Editors

Gabriela Mircea

Santoso Wibowo

Associate Editor

Nikos Bardis

Recent Advances in Finite Differences and Applied & Computational Mathematics

Proceedings of the 6th International Conference on Finite Differences, Finite Elements, Finite Volumes, Boundary Elements (F-and-B '13)

Proceedings of the 2nd International Conference on Applied and Computational Mathematics (ICACM '13)

Vouliagmeni, Athens, Greece, May 14-16, 2013

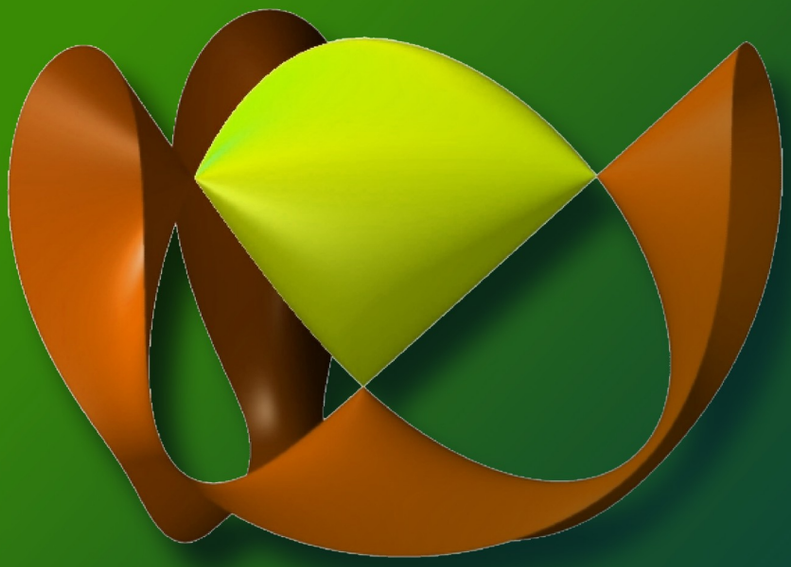
Scientific Sponsors

University Politehnica of Bucharest

University of Petrosani

University of Craiova

Technological Educational Institute of Athens



Recent Advances in Finite Differences and Applied & Computational Mathematics

Mathematics and Computers in Science and Engineering Series | 12

RECENT ADVANCES in FINITE DIFFERENCES and APPLIED & COMPUTATIONAL MATHEMATICS

Proceedings of the 6th International Conference on Finite Differences, Finite Elements, Finite Volumes, Boundary Elements (F-and-B '13)
Proceedings of the 2nd International Conference on Applied and Computational Mathematics (ICACM '13)

Vouliagmeni, Athens, Greece
May 14-16, 2013

Scientific Sponsors:

University Politehnica of Bucharest

University of Petrosani

University of Craiova

TEI of Athens

Mathematics and Computers in Science and Engineering Series | 12

ISSN: 2227-4588
ISBN: 978-1-61804-184-5

RECENT ADVANCES in FINITE DIFFERENCES and APPLIED & COMPUTATIONAL MATHEMATICS

Proceedings of the 6th International Conference on Finite Differences, Finite Elements, Finite Volumes, Boundary Elements (F-and-B '13)

Proceedings of the 2nd International Conference on Applied and Computational Mathematics (ICACM '13)

Vouliagmeni, Athens, Greece
May 14-16, 2013

Published by WSEAS Press
www.wseas.org

Copyright © 2013, by WSEAS Press

All the copyright of the present book belongs to the World Scientific and Engineering Academy and Society Press. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the Editor of World Scientific and Engineering Academy and Society Press.

All papers of the present volume were peer reviewed by no less that two independent reviewers. Acceptance was granted when both reviewers' recommendations were positive.
See also: http://www.worldses.org/review/index.html

ISSN: 2227-4588
ISBN: 978-1-61804-184-5

RECENT ADVANCES in FINITE DIFFERENCES and APPLIED & COMPUTATIONAL MATHEMATICS

Proceedings of the 6th International Conference on Finite Differences, Finite Elements, Finite Volumes, Boundary Elements (F-and-B '13)

Proceedings of the 2nd International Conference on Applied and Computational Mathematics (ICACM '13)

Vouliagmeni, Athens, Greece
May 14-16, 2013

Editors:
Prof. Gabriela Mircea, West University of Timisoara, Romania.
Prof. Santoso Wibowo, CQU University, Australia.

Associate Editor:
Associate Prof. Nikos Bardis, Hellenic Military Academy, Greece.

Reviewers:
Yilun Shang
Roots Larissa
David Vallejo
Daniela Litan
Yixin Bao
Mohammadreza Sedighi
Sk. Sarif Hassan
Mihai Tiberiu Lates
Vassos Vassiliou
Vishnu Pratap Singh Kirar
Monica Ciobanu
Petras Rupšys
Konstantin Volkov
Dana Anderson
Alina Adriana Minea
Michaela Stanickova
Anca Croitoru
Suzana Arad
Yong Kheng Goh
Al Emran Ismail
Carla Pinto
Vasile Cojocaru
Alexandru Filip
David Nicoleta
Elena Scutelnicu
Morale Terry
Elena Zaitseva
Poom Kumam
Zanariah Abdul Majid
Maria Wenisch
Claudia-Georgeta Carstea
Avijit Maji
Yuqing Zhou
Calin Ciufudean
M. M. Noor
Majid Mohammed Ali
Anghel Vasile
Humberto Varum
Muhammet Koksal
Ioana Adrian
Mihaela Neamtu
Babak Khalili Hadad
Katerina Hyniova
Chao Wang
Matteo Palai
Gabriela Mircea
Emmanuel Lopez-Neri
Md. Shamim Akhter
Sorinel Oprisan
Kannan K.
Muhammad Naufal Mansor
U. C. Jha
Zakaria Zubi
Zahéra Mekkioui
Bhagwati Prasad
Hsien-Lun Wong Alan
Tsvetelina Draganova
Noor Fadiya Mohd Noor
Jose Manuel Mesa Fernández
Maria Dobritoiu
Gabriella Bognar
Ibrahim Canak
Dana Simian
Ehsan Kamrani
Huashui Zhan Zhan
Isaac Yeboah
Calbureanu Popescu Madalina Xenia
Snezhana Georgieva Gocheva-Ilieva
Pedro Nucci
Hamideh Eskandari

Preface

This year the 6th International Conference on Finite Differences, Finite Elements, Finite Volumes, Boundary Elements (F-and-B '13) and the 2nd International Conference on Applied and Computational Mathematics (ICACM '13) were held in Vouliagmeni, Athens, Greece, May 14-16, 2013. The conferences provided a platform to discuss finite differences, finite elements, finite volumes, boundary elements, linear algebra, numerical analysis, differential equations, probabilities, statistics, operational research, algorithms, discrete mathematics etc with participants from all over the world, both from academia and from industry.

Their success is reflected in the papers received, with participants coming from several countries, allowing a real multinational multicultural exchange of experiences and ideas.

The accepted papers of these conferences are published in this Book that will be sent to international indexes. They will be also available in the E-Library of the WSEAS. Extended versions of the best papers will be promoted to many Journals for further evaluation.

Conferences such as these can only succeed as a team effort, so the Editors want to thank the International Scientific Committee and the Reviewers for their excellent work in reviewing the papers as well as their invaluable input and advice.

The Editors

Table of Contents

Keynote Lecture 1

Direct Power Series for Multivaried Functions: Welcome to the Charming World of Kronecker Product

Professor Metin Demiralp
Istanbul Technical University
Informatics Institute
Istanbul, TURKEY
E-mail: metin.demiralp@gmail.com

Abstract: Multivariance is plague of plethora for applied mathematical or linear algebraical applications. For multivariate functions which are analytic in a region of the Cartesian product of its variables' complex planes, Taylor and/or Maclaurin series can be perhaps the most universal tools even though some other more generalized function series and the sums composed of finitely many terms like in high dimensional model representation (HDMR) or enhanced multivariance product representation (EMPR) can also be used to this end. However, the formulae in these types of approaches contain many indices and complicated structures for practical utilizations despite they may be considered worth of theoretical approaches like theorem proofs. Hence, to find a way for conciseness gains a lot of importance.

Perhaps the most prominent preference for the conciseness is the use of Kronecker power of vectors and/or matrices in ordinary linear algebra. Kronecker power is somehow a specific form a more general and rather abstract operation, direct product. We generally use the phrase "Direct Product" and "Kronecker Product" equivalently in linear algebra. Multiple products of a unique entity is called either "Kronecker Power", or equivalently, "Direct Power". Multivariate Taylor or Maclaurin series can be concisely represented in Kronecker powers of a state vector composed of independent variables with certain matrix coefficients. The matrix type of each term should be same even though the number of elements in state vector's Kronecker powers changes from summand to summand. Hence the type of the each coefficient matrices from summand to summand should change to conserve the type of each summand.

We have recently developed a more general theory to solve the set of ODEs by using an infinite complete basis set of functions over unknowns. This led us to a denumerably infinite set of autonomous and homogenous ODEs. The infinite constant coefficient matrix is called "Evolution Matrix" because of its responsibility for the evolution of the system described by the original ODE set. We revealed that the initial infinite vector is composed of blocks which are indinvidually different Kronecker powers of a unique initial vector of finitely many elements. However, the constructed infinite ODE set does not need to have such a restrictive initial vector. It can be composed of completely different elements. This implies that the initial vector elements can be expressed of expectation values of certain Kronecker power blocks. Therefore initial vector definition may bring the probability concept to the theory. For this reason, we called this new concept "Probabilistic Evolution Approach (PEA)".

PEA uses the Kronecker powers of certain vectors and their Kronecker products with some matrices and/or vectors. Despite the assistive properties of the Kronecker powers the formulae in PEA may necessitate further simplifications and shorthands to facilitate the analysis and its applications. To this end various properties of the Kronecker powers can be used. This talk focuses on this issue involving some original findings also.

Brief Biography of the Speaker: Metin Demiralp was born in Türkiye (Turkey) on 4 May 1948. His education from elementary school to university was entirely in Turkey. He got his BS, MS degrees and PhD from the same institution, ˙Istanbul Technical University. He was originally chemical engineer, however, through theoretical chemistry, applied mathematics, and computational science years he was mostly working on methodology for computational sciences and he is continuing to do so. He has a group (Group for Science and Methods of Computing) in Informatics Institute of ˙Istanbul Technical University (he is the founder of this institute). He collaborated with the Prof. Herschel A. Rabitz's group at Princeton University (NJ, USA) at summer and winter semester breaks during the period 1985-2003 after his 14 month long postdoctoral visit to the same group in 1979-1980. He was also (and still is) in collaboration with a neuroscience group at the Psychology Department in the University of Michigan at Ann Arbour in last three years (with certain publications in journals and proceedings).

Metin Demiralp has more than 100 papers in well known and prestigious scientific journals, and, more than 230 contributions together with various keynote, plenary, and, tutorial talks to the proceedings of various international

conferences. He gave many invited talks in various prestigious scientific meetings and academic institutions. He has a good scientific reputation in his country and he was one of the principal members of Turkish Academy of Sciences since 1994. He has resigned on June 2012 because of the governmental decree changing the structure of the academy and putting politicial influence possibility by bringing a member assignation system. Metin Demiralp is also a member of European Mathematical Society. He has also two important awards of turkish scientific establishments.

The important recent foci in research areas of Metin Demiralp can be roughly listed as follows: Probabilistic Evolution Method in Explicit ODE Solutions and in Quantum and Liouville Mechanics, Fluctuation Expansions in Matrix Representations, High Dimensional Model Representations, Space Extension Methods, Data Processing via Multivariate Analytical Tools, Multivariate Numerical Integration via New Efficient Approaches, Matrix Decompositions, Multiway Array Decompositions, Enhanced Multivariate Product Representations, Quantum Optimal Control.

Plenary Lecture 1

Mathematical Models for Analogical Reasoning

Professor Michael Gr. Voskoglou
School of Technological Applications
Graduate Technological Educational Institute (T. E. I.)
Patras, Greece
E-mail: voskoglou@teipat.gr

Abstract: Analogical Reasoning (AR) is a method of processing information that compares the similarities between new and past understood concepts, then using these similarities to gain understanding of the new concept. The basic intuition behind AR is that when there are substantial parallels across different situations there are likely to be further parallels. AR is ubiquitous in human cognition. Analogies are used in explaining concepts which cannot directly perceived (e.g. electricity in terms of the water flow), in making predictions within domains, in communication and persuasion, etc. Within cognitive science mental processes are likened to computer programs (e.g. neural networks) and such analogies serve as mental models to support reasoning in new domains. AR is important in general in creativity and scientific discovery.
Several studies (Holyoak 1985, Genter & Toupin 1986, Novick 1988, Genter & Markman 1997, etc) have provided detailed models for the process of AR which are broadly consistent with reviews of problem solving strategy training studies, in which factors associated with instances of successful transfer – that is, use of already existing knowledge to produce new knowledge - are identified. According to these studies the main steps involved in AR include:
• Representation of the target problem.
• Search-retrieval of a related past problem.
• Mapping of the representations of the target and the related problem.
• Adaptation of the solution of the related problem for use with the target problem.
In this work we develop two mathematical models for the description of the process of AR: A stochastic model by introducing a finite ergodic Markov chain on the steps of the AR process and a fuzzy model by representing the main steps of the AR process as fuzzy subsets of a set of linguistic labels characterizing the individuals' performance in each of these steps. The two models are compared to each other by listing their advantages and disadvantages. Experiments are also performed to illustrate their use in practice.

Brief Biography of the Speaker: Michael Gr. Voskoglou (B.Sc., M.Sc., M.Phil. , Ph.D. in Mathematics) is a Professor of Mathematical Sciences at the Graduate Technological Educational Institute of Patras, Greece. He has also taught at the Hellenic Open University, at the Mathematics Department of the University of Patras, at TEI of Messolonghi, etc. As a visiting professor he has taught in M.Sc. courses of the department of Operational Mathematics at the University of Applied Sciences in Berlin and of the School of Management at the University of Warsaw, while he worked for 3 years (1997-2000) as a post doctoral researcher in the Bulgarian Academy of Sciences in Sofia (under sabbatical).
He is the author of 8 books (7 in Greek and 1 in English language) and of more than 260 papers published in reputed journals and proceedings of conferences of 22 countries in 5 continents, with many references from other researchers.
He is also the Editor in Chief and publisher of the "International Journal of Applications of Fuzzy Sets" (e-journal), reviewer of the American Mathematical Society and member of the Editorial Board or referee in several mathematical journals.
His research interests include Algebra, Fuzzy Sets, Markov Chains and Mathematics Education.

Plenary Lecture 2

Optimal Control of Dynamic Stochastic Systems: Some Mathematical and Computational Approaches

Professor Reinhard Neck
Department of Economics
Alpen-Adria Universität Klagenfurt
Klagenfurt, Austria
E-mail: Reinhard.Neck@uni-klu.ac.at

Abstract: In this paper, we give an introductory overview of the theory of optimal control of dynamic stochastic systems in discrete time. We emphasize the fact that, in spite of considerable work done on the mathematics of such systems, only very few analytical results for special cases are available. In particular, a full solution taking into account the dual effect of optimizing controls is impossible even for very simple problems with one state and one control variable. Therefore one has to resort to numerical approximations when attempting to solve such dynamic optimization problems. We next consider a class of stochastic control problems investigated intensively in the economics literature, which are characterized by a quadratic intertemporal objective function. Such systems often arise in macroeconomic policy problems, in particular in problems of quantitative macroeconomic policy. We survey some of the literature on these problems and discuss the relative advantages and shortcomings of available algorithms for approximating solutions to optimal control problems of this type. Recent work by the presenter and his collaborators is briefly described and illustrated with an application to a macroeconomic policy problem for Slovenia.

Brief Biography of the Speaker: Reinhard Neck was born in 1951 in Vienna, Austria. He received a PhD in statistics and economics from the University of Vienna and the habilitation from the Vienna University of Economics and Business Administration. He was assistant professor at the University of Fribourg, Switzerland and the Vienna University of Economics and Business Administration, Schumpeter Research Fellow at Harvard University, Cambridge, MA, USA, Full Professor of Economics at the Universities of Bielefeld and Osnabruck, Germany, and Austrian Visiting Professor at Stanford University, Stanford, CA, USA. Since 1997, he is Full Professor at the Department of Economics, Klagenfurt University, Klagenfurt, Austria, where he is now Head of Department. 2007 and 2008, he was President of the Austrian Economic Association. At present, he is Chairman of the Austrian Science Society and Vice President of the International Atlantic Economic Society. Neck has edited and co-authored more than 30 books and authored or co-authored more than 270 papers in scientific journals and collective volumes.

Plenary Lecture 3

Dynamical Analysis of a Nutrient Limited Delayed Model of Drug Resistance

Professor Yongwimon Lenbury
co-author: Pailin Chayapham
Department of Mathematics
Faculty of Science
Mahidol University
Bangkok, Thailand
E-mail: scylb@yahoo.com

Abstract: Development of resistance to drugs is a well recognized medical complication arising from prolonged drug use leading to serious side effects and causing great harm to the patient as well as grave concern on the part of the physicians in charge. In this work, we consider a model of the dynamic interaction between sensitive and resistant strains of pathogens in a nutrient limiting environment. A delay in the process of conversion from a sensitive strain to a resistant strain is taken into account. Impulsive drug treatments or external intervention is also incorporated, resulting in an impulsive system of nonlinear differential equations with delay. The system's stability and persistence are investigated. Moreover, attention is paid to the possibility of periodic behavior in the system of interest.

Brief Biography of the Speaker: After Professor Yongwimon Lenbury obtained her Ph.D. in Mathematics from Vanderbilt University, USA, she returned to the Department of Mathematics, Faculty of Science, Mahidol University to teach, and conduct research in dynamical modeling of nonlinear systems in biology and medicine. She was appointed professor of Mathematics in 1996. Prof. Lenbury has been involved in research work in the field by Mathematical Modelling and Nonlinear Systems in Biology and Medicine. Her work involves dynamical modelling and analysis of nonlinear systems such as food chains coupled by parasitic infections, hormone secretion systems in the human body, and so on. Of particular interest are the pacemaker oscillations and rhythmogenesis in human mechanism which have been proposed as a way to differentiate sickness from health. For example, some of her works involves the construction and analysis of a model for insulin kinetics and the identification of oscillatory behavior subject to various feeding regimens. Her recent interest has been concentrated in the signal transduction system involving GPCR, a major drug target. She received an award from the National Research Council as the Outstanding Researcher in the field of Physical Science in the year 1998. Her continued achievements have resulted in her being granted the prestigious position of Senior Researcher of the Thailand Research Fund in Mathematics, 2000-2002 and a Fellow of the Royal Institute of Thailand. Collaborating with several researchers in various countries such as the United States, Germany, Italy, and New Zealand, Prof. Lenbury has been devoted to the promotion of research and education in the field of Mathematics in Thailand.

Plenary Lecture 4

Artificial Neural Networks Applications in Different Scientific Areas

Associate Professor Silviya Popova
Institute of Systems Engineering and Robotics
Department of Bioengineering
Bulgarian Academy of Sciences
Bulgaria
E-mail: Popova_Silvia2000@yahoo.com

Abstract: Artificial neural networks (ANN) as an innovative approach have greatly enhanced the opportunities for analysis and treatment of information in different scientific and engineering areas. The great advantage of ANN is that they impose less restrictive requirements with respect to the available information about the character of the relationships between the processed data, the functional models, the type of distribution, etc. They provide a rich, powerful and robust non-parametric modeling framework with proven efficiency and potential for applications in many field of science. The advantages of ANN encouraged many researchers to use these models in broad spectrum of real-world applications. In some cases, the ANNs are a better alternative, either substitutive or complementary, to the traditional computational schemes for solving many engineering problems.
The purpose of this plenary talk is to present some examples of various applications of the ANNs for different purposes in the area of biotechnology, ecology, geosciences, metallurgy, etc. The examples from my research are as follow: Modelling and control of a biotechnological process; Forecasting of the daily sea level from tide gauge data; Air pollution nowcasting; Classification of yeast cells; Parameters' identification of the linear state space model; Gap filling in time series; Optimization of steel alloys.

Brief Biography of the Speaker: Silviya Popova received her M.Sc. degree in mathematics (Real and Functional Analysis) from the University of Sofia, Bulgaria, and a Ph.D. from the Institute of Control and System Research of the Bulgarian Academy of Science. Silviya Popova habilitated in 2003 as Associate Professor in "Application of the Principles and Methods of Cybernetics in Different Areas of Science".
Assoc. Prof. Popova currently works at the Institute of Systems Engineering and Robotics of the Bulgarian Academy of Science. Her research interests include: modelling of biotechnological processes, state and parameters estimation of biotechnologycal processes, neural networks, image processing. She has been awarded with five fellowships in the Czech Republic, Germany and Sweden, and has presented several lectures on topics of the ANN applications in the United Kingdom, France and Slovenia as a part of the ERASMUS programme.
Assoc. Prof. Popova has more than 25 publications in highly rated ISI journals (14 with IF), over 40 publications in scientific international conferences, over 50 citations. She took part as a principal investigator in more than 20 scientific projects.

Plenary Lecture 5

Designing Robust and Reliable Communication and Sensor Networks with Intrusion Detection against Cyberattacks

Professor Demetrios Kazakos
Texas Southern University
USA
E-mail: demetrios114@yahoo.com

Abstract: Cybersecurity and the development of secure and dependable communication and sensor networks is a major objective for both civilian and military systems. There are two types of threat that are considered in this proposal: The first type is the cyberthreat, based on cyberattacks and software based approaches. One of the thrusts of this effort is to advance the use of statistical methodology to model cyberattacks by viewing them as abrupt changes in traffic patterns. The first step is an efficient modeling approach of all Internet and Wireless Communication traffic, using all existing models. Such approaches have been effective, but there is a need to advance the state of the art, making them more sophisticated and flexible to respond to changing cyberthreat forms. A second issue is the allocation of decentralized monitoring resources for effective coverage of an existing large network of sensors or communication devices.(This includes both wired and wireless links). In this talk we discuss the use and advances of the novel approach of using statistical tools of decentralized fastest change detection as a building tool of a theoretical and practically implementable intrusion detection system. This research has been conducted at Texas Southern University during the past 3-4 years.

Brief Biography of the Speaker: Dr Demetrios Kazakos received his Diploma in Electrical and Mechanical Engineering from the National Polytechnic University of Greece. He then started graduate his graduate studies in the United States. He received a Master of Arts degree in Electrical Engineering from Princeton University and a Doctor of Philosophy degree from the University of Southern California, specializing in Statistical Communication Theory.
In 1980, he joined the Electrical Engineering Department of the University of Virginia,where he stayed until 1993.
In 1992, he was elevated to the grade of Fellow of IEEE, for his research in two areas: Enhanced Algorithms for Multiuser Multiaccess Networks and Statistical Pattern Recognition. In 2009, he was elevated to the grade of IEEE Life Fellow.
In 1993 he accepted the position of Head of the Electrical and Computer Engineering of the University of Southwestern Louisiana. At the same time he has always been a very active participant in IEEE conference organizing and editorial activities. He was Editor of the IEEE Transactions on Communications for 5 years, Technical Program Chair for two major IEEE Conferences, and member of the Technical Program Committee for several IEEE and other conferences.
In 1983 he started a new company named HITEC, INC, which undertook several Research and Development projects in Information Technology, funded by the U.S. Department of Defense and the European Community.
In 2001, he undertook the position of Professor and Chair of the Electrical Engineering and Computer Science Department at the University of Toledo. In 2004, he moved to the University of Idaho, as Professor and Chair of the Electrical and Computer Engineering Department.
From 2006 to 2008, he was Dean of the College of Science and Technology at Texas Southern University. From September 2009 to September 2011, he was at the National Science Foundation in the position of Program Director responsible for the Program: “Centers of Research Excellence in Science and Technology”.
Overall, he has published about 165 refereed journal papers, book chapters and conference proceeding papers, as well as two books.

Simply PID Equations for Liquid Level Tuning

SUPPACHAI HOWIMANPORN, SASITORN CHOOKEAW
Department of Electrical Engineering, Faculty of Industrial Education
Rajamangala University of Technology Phra Nakhon, Thailand
399 Sansean, Wachirapayaban, Dusit, Bangkok, 10300
THAILAND
Suppachaiyo@hotmail.com, Nangfa1_edt@hotmail.com

Abstract: - This paper presents the study of the water level control using Proportional, Integral and Derivative (PID) controller. Typically, water level controlled by a motor is non-linear. This paper emphasizes to solve this issue for special precision such as blooding medication, liquid feeding for patients and so on. To determine optimally mathematical models for controlling a DC motor, we are able to control the level using eliminating some errors via PID controller. The importance of PID controller bases on the constant of mathematical models. As experimental results, the constants of the proportional gain (K_p), the integral gain (K_i) and the derivative gain (K_d) were adjusted to maintain the water level and divert to a normal linear function. It is very useful for a medical technician to easily understand the best treating optimization. The experimental results show that the water level control using the PID is appreciated for designer controller. Then the control of the water level control was successfully accomplished. In additional, our experiments were corresponded with physic theories. The design in the computer simulation and experiments also validated the correctness of the theoretical analysis and the rightness of the computer simulation.

Key-Words: - Water Level Control, Proportional integral derivative Controller

1 Introduction

PID controller has been proposed for more than fifty years, it has many advantages over traditional method. It can be used to be linear systems and nonlinear systems, it also could be applied for continuous systems and discrete systems, in the sliding mode, it is robust to outer interferences, it is this unique characteristic that the control method is used to design control system in the field of machinery, robotics, aeronautics and astronautics. This paper is organized as follows: combining three controllers of the flowing force of the water level plant and viscous moment of the hinge are considered. The traditional on-off controller was proposed the simulation and was performed under the MATLAB/SIMULINK program. The PID controller is aimed to propose and then it is also verified by simulation under the same environment. Finally, the comparison between the on-off control and PID controller concluded that some issues need to be solved exactly

2 Tank level

Water level control is one of the most important plants in the science and industrial technology. For instance, rockets, robotics can be considered as water level control, it has many common typical features of nonlinear systems. The design of the control system is the important issue in the control system field, there are many control laws that proposed, such as law, adaptive control law, fuzzy law and even neural network law. Consequently, PID controller is enough for the paper.

Considering a simple to control water level plant PID equation is defined by objectives of stabilized water level control in the unstable water level by an input torque of a motor. Also known as, under the assumption that may be selected constant controller. In a real system, this torque is developed by a DC motor whose equation is: where is the motor current, K_n, K_m are DC motor parameters and u is the supply voltage to the motor.

ISBN: 978-1-61804-184-5

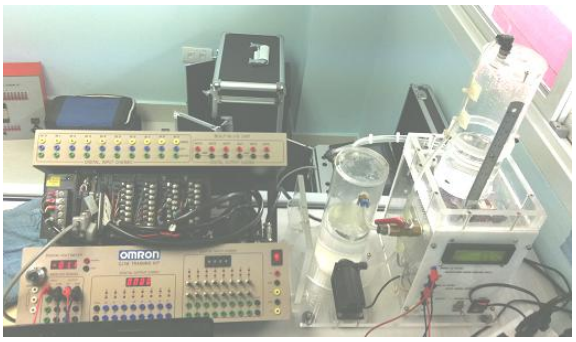


Figure1. Setup water level control plant

.

3 Controller Design

Proportional, Integral and Derivative The aim is to maintain water level on the motor driven. Level of water is steered to different flow level which is sensed by a sensor reference signal. PID is a closed-loop control of water level using proportional and derivative terms. The term "closed-loop" stands for a continuous status feedback given to the controller. The PID control law is generally of the form

$$u(t) = K_p.e(t) + K_d \frac{d}{dt} e(t) \qquad (1)$$

where e is the system error between the desired and actual outputs, u is the control force, K_p is the proportional gain, K_i is Integral gain and K_d is the derivative gain.

PID controller is one type of robustness algorithm that after nonlinear system by application of a high frequency switching controls. Consider the following dynamical system a turning optimal parameter control

PID controller theory appeared in conjunction with systems being described by differential equations with discontinuities such as variable structure or relay systems. Consider the state-space of an n-dimensional affine system with m-dimensional vector Sliding mode may occur in the intersection of m surfaces. Using discontinuous control in enforcing sliding modes results in order reduction, decoupling and simplification of the design methodology The design procedure should consist of selecting the PID controller in order to design the desired dynamics of the water level control equation and finding a such as that the state reaches the design of control for systems given by Figure3

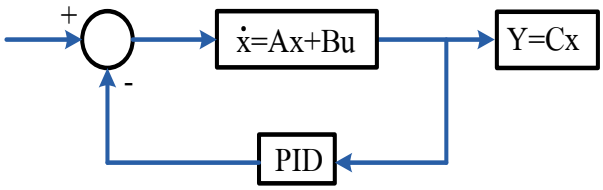


Fig. 2 Block diagram PID controller

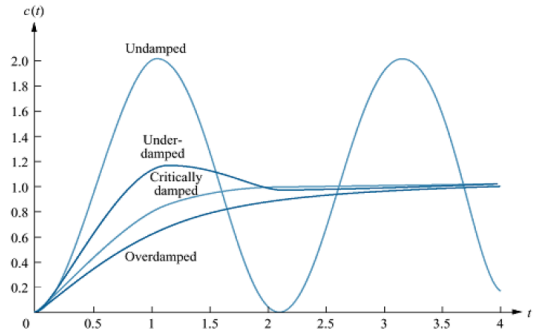


Figure3. Natural frequency response

4 Experimental Results

Figure 4-7 present the experimental results sensitivity responses measure with P, PI_1, PI_2, PD, PID controller

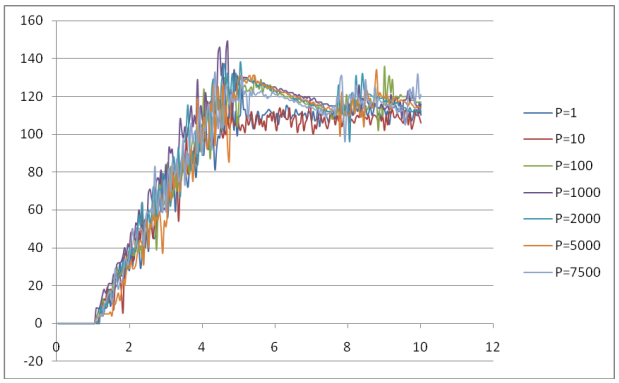


Figure 4. Sensitivity responses measurement (P)

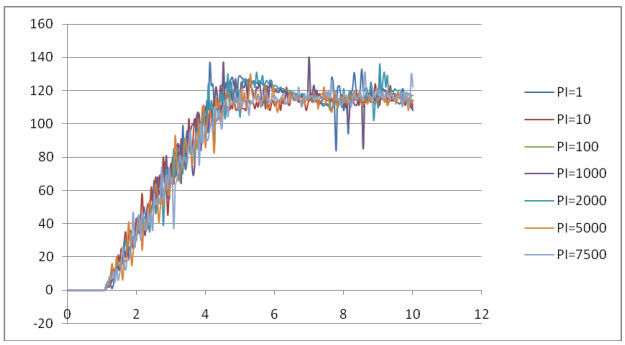


Figure 5. Sensitivity responses measurement (PI_1)

ISBN: 978-1-61804-184-5

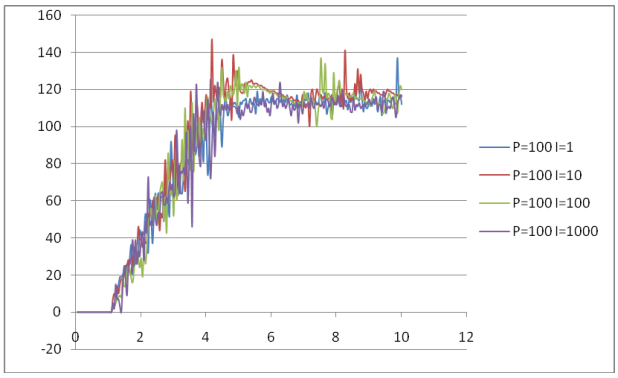


Figure 6. Sensitivity responses measurement (PI_2)

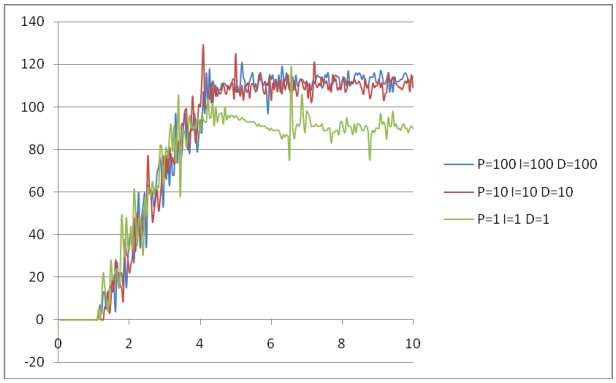


Figure 7. Sensitivity responses measurement (PID)

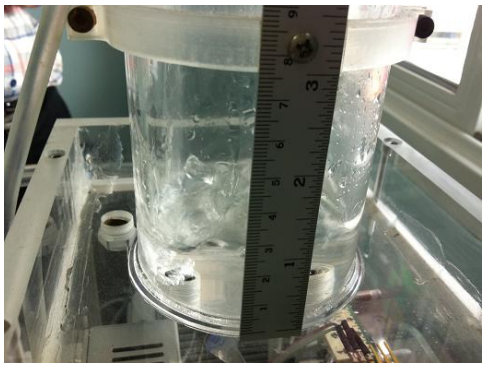
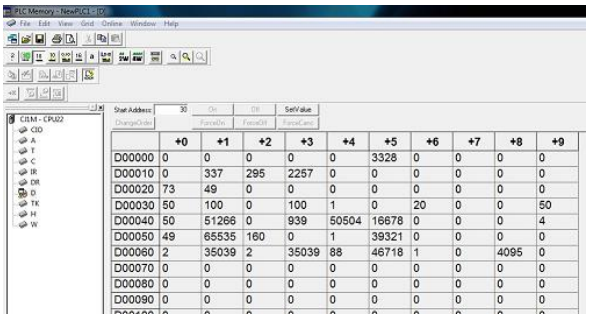


Figure 8. Experimental water level control



	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
D00000	0	0	0	0	0	3328	0	0	0	0
D00010	0	337	295	2257	0	0	0	0	0	0
D00020	73	49	0	0	0	0	0	0	0	0
D00030	50	100	0	100	1	0	20	0	0	50
D00040	50	51266	0	939	50504	16678	0	0	0	4
D00050	49	65535	160	0	1	39321	0	0	0	0
D00060	2	35039	2	35039	88	46718	1	0	4095	0
D00070	0	0	0	0	0	0	0	0	0	0
D00080	0	0	0	0	0	0	0	0	0	0
D00090	0	0	0	0	0	0	0	0	0	0

Figure 9. Experimental constant parameter

4 Conclusion

In this paper present to the water level control problem due to signal nonlinear, we present PID controller laws: The traditional On-Off control cannot solve that. The experimental results show that the water level control using the PID is appreciated for designer controller. Then the control of the water level control was successfully accomplished under the same Experiment environment shows that P, PI_1, PI_2, PD, PID were superior over the traditional On-Off in the static errors and robustness when perturbations is applied to systems. The design in the computer simulation and experiments also validated the correctness of the theoretical analysis and the rightness of the computer simulation

References:

[1] Fujiwara , Kouji Matsumoto, Hideyuki Nishida Jun Ando, Masato Kawaura, “Development of PSO-based PID TuningHarris, T.J., 1989. Assessment of control loop performance. Can. J. Chem. Eng. 67, 856–861

[2] Astrom, K., Hagglund, T., Hang, C., Ho, W., 1993. Automatic tuning and adaptationfor PID controllers—a survey. Control Eng. Prac. 1, 699–714

[3] T. K. Teng, J. S. Shieh, C. S. Chen, “Genetic algorithms applied in online auto tuning PID parameters of a liquid-level control system”, Transactions of the Institute of Measurement and Control 2003; 25:433

[4] Chengwei Li, Jiandong Lian, “The Application of Immune Genetic Algorithm in PID Parameter Optimization for Level Control System”.

[5] Method”, International Conference on Control, Automation and Systems 2008 Oct. 14-17, 2008 in COEX, Seoul, Korea

[6] Akihiro Oi, Chikashi Nakazawa, Tetsuro Matsui, Hiroe

ISBN: 978-1-61804-184-5