A codimension two bifurcation in a railway bogie system

In this paper, a comprehensive analysis is presented to investigate a codimension two bifurcation that exists in a nonlinear railway bogie dynamic system combining theoretical analysis with numerical investigation. By using the running velocity $V$ and the primary longitudinal stiffness (Formula presented.) as bifurcation parameters the first and second Lyapunov coefficients are calculated to determine which kind of Hopf bifurcation can happen and how the system states change with the variance of the bifurcation parameters. It is found that multiple solution branches both stable and unstable coexist in a range of the bifurcation parameters which can lead to jumps in the lateral oscillation amplitude of the railway bogie system. Furthermore, reduce the values of the bifurcation parameters gradually. Firstly, the supercritical Hopf bifurcation turns into a subcritical one with multiple limit cycles both stable and unstable near the Hopf bifurcation point. With a further reduction in the bifurcation parameters two saddle-node bifurcation points emerge, resulting in the loss of the stable limit cycle between these two bifurcation points.
Dynamics of a railway vehicle on a laterally disturbed track

In this article a theoretical investigation of the dynamics of a railway bogie running on a tangent track with a periodic disturbance of the lateral track geometry is presented. The dynamics is computed for two values of the speed of the vehicle in combination with different values of the wavelength and amplitude of the disturbance. Depending on the combinations of the speed, the wavelength and the amplitude, straight line forward motion, different modes of symmetric or asymmetric periodic oscillations or aperiodic motions, which are presumably chaotic, are found. Statistical methods are applied for the investigation. In the case of sinusoidal oscillations they provide information about the phase shift between the different variables and the amplitudes of the oscillations. In the case of an aperiodic motion the statistical measures indicate some non-smooth transitions.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems
Authors: Christiansen, L. E. (Intern), True, H. (Intern)
Number of pages: 32
Pages: 1-32
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Main Research Area: Technical/natural sciences

Publication information
Journal: Vehicle System Dynamics
ISSN (Print): 0042-3114
Ratings:
Warum ist es so schwierig, die lateralen Gleisstörungen durch Messungen der Fahrzeugdynamik zu bestimmen

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems
Authors: Christiansen, L. E. (Intern), True, H. (Intern)
Pages: 133 -139
Publication date: 2017
Conference: 44. Tagung „Moderne Schienenfahrzeuge“, Graz, Austria, 10/09/2017 - 10/09/2017
Why is it so difficult to determine the lateral Position of the Rails by a Measurement of the Motion of an Axle on a moving Vehicle?

Several attempts of measuring the exact location of the rails by the use of ordinary vehicles have been made. While the method works reasonably well in the vertical direction, the results of the lateral measurements made with different vehicles are so widely scattered that it is virtually impossible to draw any conclusions. We may therefore ask: does a wheel set follow the track disturbances exactly? In this article we investigate the lateral dynamics of a half-car vehicle model with two-axle bogies running on a rigid tangent track with sinusoidal lateral disturbances of the rails. The wavelength, the amplitude and the phase between the rail disturbances are varied. Two different vehicle speeds are investigated. One speed is under and the other above the vehicle critical speed. In the article we show examples of axle motions that do not follow the track disturbances in phase, amplitude or period or several of these together. The results are discussed, and we must conclude that it is in general impossible to determine the track geometry from the motion of a wheel set.

Lateral dynamic features of a railway vehicle

The lateral dynamic features of a railway vehicle are investigated using two similar wheel/rail contact models: the Vermeulen-Johnson and the Shen-Hedrick-Elkins models. The symmetric/asymmetric bifurcation behaviour and chaotic motions of the railway vehicle are investigated in great detail by varying the speed and using the resultant bifurcation diagram method. It is found that multiple solution branches exist and they can lead to more steady states in the dynamic behaviour of the railway vehicle. The coexistence of multiple steady states can lead to jumps in the amplitude of oscillations, resulting in problems for safe operation of the vehicle. Therefore, it should be avoided in everyday operation. Furthermore, the creation of multiple solution branches suggests that the critical speed of a vehicle should be determined from a comprehensive analysis of the various kinds of possible excitations and numerous tests.
Analysis of the nonlinear dynamics of a 2-axle freight wagon in curves

This paper deals with the study of the nonlinear dynamic behaviour of 2-axle freight wagons in curves, considering the case of one single wagon (neglecting inter-car coupling forces) and of multiple wagons interacting through the buffers and the couplers. A multi-body model of a single wagon and of a three-car assembly is introduced, paying particular attention to the nonlinear and nonsmooth modelling of the suspensions and of the inter-car coupling elements. Using this model, a numerical analysis of the steady-state solution reached after the negotiation of curve transition is presented and bifurcations are identified for some particular values of the curve radius. For the single car case, it is shown that depending on the curve radius and the vehicle speed the carbody may experience severe periodic oscillations at speeds lying in the operating range of the vehicle. For the car-assembly case, it is shown that the coupling forces exchanged by the wagons significantly affect their dynamics in a curve, reducing the amplitude of vibration.

General information

State: Published
Organisations: Department of Applied Mathematics and Computer Science , Politecnico di Milano
Authors: Di Gialleonardo, E. (Ekstern), Bruni, S. (Ekstern), True, H. (Intern)
Pages: 125-141
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
On the numerical and computational aspects of non-smoothnesses that occur in railway vehicle dynamics

The paper contains a report of the experiences with numerical analyses of railway vehicle dynamical systems, which all are nonlinear, non-smooth and stiff high-dimensional systems. Some results are shown, but the emphasis is on the numerical methods of solution and lessons learned. But for two examples the dynamical problems are formulated as systems of ordinary differential-algebraic equations due to the geometric constraints. The non-smoothnesses have been
neglected, smoothened or entered into the dynamical systems as switching boundaries with relations, which govern the continuation of the solutions across these boundaries. We compare the resulting solutions that are found with the three different strategies of handling the non-smoothnesses. Several integrators – both explicit and implicit ones – have been tested and their performances are evaluated and compared with respect to accuracy, and computation time.

**General information**

State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing
Authors: True, H. (Intern), Engsig-Karup, A. P. (Intern), Bigoni, D. (Intern)
Pages: 78–97
Publication date: 2014
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Mathematics and Computers in Simulation
Volume: 95
ISSN (Print): 0378-4754
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.43 SJR 0.537 SNIP 1.062
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.643 SNIP 1.096 CiteScore 1.29
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.579 SNIP 1.147 CiteScore 1.27
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.581 SNIP 1.067 CiteScore 1.16
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.61 SNIP 1.029 CiteScore 1.11
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.591 SNIP 1.098 CiteScore 1.21
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.735 SNIP 0.797
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.457 SNIP 0.977
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.524 SNIP 0.888
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.457 SNIP 0.902
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.267 SNIP 0.88
Scopus rating (2005): SJR 0.362 SNIP 0.814
Scopus rating (2004): SJR 0.329 SNIP 0.937
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.289 SNIP 0.804
Scopus rating (2002): SJR 0.344 SNIP 0.544
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.308 SNIP 0.626
Sensitivity Analysis of the Critical Speed in Railway Vehicle Dynamics

We present an approach to global sensitivity analysis aiming at the reduction of its computational cost without compromising the results. The method is based on sampling methods, cubature rules, High-Dimensional Model Representation and Total Sensitivity Indices. The approach has a general applicability in many engineering fields and does not require the knowledge of the particular solver of the dynamical system. This analysis can be used as part of the virtual homologation procedure and to help engineers during the design phase of complex systems. The method is applied to a half car with a two-axle Cooperider bogie, in order to study the sensitivity of the critical speed with respect to suspension parameters. The importance of a certain suspension component is expressed by the variance in critical speed that is ascribable to it. This proves to be useful in the identification of parameters for which the exactness of their values is critically important.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Scientific Computing
Authors: Bigoni, D. (Intern), True, H. (Intern), Engsig-Karup, A. P. (Intern)
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Conference: 23rd Symposium on Dynamics of Vehicles on Roads and Tracks (IAVSD 2013), Qingdao, China, 19/08/2013 - 19/08/2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Vehicle System Dynamics
Volume: 52
Issue number: Suppl. 1
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.58 SJR 1.058 SNIP 2.265
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.047 SNIP 2.116 CiteScore 2.01
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.033 SNIP 2.69 CiteScore 1.88
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.715 SNIP 2.22 CiteScore 1.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.723 SNIP 2.109 CiteScore 1.44
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.749 SNIP 1.996 CiteScore 1.38
Inaugural editorial for the international journal of rail transportation

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Southwest Jiaotong University, Oklahoma State University
Authors: True, H. (Intern), Zhai, W. (Ekstern), Wang, K. C. (Ekstern)
Number of pages: 2
Pages: 1-2
Publication date: 1 Jan 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Rail Transportation
Volume: 1
Issue number: 1
ISSN (Print): 2324-8378
Ratings:
Web of Science (2018): Indexed yes
Scopus rating (2016): CiteScore 2.37
Original language: English
Electronic versions:
2013_IJRT_11_2_0_Editorial.pdf
DOIs:
10.1080/23248378.2013.798082
Source: Scopus
Source-ID: 84964307495
Publication: Research - peer-review › Editorial – Annual report year: 2013

Anwendung der "Uncertainty Quantification" bei eisenbahndynamischen problemen
The paper describes the results of the application of "Uncertainty Quantification" methods in railway vehicle dynamics. The system parameters are given by probability distributions. The results of the application of the Monte-Carlo and generalized Polynomial Chaos methods to a simple bogie model will be discussed.

General information
A Review on the Linear and Nonlinear Critical Speeds

In recent years several authors have proposed 'easier numerical methods' to find multiple attractors and the critical speed in railway dynamical problems. Actually, the methods do function in some cases, but they are not safe in the sense that you will calculate the relevant critical parameter values with a reasonable accuracy. In some cases the 'easier numerical methods' are really just a gamble. In this presentation the methods will be discussed. For this purpose linearisations of the nonlinear dynamical problem are made. A linearisation of the nonlinear dynamical problem simplifies the calculations and may give relevant answers to important questions such as the possibility of resonance phenomena in the designs, but a linearisation is not always allowed, and it does not help to find the critical speed of a railway vehicle. We shall also address the curious fact that the hunting motion is more robust than the ideal stationary state motion in the track.
methods are discussed and the pros and contras are commented upon. I also address the questions when a linearisation
is allowed and the curious fact that the hunting motion is more robust than the ideal stationary-state motion on the track.
Concepts such as multiple attractors, subcritical and supercritical bifurcations, permitted linearisation, the danger of
running at supercritical speeds and chaotic motion are addressed.

**General information**

State: Published
Organisations: Department of Applied Mathematics and Computer Science
Authors: True, H. (Intern)
Pages: 443-459
Publication date: 2013
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Vehicle System Dynamics
Volume: 51
Issue number: 3
ISSN (Print): 0042-3114
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.58 SJR 1.058 SNIP 2.265
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.047 SNIP 2.116 CiteScore 2.01
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.033 SNIP 2.69 CiteScore 1.88
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.715 SNIP 2.22 CiteScore 1.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.723 SNIP 2.109 CiteScore 1.44
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.749 SNIP 1.996 CiteScore 1.38
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.669 SNIP 2.099
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.588 SNIP 1.261
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.744 SNIP 2.057
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.386 SNIP 0.898
Scopus rating (2006): SJR 0.485 SNIP 1.523
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.418 SNIP 1.425
Scopus rating (2004): SJR 0.614 SNIP 1.87
Scopus rating (2003): SJR 0.629 SNIP 1.464
Scopus rating (2002): SJR 0.527 SNIP 0.956
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.529 SNIP 0.928
Scopus rating (2000): SJR 0.471 SNIP 1.604
Nonlinear Vehicle Dynamics

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science
Authors: True, H. (Intern)
Pages: 121–158
Publication date: 2013

Host publication information
Title of host publication: Road and Off-Road Vehicle System Dynamics Handbook
Publisher: C R C Press LLC
Editor: Ploechl, M.
ISBN (Print): 978-0-8493-3322-4
ISBN (Electronic): 978-1-4200-0490-8
Chapter: 5
Main Research Area: Technical/natural sciences
DOIs:
10.1201/b15560-7
Publication: Research - peer-review › Book chapter – Annual report year: 2013

Sensitivity Analysis of the Critical Speed in Railway Vehicle Dynamics
We present an approach to global sensitivity analysis aiming at the reduction of its computational cost without compromising the results. The method is based on sampling methods, cubature rules, High-Dimensional Model Representation and Total Sensitivity Indices. The approach has a general applicability in many engineering fields and does not require the knowledge of the particular solver of the dynamical system. This analysis can be used as part of the virtual homologation procedure and to help engineers during the design phase of complex systems. The method is applied to a half car with a two-axle Cooperider bogie, in order to study the sensitivity of the critical speed with respect to suspension parameters. The importance of a certain suspension component is expressed by the variance in critical speed that is ascribable to it. This proves to be useful in the identification of parameters for which the exactness of their values is critically important.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Scientific Computing
Authors: Bigoni, D. (Intern), True, H. (Intern), Engsig-Karup, A. P. (Intern)
Number of pages: 9
Publication date: 2013

Host publication information
Title of host publication: Proceedings of IAVSD2013
Editor: Iwnicki, S.
Article number: 28.2
Main Research Area: Technical/natural sciences
Conference: 23rd Symposium on Dynamics of Vehicles on Roads and Tracks (IAVSD 2013), Qingdao, China, 19/08/2013 - 19/08/2013
Electronic versions:
PaperFinal.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Symmetric/asymmetric bifurcation behaviours of a bogie system
Based on the bifurcation and stability theory of dynamical systems, the symmetric/asymmetric bifurcation behaviours and chaotic motions of a railway bogie system under a complex nonlinear wheel–rail contact relation are investigated in detail by the ‘resultant bifurcation diagram’ method with slowly increasing and decreasing speed. It is found that the stationary equilibrium solution and the periodic motions coexist due to the sub-critical Hopf bifurcation in the railway bogie system. It
is also found that multiple solutions coexist in many speed ranges. The coexistence of multiple solutions may result in a jump and hysteresis of the oscillating amplitude for different kinds of disturbances. It should be avoided in the normal operation. Furthermore, it is found that symmetry-breaking of the system through a pitchfork bifurcation leads to asymmetric chaotic motions in the railway bogie system. The speed ranges of asymmetric chaotic motions are, however, small.

**General information**
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Chengdu University of Technology, Southwest Jiaotong University
Authors: Xue-jun, G. (Ekstern), Ying-hui, L. (Ekstern), Yuan, Y. (Ekstern), True, H. (Intern)
Pages: 936-951
Publication date: 2013
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Journal of Sound and Vibration
Volume: 332
Issue number: 4
ISSN (Print): 0022-460X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.09 SJR 1.462 SNIP 2.162
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.391 SNIP 2.142 CiteScore 2.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.447 SNIP 2.38 CiteScore 2.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.391 SNIP 2.64 CiteScore 2.61
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.495 SNIP 2.992 CiteScore 2.3
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.441 SNIP 2.698 CiteScore 2.05
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.218 SNIP 2.069
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.384 SNIP 2.185
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.205 SNIP 1.96
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.173 SNIP 1.701
Web of Science (2007): Indexed yes
Comparison of Classical and Modern Uncertainty Qualification Methods for the Calculation of Critical Speeds in Railway Vehicle Dynamics

This paper describes the results of the application of Uncertainty Quantification methods to a railway vehicle dynamical example. Uncertainty Quantification methods take the probability distribution of the system parameters that stems from the parameter tolerances into account in the result. In this paper the methods are applied to a lowdimensional vehicle dynamical model composed by a two-axle bogie, which is connected to a car body by a lateral linear spring, a lateral damper and a torsional spring.

Their characteristics are not deterministically defined, but they are defined by probability distributions. The model - but with deterministically defined parameters - was studied in [1], and this article will focus on the calculation of the critical speed of the model, when the distribution of the parameters is taken into account.

Results of the application of the traditional Monte Carlo sampling method will be compared with the results of the application of advanced Uncertainty Quantification methods such as generalized Polynomial Chaos (gPC) [2]. We highlight the computational performance and fast convergence that result from the application of advanced Uncertainty Quantification methods. Generalized Polynomial Chaos will be presented in both the Galerkin and Collocation form with emphasis on the pros and cons of each of those approaches.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing
Authors: Bigoni, D. (Intern), Engsig-Karup, A. P. (Intern), True, H. (Intern)
Number of pages: 10
Publication date: 2012

Host publication information
Title of host publication: Proceedings of 13th Mini Conference on Vehicle System dynamics, Identification and Anomalies
Main Research Area: Technical/natural sciences
Railway vehicle dynamics, Nonlinear dynamics, Uncertainty quantification, Generalized polynomial chaos, High-order cubature rules
Electronic versions:
Comparison_of_Classical_and_Modern_Uncertainty_Qualification.pdf

Relations
Activities:
Comparison of Classical and Modern Uncertainty Qualification Methods for the Calculation of Critical Speeds in Railway Vehicle Dynamics
Uncertainty Quantification on High-speed Railway Dynamics

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing
Authors: Bigoni, D. (Intern), Engsig-Karup, A. P. (Intern), True, H. (Intern)
Publication date: 2012
Event: Poster session presented at Uncertainty Quantification for High-Performance Computing Workshop, Oak Ridge, TN, United States.
Main Research Area: Technical/natural sciences
Electronic versions:
poster.pdf

Relations
Activities:
Uncertainty Quantification for High-Performance Computing Workshop
Publication: Research - peer-review › Poster – Annual report year: 2012

Analysis of the nonlinear dynamics of a 2-axle freight wagon in curves

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Publication date: 2011

Host publication information
Title of host publication: IAVSD 14-19 August 2011 : Proceedings
Main Research Area: Technical/natural sciences
Conference: 22nd International Symposium on Dynamics of Vehicles on Roads and Tracks, Manchester, United Kingdom, 14/08/2011 - 14/08/2011
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Die Berechnung der kritischen Geschwindigkeit eines Eisenbahnfahrzeuges: Die richtige, die falsche und die Zufallsmethode

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 162-169
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Z E Vrail - Glasers Annalen
Volume: 135
ISSN (Print): 1618-8330
Ratings:
Scopus rating (2016): SJR 0.1 SNIP 0.137
Scopus rating (2015): SJR 0.101 SNIP 0.008
Scopus rating (2014): SJR 0.1 SNIP 0.123
Scopus rating (2013): SJR 0.159 SNIP 0
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.101 SNIP 0.041
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.173 SNIP 0.223
On multiple attractors and critical parameters and how to find them numerically: The right, the wrong and "the American way"

In recent years several authors have proposed, "easier" numerical methods' to find the critical speed in railway dynamical problems. Actually the methods do function in some cases, but in most cases it is really a gamble. In this presentation the methods will be discussed and the pros and contras commented. We shall also address the questions when a linearisation is allowed and the curious fact that the hunting motion is more robust than the ideal stationary state motion in the track. Concepts such as "multiple attractors", "permitted linearisation", "subcritical and supercritical bifurcations", "the danger of running at supercritical speeds" and "chaotic motion", will be addressed.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Publication date: 2011

Host publication information
Title of host publication: IAVSD 14-19 August 2011 : Proceedings
Main Research Area: Technical/natural sciences
Conference: 22nd International Symposium on Dynamics of Vehicles om Roads and Tracks, Manchester, United Kingdom, 14/08/2011 - 14/08/2011
Source: orbit
Source-ID: 314822
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Non-smooth problems in vehicle systems dynamics: Proceedings of the Euromech Colloquium

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Thomsen, P. G. (ed.) (Intern), True, H. (ed.) (Intern)
Number of pages: 270
Publication date: 2010

Publication information
Publisher: Springer
ISBN (Print): 9783642013553
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 274958
Publication: Research - peer-review › Book – Annual report year: 2009

On the critical speed of high-speed railway vehicles

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
The Dynamics of a Railway Wagon Wheel-Set with Dry Friction Damping

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern), Grieuc, G. (Ekstern)
Pages: 203-210
Publication date: 2008

Host publication information
Title of host publication: Noise and Vibration on High-Speed Railways, 2-3 October, Porto, 2008
ISBN (Print): 97-27-52106-1
Main Research Area: Technical/natural sciences
Conference: Noise and Vibration on High-Speed Railways, 2-3 October, Porto, 2008, 01/01/2008
Source: orbit
Source-ID: 224234
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

The dynamics of European two-axle railway freight wagons with UIC standard suspension

The dynamics of two-axle railway freight wagons with the UIC standard Suspension is investigated theoretically and the dynamic behaviour is explained. Fully nonlinear models are considered. The hysteresis from dry friction and the effect of impacts between elements of the suspension are included. Different wheel-rail geometries are investigated and the results commented. Bifurcation diagrams are used to describe the eigen-dynamics of the wagons.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing
Authors: Hoffmann, M. (Intern), True, H. (Intern)
Pages: 225-236
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Vehicle System Dynamics
Volume: 46
Issue number: 1-2
ISSN (Print): 0042-3114
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.58 SJR 1.058 SNIP 2.265
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.047 SNIP 2.116 CiteScore 2.01
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.033 SNIP 2.69 CiteScore 1.88
The dynamics of non-smooth vehicle dynamical systems and their numerical treatment

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 15-22
Publication date: 2008

Host publication information
Title of host publication: 10th mini conference on vehicle system dynamics, identification and anomalies, Budapest, nov. 6-8, 2006
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 224416
Publication: Research › Article in proceedings – Annual report year: 2008
The dynamics of two-axle freight wagons with UIC standard suspension

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing
Authors: Hoffmann, M. (Intern), True, H. (Intern)
Pages: 183-190
Publication date: 2008

Host publication information
Title of host publication: 10th mini conference on vehicle system dynamics, identification and anomalies, Budapest, nov. 6-8, 2006
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 224414
Publication: Research › Article in proceedings – Annual report year: 2008

Dynamics of European two-axle freight wagons

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
Authors: Hoffmann, M. (Intern), Thomsen, P. G. (Intern), True, H. (Intern), Sørensen, M. P. (Intern)
Publication date: Jan 2007

Publication information
Original language: English
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Main Research Area: Technical/natural sciences
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Publication: Research › Ph.D. thesis – Annual report year: 2007

Dynamics of Railway Vehicles and Rail/Wheel Contact
In these notes the fundamentals of the mechanics of rail/wheel contact and deterministic vehicle dynamics is explained. Chapter 1 describes the kinematics and dynamics of rail/wheel contact. Chapter 2 explains why vehicle dynamics must be treated as a nonlinear dynamic problem and how the model problem must be formulated. Chapters 3 and 4 deal with the theory of nonlinear parameter dependent dynamic systems in general, and chapter 5 yields the proof that the theory also applies to the high-dimensional vehicle dynamic problems. In chapter 6 the concept of non-smooth systems is introduced and some of the most important dynamic effects on vehicle dynamic problems are described. In chapter 7 characteristic features of railway vehicle dynamics are described, and in chapter 8 recommendations are presented for the numerical handling that is necessary for the investigation of vehicle dynamic problems. The notes end with a guide to vehicle system dynamics and 47 literature references.

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Number of pages: 304
Pages: 75-128
Publication date: 2007

Host publication information
Title of host publication: Dynamical Analysis of Vehicle Systems : CISM Courses and Lectures
Volume: 497
Editor: Schiehlen, W.
ISBN (Print): 978-3-211-76665-1
Main Research Area: Technical/natural sciences
On Nonlinear Railway Vehicle Dynamics

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 45-66
Publication date: 2007

Host publication information
Title of host publication: Workshop: Track for High-Speed Railways, 12. and 13. October 2006, FEUP Porto, Portugal
Place of publication: Civil Engineering Department, Faculty of Engineering of the University of Porto
Publisher: Faculty of Engineering of the University of Porto (FEUP)
Main Research Area: Technical/natural sciences
Workshop: Track for High-Speed Railway, Porto, Portugal, 12/10/2006 - 12/10/2006
Source: orbit
Source-ID: 198589
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

Zur äquivalenten Konizität

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 290-298
Publication date: 2007

Host publication information
Title of host publication: ZEVrail Glasers Annalen, Tagungsband SFT Graz 2007
Publisher: Georg Siemens Verlag
Main Research Area: Technical/natural sciences
Conference: ZEVrail Glasers Annalen, Tagungsband SFT Graz 2007, 01/01/2007
Links:
http://www2.imm.dtu.dk/pubdb/views/publication_details.php?id=5333
Source: orbit
Source-ID: 202568
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

Dynamics of two-axle railway freight wagons with UIC standard suspension
The dynamics of two different two-axle railway freight wagons is investigated theoretically and compared. Fully nonlinear models are considered. The hysteresis from dry friction and the effect of impacts between elements of the suspension are included. Bifurcation diagrams are shown in order to describe the eigen-dynamics of the wagons. Finally, the dynamics in a given curve is calculated for three different speeds.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Hoffmann, M. (Intern), True, H. (Intern)
Pages: 139-146
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Vehicle System Dynamics
Volume: 44
ISSN (Print): 0042-3114
Ratings:
BFI (2018): BFI-level 1
Recent advances in the fundamental understanding of railway vehicle dynamics

The topic of this article is the calculation of the critical speed for railway vehicles. It is emphasised that it is misleading to formulate the mathematical problem as a stability problem. It must correctly be formulated as a problem of existence of coexisting solutions to the full non-linear dynamical problem. The lowest speed at which there exist more critical speed in road tests. A couple of examples show applications of the method to various dynamical models of railway vehicles. Freight wagons are treated in the end of the article because the dry friction damping with stick-slip and end stops in the suspensions demand the use of the newest numerical solvers and great care in their application to the dynamical problem in order to obtain reliable results.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
On quasi-stationary curving dynamics of a railway bogie

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
On the Dynamics of a railway freight wagon wheelset with dry friction damping

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern), Trzepacz, L. (Ekstern)
Pages: 159-168
Publication date: 2005

Host publication information
Title of host publication: Proceedings of the IUTAM Symposium, Rome, Italy, 8-13 June 2003
Publisher: Springer
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 185756
Publication: Research - peer-review › Article in proceedings – Annual report year: 2005

On the problems of non-smooth railway vehicle dynamics

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
Authors: Thomsen, P. G. (Intern), True, H. (Intern)
Pages: 159-168
Publication date: 2005

Host publication information
Title of host publication: Proceedings of the Eccomas Thematic Conference on Multibody Dynamics 2005
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 185752
Publication: Research - peer-review › Article in proceedings – Annual report year: 2005

On the Quasi-stationary curving dynamics of a railroad truck
We examine three aspects of the dynamics of the Cooperrrider truck travelling in a curve with constant radius. First the critical speed is found. Second we investigate the existence of multiple steady solutions to the curving problem. Third - and it is related to the second problem - we examine the position of the truck frame and the wheelsets during curving. One interesting result is that for a given superelevation there exist curve radii for which the critical speed is exceeded, when the vehicle negotiates the curve with the allowed maximum cant deficiency. These critical speeds are lower than the critical speed on straight track.

General information
State: Published
The Design and performance of the European freight wagon standard suspensions

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing
Authors: True, H. (Intern), Hoffmann, M. (Intern), Jönsson, P. (Ekstern)
Pages: 1-10
Publication date: 2005

Host publication information
Title of host publication: Proceedings of IMECE2005, November 5-11, 2005, Orlando, Florida, USA
Publisher: American Society of Mechanical Engineers
Main Research Area: Technical/natural sciences
Links:
http://www2.imm.dtu.dk/pubdb/p.php?4397
Source: orbit
Source-ID: 185754
Publication: Research - peer-review » Article in proceedings – Annual report year: 2005

Nichtlineare Schienenfahrzeugdynamik, neue Grundlagen, Methoden und Ergebnisse

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 526-537
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: ZE Vrail - Glasers Annalen
Volume: 128
Issue number: 11-12
ISSN (Print): 1618-8330
Ratings:
Scopus rating (2016): SJR 0.1 SNIP 0.137
Scopus rating (2015): SJR 0.101 SNIP 0.008
Scopus rating (2014): SJR 0.1 SNIP 0.123
Scopus rating (2013): SJR 0.159 SNIP 0
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.101 SNIP 0.041
On the Dynamics of a railway freight wagon with UIC standard suspension

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing
Authors: Hoffmann, M. (Intern), True, H. (Intern)
Pages: 91-98
Publication date: 2004

Host publication information
Title of host publication: Proceedings of the 9th mini conference on vehicle system dynamics, identification and anomalies,
Budapest University of Technology and Economics, Hungary, 8-10 November 2004 : VSDIA 2004
Main Research Area: Technical/natural sciences
Conference: Proceedings of the 9th mini conference on vehicle system dynamics, identification and anomalies, Budapest University of Technology and Economics, Hungary, 8-10 November 2004, 01/01/2004
Source: orbit
Source-ID: 224324
Publication: Research › Article in proceedings – Annual report year: 2004

The Dynamics of Railway Freight Wagon Wheelset with Dry Friction Damping in the Suspension

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern), Trzepacz, L. (Ekstern), Abe, M. (ed.) (Ekstern)
Pages: 587-596
Publication date: 2004

Host publication information
Title of host publication: Proceedings of the 18th IAVSD Symposium
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 154677
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

The Dynamics of the Three-Piece-Freight Truck

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Xia, F. (Intern), True, H. (Intern), Abe, M. (ed.) (Ekstern)
Pages: 212-221
Publication date: 2004
Die Dynamik eines Güterwagenradsatzes mit Trockenreibungsämpfung

On the dynamics of the three-piece-freight truck

Although the three-piece-freight truck is a simple design its mathematical model is very complicated. The model is definitely a nonlinear dynamical system, where the nonlinearities arise from the nonlinear kinematic and dynamical contact relations between wheels and rails, the suspensions and the nonlinear dry friction damping with hysteresis and stick-slip action. The bolster moves both vertically and laterally relative to the truck frames, so the friction forces on the contact surfaces of the wedges must be treated as two-dimensional vectors, and the same holds for the dry friction on the surfaces of the adapters. Due to the clearances between the car body and the side supports on the bolster, the side supports must be modelled as nonlinear dead-band springs. The stick-slip action and the play between elements of the truck makes the dynamical model a structure varying system. We present the dynamical system that models the dynamics of the moving wagon and show the result of numerical dynamical investigations such as the calculation of the critical speed, and the dynamics of the wagon on an irregular track and compare them with test results and simulation results using NUCARS.
The dynamics of the three-piece-freight truck

The present thesis is concerned with the modelling of the motion of the Three-Piece-Freight-Truck. Although the Three-Piece-Freight-Truck is very simple in its construction, the mathematical model is not simple at all. The model is definitely nonlinear resulting from the nonlinear kinematic and dynamical contact relations between wheels and rails, the nonlinear suspensions and the nonlinear dry friction damping. For low speeds of the truck the kinematic and dynamical nonlinearities might be linearized, but the very strongly nonlinear suspensions and the dry friction damping can not be linearized at all. The motion of the bolsters are at least two dimensional in the lateral and the vertical directions, so the friction on the surfaces of a wedge should be treated as two-dimensional dry friction, and the same is true for the dry friction on the surfaces of an adapter. For the motion with dry friction there exist two motion states: stick motion and slip motion, which leads to a discontinuity in the behaviour of the dynamical system and leads to a collapse of the state space, and consequently, change the degrees of freedom of the system repeatedly. Due to the design clearances between the car body and the side supports on the bolsters the side supports must be modelled as nonlinear dead-band springs. The clearances in the assembly in the wedge damper systems give rise to a relative yaw motion of the bolster with respect to the side frame and a rotation around the truck center line and cause a warping. In addition the assembly clearances between the side frame and the adapter both in longitudinal and lateral directions produce another dead-band spring force. Thetractive effort on the car body in the longitudinal direction may be left out of consideration in the modelling of the passenger car, but the normal forces caused by it on the surfaces of the wedges will consequently produce friction forces in the Three-Piece-Freight-Truck and should be considered. Therefore, the friction forces on the surfaces of wedges are asymmetrical for one pair of wedges as they should be. The thesis is divided into 10 chapters. In the chapter 1, the research state-of the art of the dynamics of the Three-Piece-Freight-Truck is reviewed. The framework of the model is introduced. Chapter 2 describes the concept of the friction direction angle with which the stick-slip motion with two-dimensional dry friction can be numerically simulated. Its applications are illustrated in two simple systems. One is an oscillator with a Coulomb dry friction damper in chapter 2 and the other one is the wedge damper in chapter 3. In the mechanical system it is possible that the degrees of freedom will vary with the different friction states. We give a detailed discussion of this type of structure varying systems in chapter 4. For the performances of the vehicle on the track, the contact between a wheel and a rail plays a key role, where there are two types of contacts: One is kinematic and the other is dynamical. For the kinematic contact relation we trace the contact point of the wheel on its possible trajectory and the on-line evaluation of the kinematic contact parameters is introduced. The elastic contact assumption is used to determine the normal loads in the contact patch and then a fully nonlinear contact theory is used to obtain the creep forces. They are discussed in chapter 5. The configuration of the Three-Piece-Freight-Truck and the corresponding positions of the elements, the velocities and some relations among the elements of the system will be described in chapter 6. In chapter 7 the dynamic equations of the system are derived. Chapter 8 provides the numerical methods for the simulation of the system, the discussion focuses on the differential algebraic equations(DAEs) with discontinuous characteristics caused by the two-dimensional friction. In chapter 9 the numerical investigation is provided. The four general irregularities in tangent track are usually described in the form of a power spectrum density(PSD). We transform the PSD into the corresponding series in the time domain and then use the time series as excitations for the dynamical performances of the system. The linear critical speed and nonlinear critical speed and even the chaotic motion of the Three-Piece-Freight-Truck are discussed. Finally in chapter 10 certain conclusions are drawn, and some projects for further research are indicated.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Xia, F. (Intern), True, H. (Intern)
Publication date: Oct 2002

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Structure varying system, Stick-slip motion, Two-dimensional friction, Three-Piece-Freight Truck, Dynamics

A polynomial approach to contact mechanics

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
On the dynamics of a railway wheelset with dry friction damping

We investigate the dynamics of a simple model of a wheelset that supports one end of a railway freight wagon by springs with linear characteristics and dry friction dampers. The wagon runs on an ideal, straight and level track with constant speed. The lateral dynamics in dependence on the speed is examined. We have included stick-slip and hysteresis in our model of the dry friction and assume that Coulomb's law holds during the slip phase. It is found that the action of dry friction completely changes the bifurcation diagram, and that the longitudinal component of the dry friction damping forces destabilizes the wagon.

The Dynamics of a Railway Freight Wagon Wheelset with dry friction Damping

We investigate the dynamics of a simple model of a wheelset that supports one end of a railway freight wagon by springs with linear characteristics and dry friction dampers. The wagon runs on an ideal, straight and level track with constant speed. The lateral dynamics in dependence on the speed is examined. We have included stick-slip and hysteresis in our model of the dry friction and assume that Coulomb's law holds during the slip phase. It is found that the action of dry friction completely changes the bifurcation diagram, and that the longitudinal component of the dry friction damping forces destabilizes the wagon.
Ueber die Kurvendynamik von Eisenbahnfahrzeugen

General information
State: Published
Organisations: Scientific Computing, Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern), Nielsen, J. B. (Ekstern)
Pages: 226-231
Publication date: 2000

Host publication information
Title of host publication: Tagungsband zur VDEI Fachtagung BahnBau 2000, Berlin, September 12-15
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200411
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000
On the Theory of Nonlinear Dynamics and its Applications in Vehicle Systems Dynamics

We present a brief outline of nonlinear dynamics and its applications to vehicle systems dynamics problems. The concept of a phase space is introduced in order to illustrate the dynamics of nonlinear systems in a way that is easy to perceive. Various equilibrium states are defined, and the important case of multiple equilibrium states and their dependence on a parameter is discussed. It is argued that the analysis of nonlinear dynamic problems always should start with an analysis of the equilibrium states of the full nonlinear problem whereby great care must be taken in the choice of the numerical solvers. When the equilibrium states are known certain linearizations around one chosen state may be applied carefully in order to facilitate or speed up the numerical solution of the dynamical problem. It is argued, however, that certain problems cannot be linearized. The applications of nonlinear dynamics in vehicle simulations is discussed, and it is argued that it is necessary to know the equilibrium states of the full nonlinear system before the simulation calculations are performed.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 393-421
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Vehicle System Dynamics
Volume: 31
Issue number: 5-6
ISSN (Print): 0042-3114
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.58 SJR 1.058 SNIP 2.265
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.047 SNIP 2.116 CiteScore 2.01
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.033 SNIP 2.69 CiteScore 1.88
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.715 SNIP 2.22 CiteScore 1.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.723 SNIP 2.109 CiteScore 1.44
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.749 SNIP 1.996 CiteScore 1.38
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.669 SNIP 2.099
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.588 SNIP 1.261
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.744 SNIP 2.057
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.386 SNIP 0.898
Scopus rating (2006): SJR 0.485 SNIP 1.523
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.418 SNIP 1.425
Scopus rating (2004): SJR 0.614 SNIP 1.87
Symmetry, Generic Bifurcations, and mode interaction in nonlinear railway dynamics

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Jensen, C. N. (Ekstern), Golubitsky, M. (Ekstern), True, H. (Intern)
Pages: 1321-1331
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Volume: 9
Issue number: 7
ISSN (Print): 0218-1274
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.589 SNIP 0.868 CiteScore 1.43
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.757 SNIP 0.923 CiteScore 1.34
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.571 SNIP 0.854 CiteScore 1.14
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.678 SNIP 0.943 CiteScore 1.26
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.568 SNIP 0.787 CiteScore 1.04
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.595 SNIP 0.717 CiteScore 1
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.679 SNIP 0.813
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.692 SNIP 1.006
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.691 SNIP 0.965
Web of Science (2008): Indexed yes
Systemdynamik von Schienenfahrzeugen

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern), Jensen, J. C. (Ekstern), Slivsgaard, E. (Ekstern)
Pages: 37-42
Publication date: 1999
Main Research Area: Technical/natural sciences

**Publication Information**
Journal: EI - Der Eisenbahn Ingenieur
Volume: 2
Original language: Undefined/Unknown
Source: orbit
Source-ID: 173618
Publication: Research - peer-review › Journal article – Annual report year: 1999

Dynamics of an electrical overhead line system and moving pantographs

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling, ES-Consult Ltd.
Authors: True, H. (Intern), Nordstroem Jensen, C. (Ekstern), Palkovics, L. (ed.) (Ekstern)
Pages: 104-113
Publication date: 1998

**Host publication information**
Title of host publication: The Dynamics of vehicles on roads and on tracks
Publisher: Swets & Zeitlinger
Main Research Area: Technical/natural sciences
Conference: The 15th IAVSD Symposium, Budapest, 01/01/1997
Source: orbit
Source-ID: 170871
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Mathematical Simulation of the Dynamics of the Danish IC3 train

**General information**
State: Published
On a New Route to Chaos in Railway Dynamics

Cooperrider's mathematical model of a railway bogie running on a straight track has been thoroughly investigated due to its interesting nonlinear dynamics (see True [1] for a survey). In this article a detailed numerical investigation is made of the dynamics in a speed range, where many solutions exist, but only a couple of which are stable. One of them is a chaotic attractor.

Cooperrider's bogie model is described in Section 2, and in Section 3 we explain the method of numerical investigation. In Section 4 the results are shown. The main result is that the chaotic attractor is created through a period-doubling cascade of the secondary period in an asymptotically stable quasiperiodic oscillation at decreasing speed. Several quasiperiodic windows were found in the chaotic motion.

This route to chaos was first described by Franceschini [9], who discovered it in a seven-mode truncation of the plane incompressible Navier-Stokes equations. The problem investigated by Franceschini is a smooth dynamical system in contrast to the dynamics of the Cooperrider truck model. The forcing in the Cooperrider model includes a component, which has the form of a very stiff linear spring with a dead band simulating an elastic impact. The dynamics of the Cooperrider truck is therefore "non-smooth".

The quasiperiodic oscillation is created in a supercritical Neimark bifurcation at higher speeds from an asymmetric unstable periodic oscillation, which gains stability in the bifurcation. The bifurcating quasiperiodic solution is initially unstable, but it gains stability in a saddle-node bifurcation when the branch turns back toward lower speeds.

The chaotic attractor disappears abruptly in what is conjectured to be a blue sky catastrophe, when the speed decreases further.

On a New Route to Chaos in Railway Dynamics

Cooperrider's mathematical model of a railway bogie running on a straight track has been thoroughly investigated due to its interesting nonlinear dynamics (see True [1] for a survey). In this article a detailed numerical investigation is made of the dynamics in a speed range, where many solutions exist, but only a couple of which are stable. One of them is a chaotic attractor.

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The chaotic attractor disappears abruptly in what is conjectured to be a blue sky catastrophe, when the speed decreases further.
On the Ultimate Transition to Chaos in the Dynamics of Cooperrider's Bogie

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern), Isaksen, P. (Ekstern)
Pages: 559-581
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Chaos, Solitons & Fractals
Volume: 8
Original language: English
Source: orbit
Source-ID: 168992
Chaos and its Role in Design and Simulation of Railway Vehicles.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 108-128
Publication date: 1996

Host publication information
Title of host publication: Samverkan fordon - bana
Place of publication: Linköping
Publisher: Vaeg- och transportforskningsinstitutet
Main Research Area: Technical/natural sciences
Conference: VTI konferens 6, Linköping, 01/01/1996
Source: orbit
Source-ID: 164908
Publication: Research - peer-review › Journal article – Annual report year: 1997

Non-linear Railway dynamics and chaos

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern), Jensen, J. C. (Ekstern), Slivsgaard, E. (Ekstern)
Pages: 51-60
Publication date: 1996

Host publication information
Title of host publication: 5th Mini conference on vehicle system dynamics, identification and anomalies
Place of publication: Budapest
Publisher: Technical University of Budapest
Main Research Area: Technical/natural sciences
Conference: 5th Mini conference on vehicle system dynamics, identification and anomalies, Budapest, 01/01/1996
Source: orbit
Source-ID: 173490
Publication: Research - peer-review › Article in proceedings – Annual report year: 1996

On the interaction between wheels and rails in railway dynamics
The present thesis is concerned with the mathematical modelling of a railway vehicle. The modelling does not only deal with the vehicle but also the track it runs on. Different models are described and investigated as to how they affect the dynamics of the vehicle. The bulk of the investigations is focussed on the stability of the vehicle. For this we introduce two stability criteria: the linear critical speed and the nonlinear critical speed. The linear critical speed is the vehicle speed at which the vehicle becomes unstable in a linear analyses, while the nonlinear critical speed is such that no oscillating solutions occur below this vehicle speed. The difference between a linear and a nonlinear analysis is hereby pointed out. The oscillating solutions found are analysed by applying methods from the nonlinear dynamics. By this periodic and chaotic solutions are described, for instance a scenario of a period adding sequence. For the vehicle we use a two-car test vehicle with a prototype of a single-axle bogie (a so-called KERF bogie). The vehicle is from the Danish State Railways and runs on the Copenhagen network. What is special about this vehicle is that the single axle bogie is steered by a mechanical steering system. Interest is focussed on the single-axle bogie. For simplification a model of the single-axle bogie alone is analysed under different modelling conditions. The dynamics of a model of the whole vehicle are investigated on: A) a straight track, B) a curved track, C) a track flexible in the vertical direction, D) a track with irregularities. Among other things, the investigations lead to the understanding of the influence of the stiffness in the steering system. On the irregular track the simulations are compared with corresponding measurements. Furthermore two different models are developed for the track: A simple model of the whole track as one rigid body following each wheelset. An elastic model where the rails are modelled as Euler-Bernoulli beams discretely supported by rigid sleepers. The simple model is used to find the influence of a flexible track on the dynamics of the single-axle bogie, while the elastic model is more useful to for example study the effect of changes in flexibility along the track. Finally measurements of the flexibility of tracks are described.

General information
State: Published
Does a critical speed for railroad vehicles exist?
The author discusses the definition and existence of a critical speed for the onset of hunting of railroad vehicles. First the field test situation is described. It is argued that the important problem is the determination of the forces and accelerations in the vehicle and the rails, which may be large even when the vehicle does not hunt. Next the author discusses the relevance of the critical speed in railway engineering. It is desirable to know the speed below which a vehicle will not hunt, since hunting is always connected with large wheel-rail forces. Next the modelling of railroad vehicles is discussed and the nonlinear aspects are emphasized. The author explains why it is necessary to reformulate the mathematical problem for calculation of the critical speed due to the nonlinear character of the modelling. It is suggested that another critical speed be defined for a railroad vehicle. It can be calculated without great effort using a well functioning simulation program. It yields a “global” criterion for the onset of hunting, in contrast to the linear stability criterion, which is still commonly used. The linear eigenvalue problem yields a bifurcation point, which in general will not be the lowest parameter value for existence of oscillating solutions in a nonlinear dynamical system. The author suggests the use of a “nonlinear critical speed” as an acceptance criterion for railroad vehicles

Asymmetric Hunting And Chaotic Motion Of Railroad Vehicles

Asymmetric Hunting And Chaotic Motion Of Railroad Vehicles

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: True, H. (Intern)
Pages: 125-131
Publication date: 1994

Host publication Information
Title of host publication: Proceedings of the ASME/IEEE Joint Railroad Conference
Publisher: IEEE
ISBN (Print): 07-80-31890-0
Main Research Area: Technical/natural sciences
Electronic versions:
True.pdf
DOIs:
10.1109/RRCON.1994.289013

Bibliographical note
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Source: orbit
Source-ID: 264938
Publication: Research - peer-review › Article in proceedings – Annual report year: 1994

Asymmetric Hunting And Chaotic Motion Of Railroad Vehicles
Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnnet stipendie
Project: PhD

Freight Wagon Dynamics and Safety
Department of Informatics and Mathematical Modeling
Period: 01/09/1999 → 25/10/2002
Number of participants: 6
PhD Student:
Xia, Fujie (Intern)
Supervisor:
Van, Bent C. (Ekstern)
Main Supervisor:
True, Hans (Intern)
Examiner:
Thomsen, Per Grove (Intern)
Nielsen, Jakob Birkedal (Intern)
Pascal, Jean-Pierre (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU, Samfinansiering
Project: PhD

Bifurcations and chaos in Nonlinear Dynamics
In relation to specific high-dimensional parameter dependent nonlinear dynamic systems - mainly models of moving railway vehicles - the dynamics of the systems is examined, and the qualitative behaviour investigated. Since the models are rather complicated, the analysis is carried out numerically, and some results verified through analytic investigations of simple model examples. The results are applied to actual railway vehicles, and have demonstrated their ability to predict accurately the critical speed, at which a railway vehicle may change its stable equilibrium state from steady motion along the track center line, to a motion along the track combined with a lateral oscillation. Chaotic motion has been predicted, and recently confirmed by japanese scientists.

Department of Informatics and Mathematical Modeling
Period: 01/01/1996 → …
Number of participants: 1
Project Manager, organisational:
True, Hans (Intern)

Højrekvent hjul-skinnedynamik
Technical University of Denmark
Period: 01/09/1995 → 29/01/1999
Number of participants: 4
PhD Student:
Nielsen, Jakob Birkedal (Intern)
Main Supervisor:
True, Hans (Intern)
Examiner:
Hansen, John Michael (Intern)
Knothe, Klaus (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsstip.-SU, Eksp
Project: PhD
teoretiske dynamiske undersøgelser af samspillet mellem hjul og spor for jernbane køretøjer

Technical University of Denmark
Period: 01/02/1993 → …
Number of participants: 2
Phd Student: 
Slivsgaard, Eva Charlotte (Intern)
Main Supervisor: 
True, Hans (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: ATV- Gammel ordning
Project: PhD

Teoretiske og eksperimentelle dynamiske undersøgelser af jernbanekøretøjer

Technical University of Denmark
Period: 01/07/1992 → …
Number of participants: 2
Phd Student: 
Jensen, Jens Christian (Intern)
Main Supervisor: 
True, Hans (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: ATV- Gammel ordning
Project: PhD

Activities:

President of the International Association of Vehicle System Dynamics (External organisation)
Period: Aug 2003 → Aug 2017
Hans True (Chairman)
Department of Informatics and Mathematical Modeling

Description
Body type: Scientific association

Related external organisation

President of the International Association of Vehicle System Dynamics
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Prizes:

Life long Honorary Member of 'The International Association of Vehicle Systems Dynamics' (IAVSD)
Hans True (Recipient)
Department of Applied Mathematics and Computer Science

Details
Awarded date: 15 Aug 2017
Degree of recognition: International
Granting Organisations: The International Association of Vehicle Systems Dynamics
Prize: Prizes, scholarships, distinctions