Master's Theses in Automatic Control 1984-1985

Wittenmark, Björn

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Master Theses in Automatic Control

Björn Wittenmark

Department of Automatic Control
Lund Institute of Technology
December 1985

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Lund Institute of Technology
P.O. Box 118
S-221 00 Lund Sweden

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MASTER THESES REPORT

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Author(s)
B. Wittenmark

Supervisor

Sponsoring organisation

Title and subtitle
Master theses in Automatic Control 84/85

Abstract

The report contains abstracts of Master Theses (examensarbeten) made at the Department of Automatic Control, Lund, during the academic year 84/85. During this year 16 theses were made by 18 students. Most of the theses are written in Swedish with an English abstract.

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MASTER THESES IN AUTOMATIC CONTROL 84-85

B. Wittenmark

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 month of full time work. The thesis can be made individually or by two students together.

This report is a collection of the document pages of the theses completed during the academic year 1984/1985. During this time 16 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 in cooperation with the industry or other departments at the university.

Further information concerning the results can be obtained from the Department of Automatic Control by contacting the advisor. The theses may be borrowed through your library service or from the following libraries in Sweden:

Linköpings Universitetsbibliotek
Svensktrycket, S-581 83 Linköping, Sweden

UB 2, Svenska Tryckavdeln.
Box 1010, S-221 03 Lund, Sweden

Stockholms Universitetsbibliotek
Svenska Tryckavdeln., S-106 91 Stockholm, Sweden

Kungliga Biblioteket
Box 5039, S-102 41 Stockholm, Sweden

Umeå Universitetsbibliotek
Box 718, S-901 10 Umeå, Sweden

Uppsala Universitetsbibliotek
Box 510, S-751 20 Uppsala, Sweden

2. LIST OF THESES

TFRT-5308 Björn Malmström: Dynamisk modellering och simulering av värmecentral med fjärrvärmenät-tillämpning Skurup (Dynamical modelling and simulation of a district heating plant and network in Skurup). July 1984.

TFRT-5309 Ulf Steen: Simulering och reglering av ett system med en tre-fluids-värmeväxlare (Simulation and regulation of a system including a three-fluid heatexchanger). June 1984.

TFRT-5310 Jan Eric Larsson: An expert system interface for Idpac. July 1984.

TFRT-5311 Carl Almquist: Automatisk utvärdering av mätvärden från en hammarkvarnsprocess (Automatic evaluation of measurement values from a hammer mill process). Aug 1984.

TFRT-5312 Peter Lerup: Ett grafiskt hjälpmedel för programutveckling i Ada (A graphical tool for program development in Ada). Sept 1984.

TFRT-5313 Anders Jansson: Beräkning av regulatorparametrar med hjälp av i regulatorn inbyggd process modell (Computation of regulator parameters using gain scheduling). Sept 1984.

TFRT-5314 Kenneth Nilsson: Strukturidentifering av aktivslamprocessen (Structural identification of the Activated sludge process). Nov 1984.

TFRT-5315 Ulf Persson: Reglering av system med variabel tidsfördröjning (Control of systems with timevarying timedelay). Nov 1984.

TFRT-5316 Bernt Nilsson: Enzymatisk hydrolys av cellulosa i tvåfas-system (Enzymatic hydrolis of cellulose in two-phase system). Dec 1984.

TFRT-5317 Magnus Taube: Grafisk presentation och editering av matematiska uttryck och reläschema (Graphic Presentation and editing of mathematical expressions and ladder diagrams). Dec 1984.

TFRT-5318 Ulf Holmberg: Simulering av aktivslamprocessers dynamik (Simulation of the dynamics of activated sludge systems). Febr 1984.

TFRT-5319 Magnus Lundblad, Richard Svensson: Simulering av frekvenssyntes (Design and simulation of frequency synthesis). Dec 1984.

TFRT-5320 Mårten Lindberg: Reglering av aktivslamprocessen vid AKO, Karlshamn. En förstudie (Control of an activated sludge process at AKO, Karlshamn. A feasibility studie). Jan 1985.

TFRT-5321 Jonas Brånhult: Optimal "fed-batch"-odling av jäst (Optimal fed-batch growth of bakers yeast). May 1985.

TFRT-5322 Ulf Adamsson: Infrysning av livsmedel - simulering av en industriell process (Freezing of foods - simulation of an industrial process). May 1985.

TFRT-5323 Stefan Nilsson, Tor Sjödin: Autonom reglercentral (Stand alone controller). June 1985.

3. LIST OF SUBJECTS

Subject	Thesis
Adaptive control	5315
Analysis and synthesis	5311, 5323
Biological processes	5316, 5321
Digital control	5317
Expert systems	5310
Modelling and identification	5308, 5309, 5319, 5322
Power systems	5308, 5313
Programming tools	5312
Waste water treatment	5314, 5318, 5320

4. DOCUMENT PAGES

The following pages contain the document pages of the theses. Most of the theses are written in Swedish with only an abstract in Enlish.

LUND INSTITUTE OF TECHNOLOGY
DEPARTMENT OF AUTOMATIC CONTROL
Box 725
S 220 07 Lund 7 Sweden

Document name
MASTER THESIS

Date of issue
July 1984

Document number
CODEN.LUTFD2/(TFRT-5308)/(1-63)/(1984)

Author(s)
Björn Malmström

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle
Dynamisk modellering och simulering av värmecentral med fjärrvärmenät - tillämpning Skurup. (Dynamical modelling and simulation of a district heating plant and network in Skurup.)

Abstract
The thesis analyzes a heating system comprising a heat pump, auxiliary boilers, piping system, and buildings, including the internal radiator systems. The work concerns a given plant in the town Skurup (in the southern part of Sweden), where the task was to examine the cooperation between the various generating plants to provide a basis for improved control system operation.

A general discription is first given of the various part systems, including: sewage water system (the heat source), heat pump, radiator systems, oil boilers, and the control system.

From plant measurements the following main conclusions can be drawn:

- The radiator supply temperature shows a significant deviation from stipulated value.
- A propensity to unstable control system operation is observed

For system parts dynamical models were developed and the performance of the system as a whole was simulated by means of the computer program called SIMNON. As an important result the auxiliary boilers were seen to partly replace the heat pump during start-up periods.

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MASTER THESIS
Date of issue
JUNE 1984
Document number
CODEN:LUTFD2/(TFRT-5309)/0-064/(1984)

Author(s)
Ulf Stéen

Supervisor

Sponsoring organization

Title and subtitle
Simulering och reglering av ett system med en Tre-fluids-värmeväxlare.
(Simulation and regulation of a system including a Three fluid heatexchanger.)

Abstract
In this report the equations that describes the dynamics of a three-fluid heat-exchanger and also in a counterflow radiator are derived. To be able to simulate the dynamic wring the simulationlanguage SIMNON, the equations has been discretisized. The discretized models presented has shown a non-minimum-phase effect. To control and regulate a system consisting of a three-fluid heatexchanger followed by a radiator, the out-temperature of the radiator's airflow was feedback with the mass-velocity of the radiator's waterflow with a PI-regulator. It was shown that disturbances on the system was quickly eliminated with this feedback.
In this report examples are given how to further develop and improve the mathematical models and the regulation of the system.

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Document name: Masters Thesis
Date of issue: July 1984
Document number: CODEN: LUTFD2/(TFRT-5310)/1-84/(1984)

Author(s): Jan Eric Larsson
Supervisor: Karl Johan Åström

Sponsoring organization:

Title and subtitle

An Expert System Interface for Idpac

Abstract

This masters thesis deals with the design of an expert system for performing systems identification. The system is to be used as an expert interface for Idpac, a command driven, interactive program. There is a brief overview of systems identification and possible user types are discussed. The thesis treats the different parts of an expert system: the data base, the production rules handling system and the user interface. Some aspects on implementation and the feasibility of using an existing framework are given. Finally, a small rule base for systems identification is developed.

Key words

Expert Systems, Expert Interfaces, Interaction, Systems Identification.

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August 1984

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(TFRT - 5311)/1-058/(1984)

Author(s)
Carl Almquist

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle
Automatisk utvärdering av mätvärden från en hammarkvarnsprocess
(Automatic evaluation of measurment values from a hammer mill process)

Abstract

The process in a mill is frequently monitored with the assistance of list of measurment values and alarms from the process. Much time and concentration is sometimes needed to interpret these lists.

If the process is described using a model the interpretation can be made automatically by a computer. This would unload the operator and permit the concentration of the operator to be focused on running the process in an economic and energy saving manner.

The possibilities of creating such a model, describing a hammer mill process, are studied. Different parameters and methods of measuring these are discussed. The results of the discussions lead to a series of measurements related to the process. An attempt is made to set up a model to describe how efficently the energy is used and the quality of the product. The results is expresses as the coefficient of process efficency and is given in percent.

The measurement results show very complicated interrelations. They are too few to allow an acceptable model to be set up.

In spite of this some conclusions have been made. It seems as if the hammer mill used for the investigations is run unefficently and with great stress. The probable reasons are brought up and suggestions are made to eliminate the causes.

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Author(s)
Peter Lerup

Supervisor
Hilding Elmqvist

Sponsoring organization

Title and subtitle
Ett grafiskt hjälpmedel för programutveckling i Ada.
(A graphical tool for program development in Ada.)

Abstract

Nowadays abstraction, information hiding and modularization are well known concepts which can be used as tools when creating large, complex software systems. Ada is a programming language which makes good use of these concepts.

A system has been developed which, by using computer animation, creates a "programming space" for an Ada program. A user of the system is able to move around within this space consisting of his own Ada program, and place himself at its different modules. Within each module one of the different levels of abstraction can be selected and this level can be studied or changed. Furthermore the user is able, when in a module, to zoom down to submodules on a lower hierarchical level.

All this makes it easier to obtain an overview of a complex system and facilitates the use of modularization, information hiding and abstraction.

The system can be regarded as a prototype of a software developing system for Ada intended to be used on scientific personal computers.

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Author(s)
Anders Jansson

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle
Beräkning av regulatorparametrar med hjälp av i regulatorn inbyggd process modell.
(Computation of regulator parameters using gain scheduling.)

Abstract
This master thesis describes a way to construct a controller with a built-in model of the controlled process, making it possible to increase the performance over the whole working-area. This resulted in a gain-scheduled controler.

The approach has been applied to the control of a hydro-power station, which is a nonlinear and non-minimum phase process.

The aim was to improve the performance of frequency control, on disturbances from the connected grid.

This resulted in a built-in linear model whose process variables change with the working point of the hydro power process.

Controller parameters are computed from this linear model and used for the control of the non-linear process.

Simulations for the comparison between the hydro power system with a conventional controller e.g. PID with fixed parameters, and the described controller have been made.

This master thesis has been done at the Department of Automatic Control, Lund Institute of Technology.
Inititator was ASEA Otkus, Lund.

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Master thesis

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November

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CODEN:LUTFD2/(TFRT-5314)/1-052/(1984)

Author(s)
Kenneth Nilsson

Supervisor
Gustaf Olsson

Sponsoring organization

Title and subtitle
Strukturidentifiering av aktivslamprocessen.
(Structural Identification of the Activated Sludge Process.)

Abstract

In this report, the possibilities to identify unknown model parameters are studied, using real measurements. The actual model describes the biological reactor in a wastewater treatment plant. The model contains many unknown parameters, which makes it awkward to simulate and adapt all of them at the same time. For that reason the model is divided into smaller parts.

First the differential equation of dissolved oxygen has been studied. The dissolved oxygen model is simulated using two input signals, the air flow and the influent water flow rates. The output signal (dissolved oxygen) from the model is compared with the real output. This gives an estimation of the oxygen uptake rate OUR of the microorganisms, and of the oxygen transfer rate.

Further the suspended solids concentration is studied, using the calculated OUR. From the OUR the specific growth rate for zoogleal organisms is calculated.

It is difficult to verify the mass balance of the substrate due to insufficient measurements.

At last some simulations are made with an expanded model.

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Author(s)
Ulf Persson

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle
Reglering av system med variabel tidsfördröjning.
(Control of systems with timevarying timedelay.)

Abstract

A method for control of systems with timevarying time delay is investigated. The control algoritm can be viewed as minimizing the expected variance of an auxillary signal which is a function of the system output, input and reference signal.

The auxillary signal is defined in such a way that the auxillary-system time delay are less or equal to the system time delay.

The parameters in the control law are estimated by the method recursive least-squares from the auxillary signal.

The only needed knowledge of the process is the order of the process polynomials and the maximum time delay.

The method is investigated using simulation with the interactive simulation program package SIMNON.

It is shown that the controller can adapt to changes in the time delay.

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CODEN:LUTFD2/(TFRT-5316)/1-063/(1984)

Author(s)
Bernt Nilsson

Supervisor
Per Hagander

Sponsoring organization

Title and subtitle

(Enzymatic hydrolysis of cellulose in two-phase systems.)

Enzymatisk hydrolys av cellulosa i tvåfas-system.

Abstract

A comparison of experiment and publiced models of enzymatic hydrolysis of cellulose gives:

The three models, that have been studied, predict batchwise experiments with satisfaction.

The models do not give satisfactory predicts for a continuous process.

The models were not good enough for wider studies of a continuous process, like for process engineering purpose or automatic control design.

A Flow Injection Analysis-system with a dialysis probe is a good alternativ for on-line analysis of enzymatic hydrolysis, also for the purpose of automatic control.

In a continuous two-phase process for production of glucose a SISO-regulator can be used for control of glucoseconcentration.

Reconstruction should be used in controlling enzym activities in the process.

Continuous time control desigh is enough, because the hydrolysis dynamics is slow.

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Author(s)
Magnus Taube

Supervisor
Hilding Elmqvist

Sponsoring organization

Title and subtitle

Grafisk presentation och editering av matematiska uttryck och reläschema.

Abstract

Input- and output to computers are generally still line oriented. With personal computers in combination with bitmapped displays it is possible to use a more sophistacated form and leave the line orientation.

A system for presentation and editing of mathematical expressions in conventional mathematical notation is implemented. Boolean expressions can also be presented as ladder diagrams.

As a separate part a compiler is implemented. The compiler takes a ladder represented by vectors and texts as input and builds up the corresponding boolean expression.

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Master Thesis

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February 1984

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CODEN:LUTFD2/(TFRT-5318)/1-048/(1984)

Author(s)
Ulf Holmberg

Supervisor
Gustaf Olsson

Sponsoring organization

Title and subtitle
Simulering av aktivslamprocessers Dynamik
(Simulation of the dynamics of activated sludge systems)

Abstract
This paper is built on results from dynamical simulations of an active sludge process. In the dynamical model the biological reactor (aerator) and the secondary sedimentation basin (settler) are considered as one system, because of the wrong interactions. The strategy, sludge distribution control by the return sludge flow rate, is simulated with different criteria. Also different settler models are simulated.

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Date of issue
December 1984

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CODEN:LUTFD2/(TFRT-5319)/1-086/(1985)

Author(s)
Magnus Lundblad
Richard Svensson

Supervisor
Björn Wittenmark

Sponsoring organization
Ericsson Radio System AB, Lund

Title and subtitle
Simulering av frekvenssyntes. (Design and simulation of frequency synthesis.)

Abstract

This master thesis describes an aid to construct a Phase Locked Loop, (PLL). The aim was to simulate and dimension a PLL with it's specifications given.

The simulation language Simnon is used to simulate the non-linear PLL system. The PLL have both continuous and discrete component's. This make it difficulte to analyze an PLL with other methods than simulation.

The main problem to solve was to decrease the adjustment time and keep the dampingfactor on adjacent channel's at a specified level.

It's possible with the written programs to see what influence disturbances and component variations have on the system.

Two interactive programs have been written. These programs make it possible to dimension and simulate a PLL in an easy way, without knowing any Simnon commands.

This master thesis has been done for Ericsson Radio System AB, Lund. Supervision has been given from the Company and from the Department of Automatic Control, Lund Institute of Technology.

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Document number
CODEN:LUTFD2/(TFRT-5320)/1-040/(1985)

Author(s)
Mårten Lindberg

Supervisor
Gustaf Olsson

Sponsoring organization

Title and subtitle
Reglering av aktivslamprocessen vid AKO, Karlshamn. En förstudie.
(Control of an activated sludge process at AKO, Karlshamn. A Feasibility studie.)

Abstract

This master thesis has been performed at the wastewater treatment plant at AB Karlshamns Oljefabriker. In 1981 - 82 the plant was converted from a system with biological filters into an activated sludge treatment plant.

The purpose with this study has been to design a control system for the dissolved oxygen level in the activated sludge process. Due to an inflexible design of the plant the main part of the study has been devoted to create the necessary conditions to make control possible. This has been done by installation of an oxygen sensor and air regulators.

The study concludes with a presentation of a computer code and a control strategy for the aeration process.

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May 1985

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CODEN:LUTFD2/(TFRT-5321)/1-044/(1985)

Author(s)
Jonas Brånhult

Supervisor
Per Hagander

Sponsoring organization

Title and subtitle
Optimal fed-batch growth of bakers yeast
(Optimal "fed-batch" -odling av jäst)

Abstract

regulate
media
much
and the
is derived
system. The model
resulting
feed-back
and the
cases, three
and
regulator, pole-
with and without
made giving

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CODEN:LUTFD2/(TFRT-5322)/1-096/(1985)

Author(s)
Ulf Adamsson

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle

Infrysning av livsmedel - Simulering av en industriell process.
(Freezing of foods - Simulation of an industrial process.)

Abstract

Design and operation of industrial freezers contains the crucial problem of how to make the frozen foods attain a prescribed temperature. Methods for prediction of freezing times under given constant conditions are commonly used in order to calculate the optimum product flow through continuous freezers. However, in reality the processes are time variable, due to disturbances and parameter deviations. Thus, introduction of real time temperature measurements combined with manual or automatic control would be a feasible way to obtain improved reliability, with regard to product quality.

Freezing under time-varying conditions is studied, using a numerical solution method for the heat conduction equation with temperature-dependent coefficients. A mathematical model of the freezing process is described, and a Pascal program for simulation of the Frigoscandia Gyrofreeze (spiral freezer) is presented. Finally, the process dynamics are discussed and a regulator structure, based on product temperature feedback combined with feedforward from measurable disturbances (mainly air temperatures), is proposed.

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Author(s)
NILSSON Stefan
SJÖDIN Tor

Supervisor
Björn Wittenmark. Michael Lundh

Sponsoring organization

Title and subtitle

AUTONOM REGLERCENTRAL. (Stand alone controller)

Abstract

Constructing a PID-controller by using Intel´s 8052-AH Basic makes way for a wide range of realtime applications. Implemented in this construction is a foreground process consists of operator communication while the background process contains the regulator algorithm. This makes it possible for the user to change parameters during program execution in real-time. Control over the system can be actived either by using a button-matris-hand terminal together with an LCD, or by using a usual monitor terminal.

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