

# 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

**Lingsheng Yao**



## **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

**H\_infinity Control and Filtering of Two-Dimensional Systems** Chungling Du, Lihua Xie, 2002-05-14 Over the past decades a considerable interest has been concentrated on problems involving signals and systems that depend on more than one variable 2 D signals and systems have been studied in relation to several modern engineering fields such as process control multidimensional digital filtering image

enhancement image deblurring signal processing etc Among the major results developed so far 2 D digital filters are investigated as a description in frequency domain or as a convolution of the input and the unit response which has a great potential for practical applications in 2 D image and signal processing This monograph aims to address several problems of control and filtering of 2 D discrete systems Specifically the problems of Hinfinity filtering Hinfinity control stabilization Hinfinity model reduction as well as Hinfinity deconvolution filtering of 2 D linear discrete systems are treated

*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 ltering theory and system theory From noisy or noiseless data reductionwillbemade Anewmethodwhichreducesnoiseormodelsinformation will be proposed Using this method will allow model description to be treated as noise reduction or model reduction As proof of the e cacy this monograph provides new results and their extensions which can also be applied to nonlinear dynamical systems To present the e ectiveness 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 e ciency in the elds of control economy numerical analysis and others Noise reduction problems in the analysis of noisy dynamical systems may havebecomeamajorthemeoftechnologyafter1974foremphasizinge ciencyin control However thesubjectsoftheseresearcheshavebeenmainlyconcentrated in linear systems In common model reduction of linear systems in use today a singular value decompositionofaHankelmatrixisusedto ndareducedordermodel However the existence of the conditions of the reduced order model are derived without evaluationoftheresultantmodel

Inthecommontypicalnoisereductionoflinear 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 nd one mathematical model such that it is similar totheinput outputmapandhasalowerdimensionthanthegivenminimalstate spaceofadynamicalsystemwhichhasthesamebehaviortotheinput outputmap B The noisy realization problem

[The Quarterly Journal of Pure and Applied Mathematics](#) ,1916 *Kybernetika* ,1991 **Science reports of the Tohoku University** Tōhoku Daigaku,1921 *1984 IEEE International Symposium on Circuits and Systems Proceedings* ,1984 [The Science Reports of the Tōhoku Imperial University](#) ,1921 [The dual projective geometry of elliptic and spherical space](#) Julian Lowell Coolidge,1904 *Bulletin (new Series) of the American Mathematical Society* ,1903 **Bulletin of the American Mathematical Society** American Mathematical Society,1903 **Entomological News** ,1927 *Science Reports* Tōhoku Daigaku,1921 [Proceedings of the London Mathematical Society](#) London Mathematical Society,1929 Papers presented to J

E Littlewood on his 80th birthday issued as 3d ser v 14 A 1965

The Science Reports of the Tōhoku University ,1921

The book delves into Two Dimensional Linear Systems. Two Dimensional Linear Systems is an essential topic that needs to be grasped by everyone, from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Two Dimensional Linear Systems, encompassing both the fundamentals and more intricate discussions.

1. The book is structured into several chapters, namely:
  - Chapter 1: Introduction to Two Dimensional Linear Systems
  - Chapter 2: Essential Elements of Two Dimensional Linear Systems
  - Chapter 3: Two Dimensional Linear Systems in Everyday Life
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  - Chapter 5: Conclusion
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6. In chapter 5, this book will draw a conclusion about Two Dimensional Linear Systems. The final chapter will summarize the key points that have been discussed throughout the book.

This book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Two Dimensional Linear Systems.

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