

Classification of Dynamical Systems

Two-dimensional linear or linearized systems

Set of equations for 2D system

$$\dot{x}_1 = f_1(x_1, x_2) = ax_1 + bx_2$$

$$\dot{x}_2 = f_2(x_1, x_2) = cx_1 + dx_2$$

Jacobian matrix for 2D system

$$\mathbf{J} = \mathbf{A} = \begin{bmatrix} \frac{\partial f_1}{\partial x_1} & \frac{\partial f_1}{\partial x_2} \\ \frac{\partial f_2}{\partial x_1} & \frac{\partial f_2}{\partial x_2} \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

Calculation of **eigenvalues**

$$\det(\mathbf{A} - \lambda \mathbf{E}) = 0 \Rightarrow \det \begin{bmatrix} a - \lambda & b \\ c & d - \lambda \end{bmatrix} = 0$$

$$(a - \lambda)(d - \lambda) - bc = 0 \Rightarrow \lambda^2 - (a + d)\lambda + ad - bc = 0$$

Formulation using **trace** and **determinant**

$$\text{Tr}(\mathbf{A}) = a + d; \quad \text{Det}(\mathbf{A}) = ad - bc$$

$$\lambda^2 - \text{Tr}(\mathbf{A})\lambda + \text{Det}(\mathbf{A}) = 0$$

$$\lambda_{1,2} = \frac{\text{Tr}(\mathbf{A}) \pm \sqrt{\text{Tr}(\mathbf{A})^2 - 4\text{Det}(\mathbf{A})}}{2}$$

Two Dimensional Linear Systems

T Kaczorek



Two Dimensional Linear Systems:

Two-Dimensional Linear Systems T Kaczorek,2014-01-15

Two-dimensional Linear Systems Tadeusz Kaczorek,1985

Recent Developments in Two-dimensional Linear Systems Theory Tadeusz Kaczorek,Politechnika Zielonogórska.

Wydawnictwo,1997

Two-Dimensional Systems Abdellah Benzaouia,Abdelaziz Hmamed,Fernando Tadeo,2015-10-16

A solution permitting the stabilization of 2 dimensional 2 D continuous time saturated system under state feedback control is presented in this book The problems of delay and saturation are treated at the same time The authors obtain novel results on continuous 2 D systems using the unidirectional Lyapunov function The control synthesis and the saturation and delay conditions are presented as linear matrix inequalities Illustrative examples are worked through to show the effectiveness of the approach and many comparisons are made with existing results The second half of the book moves on to consider robust stabilization and filtering of 2 D systems with particular consideration being given to 2 D fuzzy systems Solutions for the filter design problems are demonstrated by computer simulation The text builds up to the development of state feedback control for 2 D Takagi Sugeno systems with stochastic perturbation Conservatism is reduced by using slack matrices and the coupling between the Lyapunov matrix and the system matrices is broken by using basis dependent Lyapunov functions Mean square asymptotic stability and prescribed H infinity performance are guaranteed Two Dimensional Systems emphasizes practical approaches to control and filter design under constraints that appear in real problems and uses off the shelf software to achieve its results Researchers interested in control and filter design for multidimensional systems especially multi dimensional fuzzy systems will find this book a useful resource as will graduate students specializing in dynamical systems

Positive 1D and 2D Systems Tadeusz Kaczorek,2012-12-06 In the last decade a dynamic development in positive systems has been observed Roughly speaking positive systems are systems whose inputs state variables and outputs take only nonnegative values Examples of positive systems are industrial processes involving chemical reactors heat exchangers and distillation columns storage systems compartmental systems water and atmospheric pollution models A variety of models having positive linear system behaviour can be found in engineering management science economics social sciences biology and medicine etc The basic mathematical tools for analysis and synthesis of linear systems are linear spaces and the theory of linear operators Positive linear systems are defined on cones and not on linear spaces This is why the theory of positive systems is more complicated and less advanced The theory of positive systems has some elements in common with theories of linear and non linear systems Schematically the relationship between the theories of linear non linear and positive systems is shown in the following figure Figure 1

Two Dimensional Linear Systems and One Dimensional Projective Geometry Solomon Lefschetz,1939

Approximate and Noisy Realization of Discrete-Time Dynamical Systems Yasumichi Hasegawa,2008-06-02 This monograph deals with approximation and noise cancellation of dynamical systems which include linear and nonlinear input output relations It will be of special interest to researchers

engineers and graduate students who have specialized in filtering theory and system theory. From noisy or noiseless data reduction will be made. A new method which reduces noise or model information will be proposed. Using this method will allow model description to be treated as noise reduction or model reduction. As proof of the efficacy this monograph provides new results and their extensions which can also be applied to nonlinear dynamical systems. To present the effectiveness of our method many actual examples of noise and model information reduction will also be provided. Using the analysis of state space approach the model reduction problem may have become a major theme of technology after 1966 for emphasizing efficiency in the fields of control economy numerical analysis and others. Noise reduction problems in the analysis of noisy dynamical systems may have become a major theme of technology after 1974 for emphasizing efficiency in control. However the subjects of these researches have been mainly concentrated in linear systems. In common model reduction of linear systems in use today a singular value decomposition of a Hankel matrix is used to find a reduced order model. However the existence of the conditions of the reduced order model are derived without evaluation of the resultant model.

In the common typical noise reduction of linear systems in use today the order and parameters of the systems are determined by minimizing information criterion. Approximate and noisy realization problems for input output relations can be roughly stated as follows: A. The approximate realization problem: For any input output map find one mathematical model such that it is similar to the input output map and has a lower dimension than the given minimal state

space of a dynamical system which has the same behavior to the input output map. B. The noisy realization problem. *1984 IEEE International Symposium on Circuits and Systems Proceedings*, 1984. *The Quarterly Journal of Pure and Applied Mathematics*, 1916. *Kybernetika*, 1991. *The Science Reports of the Tōhoku Imperial University*, 1921. **The dual**

projective geometry of elliptic and spherical space Julian Lowell Coolidge, 1904. *Annual Catalogue of the University of Kansas* Kansas. University, University of Kansas, 1916. *Science reports of the Tohoku University* Tōhoku Daigaku, 1921. **Proceedings of the Section of Sciences** Koninklijke Akademie van Wetenschappen (Netherlands). Afdeling

Natuurkunde, 1927. *Bulletin of the American Mathematical Society* American Mathematical Society, 1903. **Bulletin**

(new Series) of the American Mathematical Society, 1916. **Meddelanden från Lunds astronomiska observatorium** Lunds universitet. Observatoriet, 1917. **Annals of Mathematics**, 1912. **Riemann Solvers and**

Numerical Methods for Fluid Dynamics E. F. Toro, 1997. High resolution upwind and centered methods are today a mature generation of computational techniques applicable to a wide range of engineering and scientific disciplines. Computational Fluid Dynamics (CFD) being the most prominent up to now. This text book gives a comprehensive coherent and practical presentation of this class of techniques. The book is designed to provide readers with an understanding of the basic concepts, some of the underlying theory, the ability to critically use the current research papers on the subject and above all with the required information for the practical implementation of the methods. Applications include compressible steady

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