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Pernebo, Lars

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LUND UNIVERSITY

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MASTER THESES IN AUTOMATIC CONTROL 1979/80

LARS PERNEBO

DEPARTMENT OF AUTOMATIC CONTROL
LUND INSTITUTE OF TECHNOLOGY
OCTOBER 1980

Organization LUND INSTITUTE OF TECHNOLOGY Department of Automatic Control Box 725 S-220 07 LUND 7, Sweden	Document name MS theses report	
	Date of issue October 1980	
	CODEN: LUTFD2/(TFRT-6011)/1-16/(1980)	
Author(s) Lars Pernebo	Sponsoring organization	
Title and subtitle Master theses in Automatic Control 1979/80		
A4 A5		
Abstract The report contains abstracts of master theses (examensarbete) made at the Department of Automatic Control, Lund, during the academic year 1979/80. During this year 14 theses were made by 18 students. The theses are written in Swedish with an English abstract.		
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A4 A5		
Classification system and/or index terms (if any)		
Supplementary bibliographical information		Language English
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DOKUMENTTABLAD enl SIS 61 41 21

1. INTRODUCTION

The education for civilingenjörsexamen (Master Degree in Engineering) is completed with an independent work, the master thesis (examensarbete). It should show the student's ability to attack and solve a larger problem. The time devoted to the thesis is about three months of full time work. The thesis can be done individually or by two students together.

This report is a collection of the document pages of the theses completed during the academic year 1979/1980. During this time 14 theses were finished by 18 students. The major part of the theses is made within the framework of the research program at the department. Some of the theses are made as feasibility studies or made in cooperation with the industry or other departments.

Further information concerning the results can be obtained from the Department of Automatic Control by contacting the advisor. The theses are available at the University Library in Lund (Address: University Library 2, Box 1010, S-221 03 LUND, Sweden).

2. LIST OF THESES

- TFRT-5222 Kongstad P: Automatisk inställning av PID-regulatorer baserad på optimering och identifiering (Automatic tuning of PID-controllers using optimization and identification), August 1979.
- TFRT-5223 Wiberg P: Vibrationer i presspartiet i en pappersmaskin (Press nip vibrations in paper machines), August 1979.
- TFRT-5224 Brännström K and Melcher H: Reglering av strängspruta (Control of a rubber extruder), August 1979.
- TFRT-5225 Tiljander S: Undersökning av två självinställande regulatorer för servoproblemet (Investigation of two selftuning regulators for the servoproblem), September 1979.
- TFRT-5226 von Knorring O and Lindsten L-G: Enkla regulatorer (Single controllers), July 1979.
- TFRT-5227 Nilsson H: Insulin-glukos reglering (Insulin-Glucose control), October 1979.
- TFRT-5228 Nielsen L: Reglering av ATP-syntesen i mitokondrier (Control of the ATP-synthesis in mitochondria), October 1979.
- TFRT-5229 Svensson G and Åhs M: Modellering och simulering av matarvattenförvärmningssystem (Modelling and simulation of feedwater preheating system), November 1979.
- TFRT-5230 Ullen K: Styrning av motorprovbädd (Control of a diesel engine test bed), April 1980.
- TFRT-5231 Hedin B: Identifiering av dynamiska modeller för temperaturen i ett kontorslandskap (Identification of dynamic models for the temperature in an office landscape), May 1980.
- TFRT-5232 Bjartmarsson K: Simulering av en kemisk reaktor (Simulation of a chemical reactor), May 1980.

- TFRT-5233 Nilsson M and Olofsson P: Likströmsmotordrivet kraftregler-system (DC-motor driven force control system), June 1980.
- TFRT-5234 Olsson R: Modellering och simulering av synkrogenerator-dynamik (Modelling and simulation of synchronous generator dynamics), June 1980.
- TFRT-5235 Wennstad P: Adaptiva regulatorer (Adaptive regulators), June 1980.

3. SUBJECT LIST

<u>Subject</u>	<u>Thesis</u>
Adaptive control	5222, 5225, 5235
Modelling and simulation	5223, 5229, 5232, 5233, 5234
Biological systems	5227, 5228
Identification	5231
Analysis and synthesis	5224, 5226, 5230

4. DOCUMENT PAGES

The following pages contain the document pages of the theses. All theses are written in Swedish with an abstract in English.

On the document page the following data are given:

Report number	(Dokumentnamn, Dokumentbeteckning)
Adviser	(Handläggare)
Author	(Författare)
Title in Swedish and English	(Dokumenttitel och undertitel)
Abstract	(Referat)
Keywords	(Förslag till ytterligare nyckelord)

Dokumentutgivare
 Lund Institute of Technology
 Department of Automatic Control
 Handläggare
 Björn Wittenmark
 Författare
 Poul Kongstad

Dokumentnamn
 REPORT LUTFD2/(TFRT-5222)/1-084/(1979)
 Utgivningsdatum
 August 1979
 Dokumentbeteckning
 06T6
 Ärendebeteckning
 06T6

10T4

Dokumenttitel och undertitel Automatisk inställning av PID-regulatorer baserad på optimering och identifiering. (Automatic tuning of PID-controllers using optimization and identification)	
Referat (sammandrag) This master thesis presents a general structure for the optimization of regulator parameters. It is assumed that control structure and control aim (given as a loss function) are chosen. The process that is controlled need not be known; identification and optimization are performed simultaneously. Processes containing pure time delay can be optimized with only minor program changes. This search method has been applied to PI- and PID-regulators and processes of moderate order and have been programmed in Simmon, a simulation language. Actual results from the computer simulations using different loss functions and programs are included. The report also contains discussions of the choice of loss function and identification in closed loop systems.	
Referat skrivet av author	
Förslag till ytterligare nyckelord 44T0	
Klassifikationssystem och -klass(er) 50T0	
Index termer (ange källa) 52T0	
Omfång 84 pages	Övriga bibliografiska uppgifter 56T2
Språk Swedish	
Sekretessuppgifter 60T0	ISSN 60T4
	ISBN 60T6
Dokumentet kan erhållas från Department of Automatic Control Lund Institute of Technology Box 725, S-220 07 LUND 7, Sweden	Mottagarens uppgifter 62T4
Pris 66T0	

DOKUMENTATABLAD enligt SIS 62 10 12

SIS-DB 1

Dokumentutgivare
Lund Institute of Technology

Handläggare
Gustaf Olsson

Författare
Per Arne Wiberg

Dokumentnamn
REPORT LUTFD2/(TFRT-5223)/1-072)/(1979)

Utgivningsdatum
August 1979

Dokumentbeteckning
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06T6

10T4

Dokumenttitel och undertitel

Vibrationer i presspartiet i en pappersmaskin
(Press nip vibrations in paper machines)

Referat (sammandrag)

Vibrations in the press section of a paper machine is getting a serious problem. This is caused by the high speeds and the high nip pressure that appear in modern paper machines. In this paper a hypothesis of the causes of vibrations in a press nip has been stated. To validate the hypothesis a mathematical model of the press nip has been derived. The basic model describes the dynamics of a continuous press roll and has been discretized into a model with eight spatial points. A simulation program in SIMNON has been written and the system was simulated on a computer. The results of the simulations seem to verify the hypothesis.

Referat skrivet av
aüthor

Förslag till ytterligare nyckelord
44T0

Klassifikationssystem och -klass(er)
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Indextermer (anga källa)
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72 pages

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66T0

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Dokumentutgivare

04T9
Lund Institute of Technology
Handläggare Dept of Automatic Control
06T0
Gustaf Olsson
Författare
Kjell Brännström
Hans Melcher

Dokumentnamn

04T9
REPORT LUTFD2/(TFRT-5224)/1-033)/(1979)
Utgivningsdatum
August 1979

Dokumentbeteckning

06T6
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06T6

10T4

Dokumenttitel och undertitel

Reglering av Strängspruta

(Control of a rubber extruder)

Referat (sammandrag)

The purpose of this work has been to identify and control a rubber extruder. The product diameter variance has to be minimized. It is controlled by the setpoint value of the screw rotation speed. During the experiments it was not allowed to change or uncouple the temperature controller. A mathematic model has been derived by a process identification of measured data. The results indicate, that the product standard deviation is only one sixth of the stipulated tolerance value, already with no automatic control. Therefore it is not considered worthwhile to implement minimal variance controller, as no significant improvement can be expected.

It is considered interesting to further study the temperature control. It is believed that an improvement of this controller can increase the production

Referat skrivet av

4 authors

rate without loosing in quality.

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DOKUMENTATABLAD enligt SIS 62 10 12

SIS-DB 1

Dokumentutgivare
Lund Institute of Technology
Handläggare Dept of Automatic Control
Björn Wittenmark
Författare
Sven Gunnar Tiljander

Dokumentnamn
REPORT LUTFD2/(TFRT-5225)/1-0667(1979)
Utgivningsdatum
September 1979
Dokumentbeteckning
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Ärendebeteckning
06T6

10T4

Dokumenttitel och undertitel

Undersökning av två självinställande regulatorer för servoproblemet
(Investigation of two self-tuning regulators for the servoproblem)

Referat (sammandrag)

Two self-tuning algorithms to take care of the problem with reference signals have been compared in this work. The first algorithm is given by B Wittenmark (1975) and the second by Clarke-Gawthrop (1975). Both regulators are based on a recursive least-squares estimator of the parameter of a feedback control law combined with feedforward signals. The estimated parameters are then used in the control law as if they are the true ones. Some precaution must then be taken to handle steady-state-errors. In this work this has been done by the following two possibilities: i) cascade the regulator with an integrator ii) and increase the order of the polynomials in the model. The properties of the algorithms are investigated by using simulations.

Referat skrivet av

author

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DOKUMENTATABLAD enligt SIS 62 10 12

SIS-
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Dokumentutgivare
 Lund Institute of Technology
 Handläggare Dept of Automatic Control
 06T0
 Författare
 Olof von Knorring
 Lars-Göran Lindsten

Dokumentnamn
 06T4 Report LUTFD2/(TFRT-5226)/1-088/(1979)
 Utgivningsdatum
 06T4 July 1979
 Dokumentbeteckning
 06T6
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 06T6

10T4

Dokumenttitel och undertitel

18T0
 Enkla regulatorer
 (single controllers)

Referat (sammandrag)

This report aims to give a general description of single controllers and their inherent characteristics. The worth of some earlier (in the 40- and 50-ies) theoretically derived rules for optimum adjustment of automatic controllers have been particularly examined. The same is applied to the specific effects resulting from the use of an integral part.

Referat skrivet av
 42T0 Authors

Förslag till ytterligare nyckelord
 44T0 enkla regulatorer, inställningsregler, integratomätning,
 single controllers, rules for optimum adjustment, reset windup

Klassifikationssystem och -klass(er)
 50T0

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 56T0 88 pages
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DOKUMENTATABLAD enligt SIS 62 10 12

Dokumentutgivare
Dund Institute of Technology
 Handläggare Dept of Automatic Control
DEF Hagander
 Författare
DST Christer Nilsson

Dokumentnamn
 R**E**PORT LUTFD2/(TFRT-5227)/1-128/(1979)
 Utgivningsdatum
 O**C**tóber 1979
 Dokumentbeteckning
 06T6
 Ärendebeteckning
 06T6

10T4

Dokumenttitel och undertitel 18T0 Insulin-glukos reglering (Insulin-glucose control)		
Referat (sammandrag) The report is divided into three main parts. In the first part an estimation has been carried out of how different insulin and glucose loads affect the blood glucose concentration in a normal dog. The blood glucose concentration has, in all cases, been measured by the use of Gambro AB's CGM-equipment. A test of three different pancreatic models is described in the second part. One model has been fitted to data from a glucose toleranse test, and one model to insulin load experiments described in part one. Based on the latter model test simulations have been carried out to test a PD-regulator and one nonlinear regulator. The simulation and the optimization of parameter fitting have been done in SIMNON, an interactive simulation program for nonlinear systems. In the third part practical regulation experiments have been made on normal and diabetic dogs. Three regulators have been tested. Despite of bad knowledge of models, the test shows that good regulation can be obtained. If the insulin need is unknown there can be considerable stationary errors for regulators without integraleffects. A timedelay leads to that the gain must be kept low to avoid oscillations.		
Referat skrivet av Author		
Förslag till ytterligare nyckelord 44T0		
Klassifikationsystem och -klass(er) 50T0		
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DOKUMENTTABLAD enligt SIS 62 10 12

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Lund Institute of Technology
 Handläggare Dept of Automatic Control
Per Hagander
 Författare
Dan Nielsen

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 REPORT LUTFD2/(TFRT-5228)/1-84/(1979)
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 October 1979
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Dokumenttitel och undertitel

^{18T0}
 Reglering av ATP-syntesen i mitokondrier
 (Control of the ATP-synthesis in mitochondria)

Referat (sammandrag)

^{26T0}
 The oxidation of NADH, with equilibrium constant $5 \cdot 10^{45}$, is the energy-source for ATP-synthesis in mitochondria. In order to study how control of such an irreversible process can be managed a mathematical model is built. The model is based on the chemiosmotic theory, where the electro-static potential difference across the inner membrane of mitochondria is explicitly considered in the equations. The results imply that the control mechanism is different from what is usual in biological systems. Also an application of irreversible thermodynamics shows that this mechanism allows a high effectiveness.

Referat skrivet av

Author

Förslag till ytterligare nyckelord

^{44T0}
 Dynamical model

Klassifikationssystem och -klass(er)

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Indextermer (ange källa)

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84T pages

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Dokumentnamn
report LUTFD2/(TFRT-5229)/1-053/(1979)

Dokumentbeteckning

Handläggare

Utgivningsdatum

Ärendebeteckning

Nov 1979

Forfattare

Göran Svensson
Magnus Åhs

Dokumenttitel och undertitel

Modellering och Simulering av
Matarvattenförvärmningssystem
(Modelling and Simulation of Feedwater
preheating system.)

Referat (sammmandrag)

Models of the feedwater preheating system at a BWR are written in the simulation language Simnon. The intention has been to find a simple dynamic model that describes the feedwater preheating system in the nuclear power plant Barsebäck, Sweden. Two different models have been constructed, one with and one without thermodynamical states. Both models have been investigated through simulations and some conclusions were made.

Referat skrivet av

Authors

Förslag till ytterligare nyckelord

Klassifikationssystem och -klass(er)

Indextermer (ange källa)

5270

Omfång

5670 53 pages

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5870 Swedish

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Lund Institute of Technology
P O Box 752, S-220 07, Sweden

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Organization LUND INSTITUTE OF TECHNOLOGY Department of Automatic Control P O Box 725 S-220 07 LUND 7 Sweden	Document name Master Thesis	
	Date of issue April, 1980	
	CODEN: LUTFD2/(TFRT-5230)/1-051/(1980)	
Author(s) Kaj Ullen	Adviser: K J Åström	
Title and subtitle STYRNING AV MOTORPROVBÄDD (CONTROL OF A DIESEL ENGINE TEST BED)		
Abstract Design of a system for automatic performance testing of diesel engines is described. The system has been in continuous operation at Volvo Skövde factory since 1977 and at Volvo Göteborg factory since 1979.		
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A4

A5

A4

A5

Organization LUND INSTITUTE OF TECHNOLOGY Department of Automatic Control P O Box 725 S-220 07 LUND 7 Sweden	Document name Master Thesis	
	Date of issue May, 1980	
	CODEN: LUTFD2/ (TRFT-5231)/1-084/(1980)	
Author(s) Björn Hedin	Adviser: Lars Jensen	
Title and subtitle Identifiering av dynamiska modeller för temperaturen i ett kontorslandskap. (Identification of dynamic models for the temperature in an office landscape).		
Abstract <p>This paper describes and analyses some experiments performed to identify dynamic models of the heating system of an office landscape.</p> <p>The heating system mainly consists of three fan systems, each of them distributes cold or warm air over one part of the landscape. If the inlets' temperatures are regarded as inputs and the space temperatures in the corresponding three parts as outputs, one can (try to) describe the interaction with three multiple input - single output ordinary difference - equations.</p> <p>To excite the process, the setpoint for the temperature in the three parts was independently varied by means of pseudo random binary sequences. Simultaneous values of the inputs and outputs were recorded and used to compute a least square or a maximum likelihood estimate of the model.</p> <p>It has appeared that first order multiple input models often are sufficient to describe the heating process. It should be stressed that these models are designed for control purpose and thus are valid only for short periods (here less than some hours).</p>		
Key words		
Classification system and/or index terms (if any)		
Supplementary bibliographical information		Language Swedish
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	Date of issue May, 1980	
	CODEN: LUTFD2/(TFRT-5232)/1-106/(1980)	
Author(s) Kristján H. Bjartmarsson	Adviser: Björn Wittenmark	
Title and subtitle Simulering av en kemisk reaktor (Simulation of a chemical reactor)		
Abstract		
<p>A continuous flow stirred tank reactor is simulated by using SIMNON, an interactive simulation program for nonlinear systems. In the reactor two parallel, irreversible reactions are assumed to take place: $A \rightarrow B$ and $A \rightarrow C$ which are, respectively, of 2nd and 1st order with respect to the concentration of A. The reactions are exothermic and hence the reactor is equipped with a cooling coil. A model of this process is derived from first principles and expressed in 5 1st order nonlinear differential equations in normalized form. The objective of the process is specified, and subject to constraints, an optimal unstable operating point is found. A linear model is derived from and compared to the nonlinear one. The eigenvalues are determined and certain transfer functions calculated. A continuous control system for the nonlinear model is developed heuristically by observing the various step responses. Cascade control is used for the temperature and composition loops. The effect of preload in connection with set-point changes is demonstrated. The sensitivity to disturbances in process parameters is investigated. An attempt is made at feedforward control. A conversion to sampled-data control system is made and associated effects on stability accounted for. A simple dead-beat strategy is obtained for the flow and level loops. Bang-bang control is shown to improve performance under certain conditions. The possibility of introducing dead time into the model is discussed briefly.</p>		
Key words		
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		Date of issue June, 1980	
		CODEN: LUTFD2/(TFRT-5233)/1-078/(1980)	
Author(s) Mats Nilsson Per Olofsson		Adviser: Björn Wittenmark	
Title and subtitle DC-motor driven force control system Likströmsmotordrivet kraftreglersystem			
Abstract			
<p>This report describes a DC-motor driven force control system based on a permanent magnetized DC-motor, a hydraulic transmission mainly comprising pump and cylinder and an electronic motor current controller.</p> <p>The transfer function from input signal to cylinder output force is derived. Simulations of the dynamic behaviour of the system are carried out utilizing the "SIMNON"-programming package. The theoretical study is verified by constructing and testing a hardware model.</p> <p>Methods for improving the system response-times are described and verified by simulations.</p>			
Key words			
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	Date of issue June 1980	
	CODEN: LUTFD2/(TFRT-5234)/0-053/(1980)	
Author(s) Rolf Olsson	Adviser: Björn Wittenmark	
Title and subtitle Modellering och Simulering av Synkrongeneratorodynamik (Modelling and Simulation of Synchronous Generator Dynamics)		
Abstract A number of simple synchronous machine models have been written in the simulation language SIMNON. The intention has been to find a set of models, which reflect physical properties and by conversion routines transfer these to Park form or vice-versa. Three different models are presented. Also the methods for determination of the parameters are presented. Simulation studies on one module show the dynamic behavior of certain step-changes in torque and magnetization.		
Key words		
Classification system and/or index terms (if any)		
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	Date of issue June 1980	
	CODEN: LUTFD2/(TFRT-5235)/1-87/(1980)	
Author(s) Pär Wennstad	Adviser: K J Åström	
Title and subtitle Adaptiva regulatorer (Adaptive regulators)		
Abstract		
<p>The aim of this work is to give an introduction to adaptive regulators and some structures. In dealing with the mathematical description, the investigated systems turn out to show non-analyticity on our way of finding usable criteria. A survey of available methods to overcome this are discussed.</p> <p>A simple adaptive controller without need of any plant model - proposed by Marsík - is shown to be insufficient in some respects. These are satisfactorily explained. In order to improve the controller some modified models are presented.</p> <p>Studies are made in the field of model reference adaptive systems. Liapunov's second method, which is used in the analysis presented, is analytically shown to be useless for some testsignals.</p>		
Key words		
Simple adaptive regulators, Marsík's regulator, Model reference adaptive systems, Analysis, Analytical calculations.		
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