillator subject to stiction. The vector field of this discontinuous model does not follow the Filippov convention, and the concept of Filippov solutions cannot be used. Furthermore, some Carathéodory solutions are unphysical. Therefore, we introduce the concept of stiction solutions: these are the Carathéodory solutions that are physically relevant, i.e. the ones that follow the stiction law. However, we find that some of the stiction solutions are forward non-unique in subregions of the slip onset. We call these solutions singular, in contrast to the regular stiction solutions that are forward unique. In order to further the understanding of the non-unique dynamics, we introduce a regularization of the model. This gives a singularly perturbed problem that captures the main features of the original
discontinuous problem. We identify a repelling slow manifold that separates the forward slipping to forward sticking solutions, leading to a high sensitivity to the initial conditions. On this slow manifold we find canard trajectories, that have the physical interpretation of delaying the slip onset. We show numerically that the regularized problem has a family of periodic orbits interacting with the canards. We observe that this family is unstable of saddle type and that it connects, in the rigid body limit, the two regular, slip-stick branches of the discontinuous problem, that were otherwise disconnected.

**General information**
State: Submitted
Organisations: Department of Applied Mathematics and Computer Science, Mathematics
Authors: Bossolini, E. (Intern), Brøns, M. (Intern), Kristiansen, K. U. (Intern)
Number of pages: 146
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**Publication information**
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Original language: English

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Main Research Area: Technical/natural sciences

**Relations**
Projects:
Geometric singular perturbation analysis of systems with friction
Publication: Research › Ph.D. thesis – Annual report year: 2017

On the approximation of the canard explosion point in singularly perturbed systems without an explicit small parameter
A canard explosion is the dramatic change of period and amplitude of a limit cycle of a system of nonlinear ODEs in a very narrow interval of the bifurcation parameter. It occurs in slow–fast systems and is well understood in singular perturbation problems where a small parameter epsilon defines the time-scale separation. We present an iterative algorithm for the determination of the canard explosion point which can be applied for a general slow–fast system without an explicit small parameter. We also present assumptions under which the algorithm gives accurate estimates of the canard explosion point. Finally, we apply the algorithm to the van der Pol equations, a Templator model for a self-replicating system and a model for intracellular calcium oscillations with no explicit small parameters and obtain very good agreement with results from numerical simulations.

**General information**
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Organisations: Department of Applied Mathematics and Computer Science, Mathematics
Authors: Brøns, M. (Intern), Kristiansen, K. U. (Intern)
Pages: 1-23
Publication date: 2017
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Dynamical Systems
ISSN (Print): 1468-9375
Ratings:
Scopus rating (2016): SJR 0.427 SNIP 0.825 CiteScore 0.83
Scopus rating (2015): SJR 0.443 SNIP 0.768 CiteScore 0.84
Scopus rating (2014): SJR 0.651 SNIP 0.722 CiteScore 0.66
Scopus rating (2013): SJR 0.548 SNIP 0.551 CiteScore 0.62
Scopus rating (2012): SJR 0.685 SNIP 0.874 CiteScore 0.74
Scopus rating (2011): SJR 0.57 SNIP 0.529 CiteScore 0.56
Scopus rating (2010): SJR 1.13 SNIP 0.996
Scopus rating (2009): SJR 0.336 SNIP 0.674
Scopus rating (2008): SJR 0.457 SNIP 0.903
Scopus rating (2007): SJR 0.558 SNIP 1.047
Scopus rating (2006): SJR 0.754 SNIP 1.035
Scopus rating (2005): SJR 0.366 SNIP 0.67
On the regularization of impact without collision: the Painlevé paradox and compliance

We consider the problem of a rigid body, subject to a unilateral constraint, in the presence of Coulomb friction. We regularize the problem by assuming compliance (with both stiffness and damping) at the point of contact, for a general class of normal reaction forces. Using a rigorous mathematical approach, we recover impact without collision (IWC) in both the inconsistent and the indeterminate Painlevé paradoxes, in the latter case giving an exact formula for conditions that separate IWC and lift-off. We solve the problem for arbitrary values of the compliance damping and give explicit asymptotic expressions in the limiting cases of small and large damping, all for a large class of rigid bodies.
In this paper we consider the one dimensional spring-block model describing earthquake faulting. By using geometric singular perturbation theory and the blow-up method we provide a detailed description of the periodicity of the earthquake episodes. In particular, the limit cycles arise from a degenerate Hopf bifurcation whose degeneracy is due to an underlying Hamiltonian structure that leads to large amplitude oscillations. We use a Poincaré compactification to study the system near infinity. At infinity the critical manifold loses hyperbolicity with an exponential rate. We use an adaptation of the blow-up method to recover the hyperbolicity. This enables the identification of a new attracting manifold that organises the dynamics at infinity. This in turn leads to the formulation of a conjecture on the behaviour of the limit cycles as the time-scale separation increases. We provide the basic foundation for the proof of this conjecture and illustrate our findings with numerics.
Exponential estimates of symplectic slow manifolds

In this paper we prove the existence of an almost invariant symplectic slow manifold for analytic Hamiltonian slow-fast systems with finitely many slow degrees of freedom for which the error field is exponentially small. We allow for infinitely many fast degrees of freedom. The method we use is motivated by a paper of MacKay from 2004. The method does not notice resonances, and therefore we do not pose any restrictions on the motion normal to the slow manifold other than it being fast and analytic. We also present a stability result and obtain a generalization of a result of Gelfreich and Lerman on an invariant slow manifold to (finitely) many fast degrees of freedom.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Mathematics, University of Surrey
Authors: Kristiansen, K. U. (Intern), Wulff, C. (Ekstern)
Number of pages: 46
Computation of saddle-type slow manifolds using iterative methods
This paper presents an alternative approach for the computation of trajectory segments on slow manifolds of saddle type. This approach is based on iterative methods rather than collocation-type methods. Compared to collocation methods, which require mesh refinements to ensure uniform convergence with respect to , appropriate estimates are directly attainable using the method of this paper. The method is applied to several examples, including a model for a pair of neurons coupled by reciprocal inhibition with two slow and two fast variables, and the computation of homoclinic connections in the FitzHugh–Nagumo system.
Publication information
Journal: SIAM Journal on Applied Dynamical Systems
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Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.88 SJR 1.256 SNIP 1.297
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.358 SNIP 1.389 CiteScore 1.89
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.167 SNIP 1.217 CiteScore 1.67
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.306 SNIP 1.34 CiteScore 1.85
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.221 SNIP 1.486 CiteScore 1.77
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.494 SNIP 1.41 CiteScore 1.91
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.204 SNIP 1.187
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.299 SNIP 1.613
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.276 SNIP 1.508
Scopus rating (2007): SJR 1.55 SNIP 1.472
Scopus rating (2006): SJR 1.781 SNIP 1.465
Scopus rating (2005): SJR 1.227 SNIP 1.899
Scopus rating (2004): SJR 1.107 SNIP 2.233
Scopus rating (2003): SJR 0.536 SNIP 0.702
Original language: English
Slow-fast systems, Slow manifolds of saddle type, Reduction methods
Electronic versions:
140961948.pdf
DOIs:
10.1137/140961948
Source: PublicationPreSubmission
Source-ID: 114011389
Publication: Research - peer-review › Journal article – Annual report year: 2015
On the use of blowup to study regularizations of singularities of piecewise smooth dynamical systems in $\mathbb{R}^3$

In this paper we use the blowup method of Dumortier and Roussarie, in the formulation due to Krupa and Szmolyan, to study the regularization of singularities of piecewise smooth dynamical systems in $\mathbb{R}^3$. Using the regularization method of Sotomayor and Teixeira, we first demonstrate the power of our approach by considering the case of a fold line. We quickly extend a main result of Reves and Seara in a simple manner. Then, for the two-fold singularity, we show that the regularized system only fully retains the features of the singular canards in the piecewise smooth system in the cases when the sliding region does not include a full sector of singular canards. In particular, we show that every locally unique primary singular canard persists the regularizing perturbation. For the case of a sector of primary singular canards, we show that the regularized system contains a canard, provided a certain nonresonance condition holds. Finally, we provide numerical evidence for the existence of secondary canards near resonance.
Periodic orbits near a bifurcating slow manifold

This paper studies a class of $1\frac{1}{2}$-degree-of-freedom Hamiltonian systems with a slowly varying phase that unfolds a Hamiltonian pitchfork bifurcation. The main result of the paper is that there exists an order of $\ln^2/\epsilon^{-1}$-many periodic orbits that all stay within an $\mathcal{O}(\epsilon^{1/3})$-distance from the union of the normally elliptic slow manifolds that occur as a result of the bifurcation. Here $\epsilon$ measures the time scale separation. These periodic orbits are predominantly unstable. The proof is based on averaging of two blowup systems, allowing one to estimate the effect of the singularity, combined with results on asymptotics of the second Painlevé equation. The stable orbits of smallest amplitude that are obtained by these methods remain slightly further away from the slow manifold being distant by an order $\mathcal{O}(\epsilon^{1/3}\ln^{1/2}\ln \epsilon^{-1})$.

General information
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Organisations: Department of Applied Mathematics and Computer Science, Mathematics
Authors: Kristiansen, K. U. (Intern)
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Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Differential Equations
Volume: 259
Issue number: 9
ISSN (Print): 0022-0396
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 2.454 SNIP 1.844 CiteScore 1.98
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.752 SNIP 1.931 CiteScore 1.95
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.042 SNIP 1.891 CiteScore 1.78
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.715 SNIP 1.726 CiteScore 1.76
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.655 SNIP 1.778 CiteScore 1.64
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.188 SNIP 1.41 CiteScore 1.31
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.354 SNIP 1.58
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.417 SNIP 1.751
BFI (2008): BFI-level 2
Regularization of Piecewise Smooth Two-Folds

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Mathematics, University of Bristol
Authors: Kristiansen, K. U. (Intern), Hogan, S. J. (Ekstern)
Number of pages: 1
Publication date: 2015
Event: Poster session presented at EquaDiff 2015, Lyon, France.
Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
Source-ID: 118523574
Publication: Research - peer-review › Poster – Annual report year: 2015

Regularizations of two-fold bifurcations in planar piecewise smooth systems using blowup
We use blowup to study the regularization of codimension one two-fold singularities in planar piecewise smooth (PWS) dynamical systems. We focus on singular canards, pseudo-equilibria and limit cycles that can occur in the PWS system. Using the regularization of Sotomayor and Teixeira [30], we show rigorously how singular canards can persist and how the bifurcation of pseudo-equilibria is related to bifurcations of equilibria in the regularized system. We also show that PWS limit cycles are connected to Hopf bifurcations of the regularization. In addition, we show how regularization can create another type of limit cycle that does not appear to be present in the original PWS system. For both types of limit cycle, we show that the criticality of the Hopf bifurcation that gives rise to periodic orbits is strongly dependent on the precise form of the regularization. Finally, we analyse the limit cycles as locally unique families of periodic orbits of the regularization and connect them, when possible, to limit cycles of the PWS system. We illustrate our analysis with numerical simulations and show how the regularized system can undergo a canard explosion phenomenon

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Mathematics, University of Bristol
Authors: Kristiansen, K. U. (Intern), Hogan, S. J. (Ekstern)
Pages: 1731-1786
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Main Research Area: Technical/natural sciences

Publication information
Journal: SIAM Journal on Applied Dynamical Systems
Volume: 14
Issue number: 4
ISSN (Print): 1075-3600
An Iterative Method for the Approximation of Fibers in Slow-Fast Systems

In this paper we extend a method for iteratively improving slow manifolds so that it also can be used to approximate the fiber directions. The extended method is applied to general finite-dimensional real analytic systems where we obtain exponential estimates of the tangent spaces to the fibers. The method is demonstrated on the Michaelis–Menten–Henri model and the Lindemann mechanism. The latter example also serves to demonstrate the method on a slow-fast system in nonstandard slow-fast form. Finally, we extend the method further so that it also approximates the curvature of the fibers.

General information

State: Published
Organisations: Department of Applied Mathematics and Computer Science, Mathematics, Dynamical Systems
Authors: Kristiansen, K. U. (Intern), Brøns, M. (Intern), Starke, J. (Intern)
Numerical modelling of elastic space tethers

In this paper the importance of the ill-posedness of the classical, non-dissipative massive tether model on an orbiting tether system is studied numerically. The computations document that via the regularisation of bending resistance a more reliable numerical integrator can be produced. Furthermore, the numerical experiments of an orbiting tether system show that bending may introduce significant forces in some regions of phase space. Finally, numerical evidence for the existence of an almost invariant slow manifold of the singularly perturbed, regularised, non-dissipative massive tether
model is provided. It is also shown that on the slow manifold the dynamics of the satellites are well-approximated by the finite dimensional slack-spring model.

**General information**

State: Published
Organisations: Department of Mathematics, Dynamical systems, University of Surrey
Authors: Kristiansen, K. U. (Intern), Palmer, P. L. (Ekstern), Roberts, R. M. (Ekstern)
Pages: 235-254
Publication date: 2012
Main Research Area: Technical/natural sciences

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Journal: Celestial Mechanics and Dynamical Astronomy
Volume: 113
Issue number: 2
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Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.613 SNIP 1.797 CiteScore 1.83
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.98 SNIP 1.538 CiteScore 1.65
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.462 SNIP 2.055 CiteScore 2.2
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.238 SNIP 1.863 CiteScore 2.1
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.259 SNIP 2.407 CiteScore 2.3
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.799 SNIP 1.163 CiteScore 1.48
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.769 SNIP 1.407
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.824 SNIP 1.837
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.891 SNIP 1.521
Scopus rating (2007): SJR 0.616 SNIP 0.777
Scopus rating (2006): SJR 0.847 SNIP 1.07
Scopus rating (2005): SJR 0.698 SNIP 1.071
Scopus rating (2004): SJR 0.595 SNIP 0.951
Scopus rating (2003): SJR 0.438 SNIP 1.08
Scopus rating (2002): SJR 0.354 SNIP 0.926
Scopus rating (2001): SJR 0.511 SNIP 0.772
Scopus rating (2000): SJR 0.373 SNIP 0.504
Scopus rating (1999): SJR 0.41 SNIP 0.681
Original language: English
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Source: dtu
Source-ID: n:oai:DTIC-ART:springer/372511917::21931
Publication: Research - peer-review › Journal article – Annual report year: 2012
Relative attitude dynamics and control for a satellite inspection mission

The problem of conducting an inspection mission from a chaser satellite orbiting a target spacecraft is considered. It is assumed that both satellites follow nearly circular orbits. The relative orbital motion is described by the Hill–Clohessy–Wiltshire equation. In the case of an elliptic relative orbit, it is shown that an inspection mission is feasible when the chaser is inertially pointing, provided that the camera mounted on the chaser satellite has sufficiently large field of view. The same possibility is shown when the optical axis of the chaser’s camera points in, or opposite to, the tangential direction of the local vertical local horizontal frame.

For an arbitrary relative orbit and arbitrary initial conditions, the concept of relative Euler angles is defined for this inspection mission. The expression of the desired relative angular velocity vector is derived as a function of Cartesian coordinates of the relative orbit. A quaternion feedback controller is then designed and shown to perform relative attitude control with admissible internal torques. Three different types of relative orbits are considered, namely the elliptic, Pogo and drifting relative orbits. Measurements of the relative orbital motion are assumed to be available from optical navigation.

General information

State: Published
Organisations: University of Surrey
Authors: Horri, N. M. (Ekstern), Kristiansen, K. U. (Intern), Palmer, P. (Ekstern), Roberts, M. (Forskerdatabase)
Pages: 109-118
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Main Research Area: Technical/natural sciences

Publication information

Journal: Acta Astronautica
Volume: 71
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Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.08 SJR 0.732 SNIP 2.017
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.721 SNIP 1.73 CiteScore 1.49
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.731 SNIP 1.714 CiteScore 1.6
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.615 SNIP 1.447 CiteScore 1.24
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.54 SNIP 1.268 CiteScore 0.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.504 SNIP 1.266 CiteScore 0.88
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.414 SNIP 1.177
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.32 SNIP 0.909
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.342 SNIP 0.787
Scopus rating (2007): SJR 0.288 SNIP 0.823
The Persistence of a Slow Manifold with Bifurcation

This paper considers the persistence of a slow manifold with bifurcation in a slow-fast two degree of freedom Hamiltonian system. In particular, we consider a system with a supercritical pitchfork bifurcation in the fast space which is unfolded by the slow coordinate. The model system is motivated by tethered satellites. It is shown that an almost full measure subset of a neighborhood of the slow manifold's normally elliptic branches persists in an adiabatic sense. We prove this using averaging and a blow-up near the bifurcation.

General information
State: Published
Organisations: Department of Mathematics, Dynamical systems, University of Surrey
Authors: Kristiansen, K. U. (Intern), Palmer, P. (Ekstern), Robert, M. (Ekstern)
Pages: 661-683
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: SIAM Journal on Applied Dynamical Systems
Volume: 11
Issue number: 2
ISSN (Print): 1536-0040
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.88 SJR 1.256 SNIP 1.297
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.358 SNIP 1.389 CiteScore 1.89
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.167 SNIP 1.217 CiteScore 1.67
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.306 SNIP 1.34 CiteScore 1.85
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.221 SNIP 1.486 CiteScore 1.77
ISI indexed (2012): ISI indexed yes
Singularity perturbed Hamiltonian systems, Slow manifolds with bifurcations, Pitchfork bifurcations, Blow-up, Tethered satellites

DOIs:
10.1137/110820671

Bibliographical note
Publication: Research - peer-review > Journal article – Annual report year: 2012

The two-body problem of a pseudo-rigid body and a rigid sphere
In this paper we consider the two-body problem of a spherical pseudo-rigid body and a rigid sphere. Due to the rotational and "re-labelling" symmetries, the system is shown to possess conservation of angular momentum and circulation. We follow a reduction procedure similar to that undertaken in the study of the two-body problem of a rigid body and a sphere so that the computed reduced non-canonical Hamiltonian takes a similar form. We then consider relative equilibria and show that the notions of locally central and planar equilibria coincide. Finally, we show that Riemann's theorem on pseudo-rigid bodies has an extension to this system for planar relative equilibria.

General information
State: Published
Organisations: Department of Mathematics, Dynamical systems, Nicolaus Copernicus University, University of Surrey
Authors: Kristiansen, K. U. (Intern), Vereshchagin, M. (Ekstern), Gózdziewski, K. (Ekstern), Palmer, P. (Ekstern), Roberts, R. (Ekstern)
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Publication date: 2012
Main Research Area: Technical/natural sciences

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Journal: Celestial Mechanics and Dynamical Astronomy
Volume: 112
ISSN (Print): 0923-2958
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.613 SNIP 1.797 CiteScore 1.83
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.98 SNIP 1.538 CiteScore 1.65
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.462 SNIP 2.055 CiteScore 2.2
BFI (2013): BFI-level 1
A Unification of Models of Tethered Satellites

In this paper, different conservative models of tethered satellites are related mathematically, and it is established in what limit they may provide useful insight into the underlying dynamics. An infinite dimensional model is linked to a finite dimensional model, the slack-spring model, through a conjecture on the singular perturbation of tether thickness. The slack-spring model is then naturally related to a billiard model in the limit of an inextensible spring. Next, the motion of a dumbbell model, which is lowest in the hierarchy of models, is identified within the motion of the billiard model through a theorem on the existence of invariant curves by exploiting Moser's twist map theorem. Finally, numerical computations provide insight into the dynamics of the billiard model.

General information
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Organisations: University of Surrey
Authors: Kristiansen, K. U. (Intern), Palmer, P. (Ekstern), Roberts, M. (Forskerdatabase)
Pages: 1042-1069
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
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Volume: 10
Issue number: 3
ISSN (Print): 1536-0040
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.88 SJR 1.256 SNIP 1.297
Dynamic systems approach to the lander descent problem

The descent of a lander from an initial circular orbit to the surface of a planet using gravity turn was studied. By choosing a controller depending upon the flight-path angle, an analytical expression was obtained for the required control as a function of the initial radius and the radius of the planet. With this controller, the system was also shown to possess an interesting geometry. The initial circular orbits and, through a proper scaling, the final states at the surface of the planet were shown to be equilibria of the system. The solutions to the problem were then geometrically interpreted as heteroclinic connections between these equilibria. The constant thrust-to-mass controller was treated numerically, and through a proper scaling the required control for a given initial and final radius through one single planar plot was determined.

However, for the constant thrust-to-weight controller it was numerically concluded that the ratio between the radius of the initial circular orbit to the radius of the planet could not exceed ≊1.162.

General information
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Relative motion of satellites exploiting the super-integrability of Kepler's problem

This paper builds upon the work of Palmer and Imre exploring the relative motion of satellites on neighbouring Keplerian orbits. We make use of a general geometrical setting from Hamiltonian systems theory to obtain analytical solutions of the variational Kepler equations in an Earth centred inertial coordinate frame in terms of the relevant conserved quantities: relative energy, relative angular momentum and the relative eccentricity vector. The paper extends the work on relative satellite motion by providing solutions about any elliptic, parabolic or hyperbolic reference trajectory, including the zero angular momentum case. The geometrical framework assists the design of complex formation flying trajectories. This is demonstrated by the construction of a tetrahedral formation, described through the relevant conserved quantities, for which the satellites are on highly eccentric orbits around the Sun to visit the Kuiper belt.
Canards in Stiction: On Solutions of a Friction Oscillator by Regularization

We consider the problem of the friction oscillator using the stiction model of friction. This friction law has a discontinuity between the dynamic and the static regime. The discontinuity set has a sticking region in which the forward solution is non-unique. In particular, there are special points along these segments where the solution is tangent to the boundary of the discontinuity set. In order to resolve this uncertainty, we introduce a regularization of the vector field and we obtain a multiple-time scale problem. Here the special points of the piecewise-smooth problem become folded saddles and a canard solution appears. We study the interaction of periodic orbits with the canard and we find that the the regularized problem has solutions that do not appear in the original problem.

Degree of recognition: International

Related event

SIAM Conference on Applications of Dynamical Systems 2017
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