Master's Theses in Automatic Control 1981-1982

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MASTER THESIS IN AUTOMATIC CONTROL 81/82

BJÖRN WITTENMARK

DEPARTMENT OF AUTOMATIC CONTROL
LUND INSTITUTE OF TECHNOLOGY

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Author(s)
Björn Wittenmark

Supervisor

Sponsoring organization

Title and subtitle
Master Thesis in Automatic Control 81/82

Abstract
The report contains abstracts of Master Theses (examensarbeten) made at the Department of Automatic Control, Lund, during the academic year 81/82. During this year 30 theses were made by 40 students. Most of the theses are written in Swedish with an English abstract.

Key words

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Distribution: The report may be ordered from the Department of Automatic Control or borrowed through the University Library 2, Box 1010, S-221 03 Lund, Sweden, Telex: 33248 lubbis lund.

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 1981/1982. During this time 30 theses were finished by 40 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 are available at the University Library in Lund (Address: University Library 2, Box 1010, S-221 03 Lund, Sweden).

2. LIST OF THESIS

TFRT-5248 Hed G, Thorselius K: Adaptivt bränsleflödesmätningssystem för motorfordon (Adaptive fuel flow measuring system for motor vehicles). July 1981.

TFRT-5249 Bjerke O: Dimensionering av en multivariabel styrregulator för en robot samt en undersökning av villkor för stabilitetsmarginaler för multivariabla system (Design of a multivariable elevator controller for a missile and an insight into conditions of robustness of multivariable systems). July 1981.

TFRT-5250 Hansson P: Implementering av självinställande PI-regulator (Implementation of self-tuning PI-controller). July 1981.

TFRT-5251 Andersson J: Implementering av DDC-6 reglersystem (Implementation of a DDC-6 control system). Aug 1981.

TFRT-5252 Emanuelsson C, Theander G: Optimal inställning av PID-regulatorer med hjälp av förlust-funktionsoptimering (Optimal tuning of PID-controllers using loss function minimization). Aug 1981.

TFRT-5253 Nilsson P-A: Lasthanteringsprogram för själv-lossande malmfartyg (Cargo-loading program for self-loading ore-vessels). Aug 1981.

TFRT-5254 Elfgren L-G: Temperaturreglering med själv-inställande PID-regulator (Temperature control with self-tuning PID-controllers). Sept 1981.

TFRT-5255 Löfstrand P-A: PID-regulatorer i en process-terminal (PID-regulators in a process terminal). June 1981.

TFRT-5256 Minör S, Permvall O: Pascal för PC-system (Pascal for PC-systems). Sept 1981.

TFRT-5257 Wikström A: Evolutionärt stabila strategier (ESS) i en predator bytesdjurs modell (Evolutionary stable strategies (ESS) in a predator prey model). Sept 1981.

TFRT-5258 Ohlsson B: Programvara för terminal med zoom (Software for terminal with zoom). July 1981.

TFRT-5259 Gunnarsson H: Recursive identification using a general model structure. Oct 1981.

TFRT-5260 Uneram M, Wegelid L: Självinställande servo implementerat med mikrodator (A microprocessor implementation of a self-tuning servo). Oct 1981.

TFRT-5261 Hagberg U: Modeller och prediktion av effektförbrukningen i fjärrvärmeverk (Model and prediction of heat load in a district heating system). Nov 1981.

TFRT-5262 Årzén K-E: LOGGER - An interactive program for data logging on PDP-11. Nov 1981.

TFRT-5263 Hillbur A: Mikrodatorbaserad temperaturregulator för ystkar (Microcomputer based temperature controller). Nov 1981.

TFRT-5264 Bååth L, Malmqvist P-O: Självinställande regulatorer på mikrodator i högnivåspråk (Self-tuning regulators on a micro-computer in high-level language). Nov 1981.

TFRT-5265 Stamoulis A, Moustakas T: Algoritmer för digitala PID-regulatorer (Algorithms for digital PID-controllers). Dec 1981.

TFRT-5266 Mårtensson B: Zeros of sampled systems. Jan 1982.

TFRT-5267 Kalliakmanis K, Tsanis E: Experimentell undersökning av blandningsprocess (Investigation of a mixing process). Jan 1982.

TFRT-5268 Axelsson J P: Reglering av sackaroshalten vid fermentation i en reaktor med kontinuerligt flöde (Control of sucrose concentration in a fermentor with continuous flow). Febr 1982.

TFRT-5269 Heder N, Speidel T: Förstudie av programmet SLIRSIM (Prestudy av the program SLIRSIM). March 1982.

TFRT-5270 Andell L-Å: Självinställande PID-regulator för system med tidsfördröjning (A self-tuning PID-controller for systems with time delay). March 1982.

TFRT-5271 Sandin G, Wullt T: Experiment med datorstyrd kännande robot (Experiments with a computer controlled touch-sensing robot). Aug 1982.

TFRT-5272 Eriksson G, Molin B-A: Design of a digital motor speed controller. May 1982.

TFRT-5273 Persson M: Mätning av banhastighet med korrelationsteknik (Measurement of web speed using correlation methods). June 1982.

TFRT-5274 Rundqwist L: Mathematical modelling for simulation of an extruder. June 1982.

TFRT-5275 Bengtsson T: Realtidskärna för Motorolas MC 68000 mikroprocessor (Real-time kernel for Motorola MC 68000 micro processor). June 1982.

TFRT-5276 Persson T: Högupplösande färggrafik för operatörskommunikation (High-resolution colour graphics in control systems). June 1982.

TFRT-5277 Lilja M: Quantum mechanics and non-linear filtering. June 1982.

3. LIST OF SUBJECTS

Subject	Thesis
Adaptive control	5250, 5252, 5254, 5260, 5264, 5270
Analysis and synthesis	5249, 5266, 5267, 5268, 5277
Biological systems	5257
Data handling and identification	5259, 5262, 5273
Digital control	5251, 5253, 5255, 5265, 5272
Modelling and identification	5248, 5257, 5261, 5263, 5267, 5269, 5274
Programming and computer science	5256, 5258, 5275, 5276
Robotics	5271

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 1981

Document number
CODEN: LUTFD2/(TFRT-5248)/1-034/(1981)

Author(s)
Göran Hed
Kaj Thorselius

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle

Adaptivt bränsleflödesmätningssystem för motofordon
(Adaptive fuel flow measuring system for motor vehicles)

Abstract

This work is ment to make it probable that, without direct measurement in the fuel line, it is possible to calculate the fuel flow with other parameters.

The investigation is made in one specific case, for a four cylinder carburetor engine. With the model parameters engine speed and intake manifold pressure it is possible to construct a model which showed a good agreement in a comparison with the car. Furthermore the system can be automatically calibrated using the least squares estimation.

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Date of issue
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Document number
CODEN: LUTFD2/(TFRT-5249)/1-089/(1981)

Author(s)
Ola Bjerke

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle Dimensionering av en multivariabel styrregulator för en robot samt en undersökning av villkor för stabilitetsmarginaler för multivariabla system. (Design of a multivariable elevator controller for a missile and an insight into conditions of robustness of multivariable systems.

Abstract

Design of a multivariable elevator controller for a missile using nose and tail elevator. The result is a state-space feedback controller, and the method, which is used, is linearquadratic optimal design. ii An insight into one theory for robust stability of linear dynamic multivariable system. One of the results is software calculating the stability margin. The conditions are sufficient but not necessary.

The relation between part one and two is in the sense of using part one as an applied example of part two. Part one gives also a useful idea useable for the chang from launching mode to tracking mode.
Not least: The author has received some good knowledge of a multivariable system and missile dynamics during the work with part one.

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CODEN:LUTFD2/(TFRT-5250)/1-040/(1981)

Author(s)
Paul Hansson

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle

Implementering av självinställande PI-regulator
(Implementation of self-tuning PI-controller)

Abstract

This paper considers implementation and test of a self-tuning PI-controller based on pole-placement. The algorithm has been implemented in BASIC on an ABC-80. The sampling of measure values and setting of digital outputs has been done with a remote station TA6500.

The controller has been tested on two processes. First on a testprocess where the temperature from a hairdryer has been controlled. Secondly, the supply air-temperature to an office building has been controlled. The algorithm has worked well at the testprocess and after some modifications even at the real process.

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CODEN:
LUTFD2/(TFRT-5251)/0-085/(1981)

Author(s)
Jonas Andersson

Sponsoring organization

Title and subtitle
Implementering av DDC-6 reglersystem
(Implementation of a DDC-6 control system)

A4 A5

Abstract
A description of the implementation of Direct Digital Control systems at TAIAB (Tour & Andersson Industrial Automation AB), and a study of the problems in such work. Including a technical introduction to the TA 6500/6501, decentralized DDC-system.

Key words
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Author(s)
Clas Emanuelsson
Göran Theander

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle

Optimal inställning av PID-regulatorer med hjälp av förlustfunktionsoptimering
(Optimal tuning of PID-controllers using lossfunction minimization)

Abstract

This report treats the adjustment of the parameters of an analogous PID-controller using a search method which optimizes a loss-function. A process model is updated periodically by means of a suitable identification algorithm. The loss-function is minimized by using a search algorithm. This is done by comparing the values of the loss-function for different setting of the parameters forming a vertex of a geometric structure in the function space and replacing the vertex with the highest value with a new calculated vertex. When acceptable controller parameters are obtained these can be automatically or manually transmitted to the real controller.

The system has been simulated and has been found to work satisfactorily especially when using reference model to calculate the loss-function.

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MASTER THESIS

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CODEN: LUTFD2/(TFRT-5253)/0-059/(1981)

Author(s)
Per-Arne Nilsson

Sponsoring organization

Title and subtitle
Lasthanteringsprogram för självlossande Malmfartyg
(Cargo-loading program for self-loading ore-vessels)

A4 A5

Abstract

When loading large ships, necessary consideration must be taken concerning the distribution of the cargo in order to avoid that harzardous shear-forces and bending moments occur.

The problem to find the distribution of the cargo will be relatively easy when loading tankers, on the other hand if we consider bulk ships with long cargo holds with more than one hatch in each, it becomes necessary to make a deeper analaysis.

This paper consists of such an analysis and in addition, programs written in FORTRAN which calculate the weight and the longitudinal centre of gravity of the cargo. These programs are intended to be incorporated in an existing program package for calculations of shear-forces and bending moments.

Key words A4 A5

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September 1981
CODEN:

Author(s)
Lars-Göran Elfgren

Sponsoring organization

Title and subtitle

Temperaturreglering med självinställande PID-regulator.

A4 A5

Abstract

A conventional PID-controller is used to investigate some process-models. Theese are going to be used later to test a self-tuner.
Some problems associated to digital PID-algorithms are discussed, and such an algorithm is described and implemented in a computer.
A simple way to obtain critical gain and period in a closed-loop situation is described, and used to design a self-tuning PID-controller.
Fimally, the method is tested and illustrated in a couple of experiments.

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A4 A5

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CODEN: LUTFD2/(TFRT-5255)/1-088/(1981)

Author(s)
Per-Arne Löfstrand

Supervisor
Leif Andersson

Sponsoring organization

Title and subtitle

PID-regulatorer i en processterminal
(PID-regulators in a process terminal)

Abstract

This paper is an outline of an implementation of regulator-algorithms in a microcomputer-based process terminal. The programs are inspired by a DDC system at the Department of Automatic Control, Lund Institute of Technology. A simple real-time scheduler after an idea of Sven Erik Mattsson is presented and some useful application programs are given. The programs are not yet tested so this paper must be looked upon more as a proposal than a ready-to--use product.

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Author(s)
Sten Minör
Oskar Permvall

Supervisor
Hilding Elmqvist

Sponsoring organization
Swedish Board for Technical Development
(STU-80-3962)

Title and subtitle

Pascal for PC-systems

(Pascal för PC-system)

Abstract

Programmable controllers (PC) is today frequently used for logic control purposes, often integrated with computers. Usually the only language available for programming PC:s is rudimentary assemblers.

Using Pascal gives many advantages, as powerful data and program-flow structures, supporting the programmer to write structured and well-documented programs.

A code generator for a small PC (Satt-Electronics PBS-mini) is implemented. A Pascal compiler producing P-code has been used. Because of the limited hardware structure of the object PC, compared to a general computer, the P-code is partially evaluated. The code produced by the code generator has, after optimization, shown to be as efficient as hand-coded PC-code.

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CODEN:LUTFD2/(TFRT-5257)/1-055/(1981)

Author(s)
Anders Wikström

Supervisor
Per Molander

Sponsoring organization

Title and subtitle

Evolutionary Stable Strategies (ESS) in a Predator Prey Model

(Evolutionärt Stabila Strategier (ESS) in en Predator Bytesdjurs Modell)

Abstract

EVOLUTIONÄRT STABILA STRATEGIER (ESS) I EN PREDATOR BYTESDJURS MODELL.
(EVOLUTIONARY STABLE STRATEGIES (ESS) IN A PREDATOR PREY MODEL.)

ABSTRACT

A system of ordinary nonlinear differential equations is used to examine evolutionary changes in a predator prey community. Evolution in the β parameter of the predator and the r parameter of the prey influence the x parameter of the model. This is discribed by matematical functions, so-called fitnessetfunctions. It is examined if the form of the curve of the fitnessetfunction influence the possibility of the predator and the prey, respectively, to develop an Evolutionary Stable Strategy (ESS). It is also examined how evolution of β and r, respectively, reflect on the ecological stability of the community. The result of analysis and simulation is that the predator can develop an ESS in two of the four curves that were examined, while the prey can develop an ESS in three out of four examined curves. Evolution in both β and r can destabilize the system. The unstable cases show a stable limit cycle.

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Author(s)
Bengt Ohlsson

Supervisor
Hilding Elmqvist

Sponsoring organization
Swedish Board for Technical Development
Contract: STU 80-3962

Title and subtitle
Programvara för terminal med ZOOM
(Software for Terminal with ZOOM)

Abstract
Software for an alphanumeric terminal with zoom is described. The terminal contains a microcomputer and a video unit capable of presenting characters of different size.

It is possible to zoom and scroll the picture by using a joy stick. About one hundred lines can be shown on the screen. This means that information such as indentations and new sections can be used for example when locating a piece of text. When the text is found it can be zoomed to any size.

The terminal also allows information zooming. It is based on the fact that the text lines are often structured as a tree. When for example editing a Pascal program, the tree structure is represented as indentations. Information zooming means that only the lines above a certain level in the tree are shown on the screen.

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CODEN:LUTFD2/(TFRT-5259)/1-103/(1981)

Author(s)
Hallgrimur Gunnarsson

Supervisor
Ivar Gustavsson

Sponsoring organization

Title and subtitle

Recursive identification using a general model structure

(Rekursiv identifiering för en generell modellstruktur)

Abstract

A program package, based on SIMNON (an interactive simulation program), for recursive identification has been developed. The program package uses a general model structure of the form:

$$(1+A) \cdot y(t) = \frac{B}{1+F} \cdot u(t) + \frac{1+C}{1+D} \cdot e(t) \qquad (I)$$

where A, F, B, D and C are polynomials in q^{-1} (the backward shift operator) such that A(0)=0 etc. and e(t) white noise. The order of the polynomials can be varied independently to arrive at a model structure that gives the "best" results. For this general structure many common identification methods such as the LS, ELS, ML and GLS can be classified as special cases in either of two approaches (LIP or CMA). Simulation experiments have been made using data generated by a relatively complex "process/system". The results indicate that the use of this general model structure can be recommended since it allows a greater flexibility and the same or a higher degree of accuracy can be achieved with fewer parameters compared to the common identification methods to obtain a good approximate description.

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Author(s)
Martin Uneram
Lennart Wegelid

Supervisor
Karl Johan Åström

Sponsoring organization

Title and subtitle

A Microprocessor implementation of a self-tuning servo

(Självinställande servo implementerat med mikrodator)

Abstract

The purpose of this work was to build a small microprocessor based self-tuning servo. A board computer was built with selected cards from SYSTEM S-99 (TLD-85), a series of euro-cards based on Texas Instruments 16-bit microprocessor TMS 9900.

The servo contains three modules for estimation, regulation and design. The estimator estimates the parameters of the process recursively. The design module uses the estimated model together with specifications on bandwidth and damping to calculate the parameters of the regulator. These modules were implemented using concurrent programming in a high level language, MicroProcessor Pascal (MPP) from Texas Instruments.

The program, which is prepared for multiloop control, consists of 900 Pascal statements. It takes 25.5 kbytes of memory space. The minimum sampling period is approximately 500 ms.

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Author(s)
Ulf Hagberg

Supervisor
Björn Wittenmark

Sponsoring organization

Title and subtitle

Modeller och prediktion av effektförbrukningen i fjärrvärmeverk

(Model and prediction of heat load in a distric heating system)

Abstract

Different models of heat load in a district heating system at Karlstad have been tested. The input of the model contains one climatic dependent part and a profile which depends on time. The climatic inputs are outdoor temperature, solar intensity and wind velocity. The profile tries to describe the consumption of hot water. This model has later been used to predict the heat load for one or a few hours. A Pascal program is also presented which converts diskett formats.

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Author(s)
Karl-Erik Årzén

Supervisor
Leif Andersson

Sponsoring organization

Title and subtitle

LOGGER - An interactive program for data logging on PDP-11..

Abstract

Logger is an interactive command driven program for data logging on PDP-11. It can also generate different signals, perform PID-control and make signal processing. During the logging it is possible to plot or print signals on the terminal. Commands can be entered via the terminal or in a command file. For conversion of the stored signals to text form the program Convrt can be used.

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Author(s)
Anders Hillbur

Supervisor
Björn Wittenmark, Conny Persson

Sponsoring organization

Title and subtitle
Mikrodatorbaserad Temperaturregulator för Ystkar
(Microcomputer based temperature controller)

Abstract
The document contains a description of the software unit of a temperature regulator and the construction of an interface used by this regulator. A PID-regulator is implemented which consists of a microcomputer and a PC-unit called PBS Micro which takes care of the interface functions for external digital signals. The regulator also contains a separate interface taking care of the analog temperature signals and in some cases also the digital signals. The document gives a brief information about the total system and then gives more specific information about the separate interface and the program unit. It also describes the theory behind the PID-algorithm and the digital filter.

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Author(s)
Lars Bååth
Per-Olof Malmqvist

Supervisor
Carl Fredrik Mannerfelt.

Sponsoring organization

Title and subtitle
Självinställande regulatorer på mikrodator i högnivåspråk.
(Self-tuning regulators on a micro-computer in high-level language.)

Abstract
This master thesis is concerned with the problem of implementation of a self-tuning regulator on a micro-computer. The computer programs for the self-tuner are organized as a control-package, which may contain ten different control loops. The package further gives the operator the possibility to interactively change the values of design parameters, etc. All the programming code was written in the high-level language Pascal.
The self-tuning regulator is of a modified minimum-variance type, which proved to behave satisfactory in the practical tests we performed. The regulator was also applied to an air heat-exchanger in a large company in Malmö. Here the self-tuner proved to be superior to the existing commercial regulator.

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Sponsoring organization

Title and subtitle
Algoritmer för digitala PID-regulatorer
(Algoritms for PID-controllers)

Abstract

The goal of this report is to give a short introduction to PID algorithms and furthermore to study the behavior of a few specific industrial digital PID regulators, through simulations.

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Sponsoring organization

Title and subtitle

Zeros of sampled systems

(Nollställen hos samplade system)

Abstract

The zeros obtained when sampling a time continuous system are explored. Theorems are given which, if the time continuous transfer function is known and of finite order, give estimations of sample intervals for which the time discrete system will have a stable inverse. For the case only the Nyquist curve is known, some results are given.

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Sponsoring organization

Title and subtitle

Experimentell undersökning av blandningsprocess

(Investigation of a mixing process)

Abstract

This thesis describes studies of a process for measurement and regulation of concentration of a soluble salt. The experimental set up includes a delay element and a tank system, both as direct systems and as systems with recirculation. The idea of the studies is to perform measurements, mathematical models, simulations, regulation and experiments with the process. The last mentioned will be the base for a new laboratory experiment in the general courses of Automatic Control System.

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Title and subtitle

Control of sucrose concentration in a fermentor with continuous flow.

(Reglering av sackaroshalten vid fermentation i en reaktor med kontinuerligt flöde.)

Abstract

Fermentation in a 5 l continuous flow reactor with immobilized yeastcells is controlled. Substrate concentration (sucrose) is continuously measured with an enzyme thermistor. The control variable is flowrate through the reactor. The main controlproblem is a timelag in the meassurementsignal. A bilinear processmodel is formulated and used for design of different controllers. Comparison is done between conventional PID-, Otto-Smith-PI-regulator, state-feedback from Kalmanfilter and regulator based on polynomsynthesis. Controllers are tested in simulation and on the real process. Implementation is done on a PDP-11 computer. Programs are written in PASCAL extended with a realtime kernel.

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Title and subtitle
Förstudie av programmet SLIRSIM.
(Prestudy of the program SLIRSIM.)

Abstract

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Title and subtitle
Självinställande PID-regulator för system med tidsfördröjning.
(A self-tuning _PID-controller for systems with time delay.)

Abstract

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Title and subtitle

Experiment med datorstyrd kännande robot.

Abstract

Electronics and software for control of a two-wheeled, touchsensing vehicle, known as the Turtle.

Program applications.

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Sponsoring organization

Title and subtitle
DESIGN OF A DIGITAL MOTOR SPEED CONTROLLER
(Konstruktion av Digital Varvtalsregulator)

Abstract
The subject of this master thesis was originally proposed by the electronic company Telsand Electronics in Arlöv. The purpose was to examine the possibilities to implement digital controllers on a one board computer based on Texas Instrument microprocessor TMS 9995. We have implemented a certain type of PID-regulator and designed both hardware and software solutions. Because of lack of time, we had to leave the work unfinished. The remaining problems are associated with the hardware, and the limited memory capacity.

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Title and subtitle
MEASUREMENT OF WEB SPEED USING CORRELATIONMETHODS
(Mätning av banhastighet med korrelationsteknik.)

Abstract
This report analyses a method for measurement of web speed in a winding machine. Precise control of speed in printing equipment, e.g. with register, is a typical application. The method used is correlation technique with two photoscanners as signaltransmitters. An algorithm has been tested with signals taken directly from the winding machine. The work has been carried out at the Telsand Electronics in Arlöv, and at the Department of Automatic Control, LTH.

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Title and subtitle
Mathematical modelling for simulation of an extruder
(Matematiska modeller för simulering av en extruder)

Abstract

The purpose of the study is to explain oscillations observed in temperature control. Mathematical models of a plastic extruder are developed. The different physical effects (e g convection and control power), of which several are nonlinear, are estimated. The models have been used in simulation studies where the extruder is controlled by parallell single-loop PID-controllers.

The results indicate that the water-cooling system is superfluously dimensioned. The appropriate action is to use a smaller magnetic valve, or by other means reduce the flow.

Cross-coupling has been analyzed on simple models. These indicate that the cross-coupling will not give rise to stability problems. The sensitivity for disturbances has been investigated by simulation, and according to them the models are well-damped.

Cascade-control has also been investigated.

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Title and subtitle
Realtidskärna för motorolas MC 68000 mikroprocessor.
(Real-Time Kernel for Motorola MC 68000 Mikro Processor.)

Abstract

A realtime kernel in Pascal for a Motorola MC 68000 mikroprocessor has been implemented to be used on ASEA:s DS101 microcomputer system.
An arbitrary number of processes can be executing concurrently. The following primitives for process synchronization are available.

1. Priority
2. Semaphores
3. Message passing.
5. Monitors.
6. Waittime.
7. Vectoried interrupt.

The processes are realised as normal Pascal programs and linked together with the kernel. The kernel itself occupies about 4-5Kbyte machine-code, and is written in a combination of Pascal and assembler. An IO-routin that handles all input and output to a terminal, like in normal Pascal.
Finally I have been writing a floppydisc-handler that usees the kernel-primitives. It can handle transfer requests from many processes at the same time.

Key words
Realtimekernel, Floppydischandler, DSCA 114 Communication card.

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Title and subtitle
Högupplösande färggrafik för operatörskommunikation
(High-resolution colour graphics in control systems)

Abstract
This paper describes the design and construction of a microprocessor-based video display control unit intended for use in industrial control systems. The unit features graphics of up to 1024 X 1024 pixels resolution and eight colours using the NEC µPD 7220 Graphics Display Controller. The design idea is based on a discussion of basic principles in colour graphics outlined in the first part of the paper. This is followed by a detailed description of the units' construction and performance including some software.

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Title and subtitle
Quantum Mechanics and Non-linear Filtering

Abstract

Integration in functional spaces is treated in two cases: Integration over Wiener measure and R. Feynman's so called path integrals. The difference between these cases is pointed out. The Feynman-Kac formula is presented and its role in the theory of non-linear filtering is explored.

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