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Mathematical Models in Engineering & Computer Science

Proceedings of the 4th International Conference on Mathematical Models for Engineering Science (MMES '13)

Proceedings of the 2nd International Conference on Computers, Digital Communications and Computing (ICDCC '13)

Brasov, Romania, June 1-3, 2013

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Plenary Lecture 1

Estimating Fuel Consumption for Station-Keeping in the Moons of the Solar System

Professor Antonio Fernando Bertachini de Almeida Prado
Space Dynamics and Control Division
National Institute for Space Research (INPE)
Brazil
E-mail: prado@dem.inpe.br

Abstract: The present research uses a new idea to map the space around celestial bodies as far as perturbations are considered. In particular, this idea can be used to estimate the fuel consumption in maneuvers of station keeping around celestial bodies. The main point is based in the integral over the time of the perturbing forces. This quantity is a measurement of the total effect of the perturbations received by the spacecraft, which would be the variation of velocity that an engine should deliver to keep the orbit of the spacecraft Keplerian all the time. This integral is a characteristic of the trajectory of the spacecraft and the perturbations considered. It is not related to the type of engine and control technique used for the real station keeping maneuver. The principle used to make this calculation is that, when this quantity becomes larger, more maneuvers are required to compensate the perturbations and so more consumption of fuel is required. This idea can be applied to any dynamical system. In the present paper, as an example, the third body perturbation is considered. Numerical simulations considering the effects of the Sun and the main planet in orbits around several moons of the Solar System are considered.

Brief Biography of the Speaker: Dr. Antonio Fernando Bertachini de Almeida Prado has 25 years of experience in research and educational activities in the aerospace field. He has published more than 100 papers in journals and scientific events around the world and has more than 1000 citations in the scholar google. He obtained five academic degrees: Ph.D. (1993) and Master (1991) in Aerospace Engineering from the University of Texas at Austin (USA), Master in Space Science/Orbital Mechanics (1989) from the National Institute for Space Research (INPE) in Brazil, BA in Physics (1986) and Chemical Engineering (1985) from São Paulo University in Brazil.
He is currently President of the Board of the Graduate School at the National Institute for Space Research (INPE) in Brazil, position that he has since December 2008. He is also professor at the same institute, where he has participated in over 50 classes in more than 15 different subjects related to Astrodynamics, Celestial Mechanics and Control of Spacecrafts for seven years.

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Plenary Lecture 2

Application of Combined Model of Continuum and Discrete Fractures for Groundwater Problems with Field Data

Associate Professor Milan Hokr
Institute for Nanomaterials, Advanced Technologies and Innovation
Technical University of Liberec
Liberec, Czech Republic
E-mail: Milan.hokr@tul.cz

Abstract: Modelling of the groundwater flow and solute transport in fractured rock is one of the challenges for numerical solution in the last decades. It is important for many engineering application of the underground – water resources, geothermal energy, mining, underground construction, or waste storage. One of the greatest problems of such a rock modeling is to represent inhomogeneities that can differ in scale from small micro-cracks to faults of kilometers' length. The complexity of the problem increases when there are excavations in the rock, with its size different from a fracture scale or a problem scale. The multidimensional (hybrid) model is based on combination of standard approaches for fractured rock – the equivalent continuum and the discrete fracture network. Numerical solution of such the problem represented with coupled 3D, 2D, and 1D subdomains is implemented in quite few of the established groundwater simulation codes. The solution with mixed-hybrid finite element method and its implementation in the open-source simulation code Flow123D will be presented. The second part of the talk is focused on practical examples of work with field data. Preprocessing of model geometry and discretisation is presented as several options for use of standard GIS and CAD programs and own problem-suited programs. Then problems of the deep tunnel inflow are solved – the model is calibrated to fit the measured water inflow rate separately from the conductive fractures (2D planes) and less conductive rock (3D volume), with use of an inverse problem solver. The results are confirmed by the tracer transport model (advection), calibrated against independently obtained data from natural tracers – estimation of travel time between the terrain surface and the tunnel.

Brief Biography of the Speaker: M. H. obtained the M.Sc. (Ing.) degree at the Czech Technical University (Prague, Czech Reo.), Faculty of Nuclear Science and Physical Engineering, in "Mathematical Engineering" branch and the Ph.D. degree at the Technical University of Liberec (Czech Rep.), Faculty of Mechatronics and Interdisciplinary Engineering Studies, in the "Science Engineering" branch (2003). He obtained Assoc.prof. degree in the same place in 2007. His research interests are related with application of numerical methods for solution of the physical problems in subsurface – finite element and finite volume methods, coupled problems (density-dependent flow, thermo-hydro-mechanical), fractured rock conceptual models, inverse problems – currently with problems coming from the safety analysis of a deep geological repository of the spent nuclear fuel. The research includes also the field methods for data measurements. He is an author of more than 50 papers, including ISI-indexed journals (*). He works in international teams in projects focused on inter-comparison of different conceptual models and simulation codes, and on interpreting the field experiments with the models. He manages the teams of young researchers and Ph.D. students working in these problems.

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Plenary Lecture 3

Identification of the Historical Time Periods in Symbolic Music Data

Professor Michele Della Ventura
Department of Technology
Music Academy "Studio Musica"
Treviso, Italy
E-mail: dellaventura.michele@tin.it

Abstract: Despite the various studies on computer-aided musical analysis, there have been relatively few attempts at trying to locate, by means of analysis, a given melody within a certain stylistic period (Baroque, Classical, Romantic or Contemporary).
The main problem is that it is difficult to formalize a compositional style of a certain historical period. This study presents a model of analysis based on the theories of Warren Weaver and Claude Elwood Shannon, able to progressively explore the symbolic level of a melody, identifying the historical period on the basis of the information that it carries. The concept of information has already been used for several years now in linguistic analysis and it has also been applied to musical language. This approach was adopted on the melodic level, omitting concepts like tonality, modulation and moreover rhythm. The efficiency of the model was verified by analyzing a series of melodies by different authors and from different times (trying to range through the different compositional techniques by means of a unique analysis methodology) emphasizing both the strong points and the weak points of the approach.

Brief Biography of the Speaker: Michele Della Ventura defined his professional training, since high school, within the framework of two distinct areas of study: music and mathematics. He embarked on a course of study of the Pianoforte under the guidance of Donato Cuzzato, continuing then with Francesco Bencivenga under the guidance of whom he brilliantly graduated from the "A. Steffani" Conservatory of Music of Castelfranco Veneto in 1993. Concurrently to the music studies he graduated in technology disciplines with the highest honors and distinction, obtaining a scholarship, defending the thesis entitled "Study on the implementation of algorithms for the melodic operators in the symbolic text segmentation and conjoint evaluation of musical entropy". His dual formation, in Information Technology and music, drives him into carrying out research activities on the relation between Music and Mathematics, attending several seminars on the "Algebraic Formalization of Musical Structures" held by Moreno Andreatta (researcher at IRCAM in Paris) during which he achieves the algebraic formalization of the "Sechs Kleine Klavierstücke op. 19" by Arnold Schönberg. The development of education-related technologies draw him to focus his attention on the innovations of information technology associated to musical programming languages and to attend a Post-Graduate Master's Degree on E-Learning (E-Learning: methods, techniques and applications) at the University Tor Vergata of Rome, graduating from it with the highest marks with the thesis "Learning and new technologies". His research activity continues within the framework of computer-aided musical analysis, publishing articles and holding national and international conferences and seminars on "Music and new technologies". From 2000 he has been holding the position of consultant for various national and multinational public and private companies for which he has been developing specific software; he collaborates, as a consultant, to the realization of audio productions exclusively in the field of classical music. He combines his research and IT consultant activity with the position of Music informatics Professor at Music Academies and Conservatories and the position of Musical Technologies Teacher in High Schools specializing in Music.

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Plenary Lecture 4

Novel Human Detection and Tracking Solutions

Professor Tudor Barbu
Institute of Computer Science
Romanian Academy
Iasi, Romania
E-mail: tudbar@iit.tuiasi.ro

Abstract: Human detection and tracking represents a high-interest computer vision research field. It is the most important sub-class of the object detection and tracking domain and it has received a considerable interest over the last decade. Significant research has been devoted to detecting, locating and tracking people in digital images and videos, since numerous applications involve humans' locations and movements.
Person detection identifies the human presence in static images and videos, differentiating humans from non-human objects. Human tracking locates the instances of each detected person in the frames of the analyzed movie. Detecting humans in images and videos represents a challenging task, being complicated by numerous factors, such as: variable people appearance, camera position, wide range of poses adopted by persons, variations in brightness, illumination, contrast levels or backgrounds, and person occlusions.
Person detection domain includes important computer vision sub-domains, such as face detection or pedestrian detection. Numerous detection techniques have been developed in recent years. Thus, face detection has been approached through skin-based techniques and Boosting algorithms using Haar features. Pedestrian detection methods include those based on Histogram of Oriented Gradients (HOGs), Partial Least Square Analysis (PLSA) or BOOST algorithms. The most important tracking techniques are based on Kalman filtering, Active Contours and template matching. Pedestrian detection and tracking has important application areas, such as robotics, video surveillance and urban trafic monitoring.
We have proposed human detection and tracking solutions that outperform state-ofthe- art techniques. First, we developed robust human skin detection approaches, which were then used for both face and pedestrian detection processes. Our face detection techniques identifies those skin segments representing faces by applying some morphological operations or correlation procedures on them and checking if some certain conditions are met.
Also, novel pedestrian detection and tracking techniques that work successfully for static-camera video sequences are proposed. They use temporal-differencing algorithms for video object detection. Then, the identified objects are classified as human or non-human by using the previously detected skin regions and a set of conditions related to human body characteristics. Person tracking is performed through a template matching process applied to the detected human objects. The human matching process may use HOG-based features or normalized correlation-based procedures.

Brief Biography of the Speaker: Dr. Tudor Barbu is currently Senior Researcher II at the Institute of Computer Science of the Romanian Academy, in Iasi, Romania. He is the coordinator of the Image and Video Processing and Analysis research collective of the institute and also member of the leading Scientific Council of this institute. Mr. Barbu has a PhD degree in Computer Science, awarded by the Faculty of Automatic Control and Computers of the University “Politehnica” of Bucharest.
He has a remarkable research profile. In the last decade he published two books and four book chapters as single or main author. Also, Dr. Tudor Barbu published more than 70 articles in prestigious international journals and volumes of international scientific events (conferences, symposiums and workshops). His prolific scientific activity also includes more than 36 research reports, elaborated with the institute research team coordinated by him or related to various research projects. His scientific publications have got over 80 citations, according to Google- Academic. He was Invited Plenary Speaker at numerous international conferences.
In recent years he also coordinated various research directions in 6 projects based on contracts/grants. Dr. Tudor Barbu received also several awards for his research results, the most important being the Romanian Academy Prize “Gheorghe Cartianu”, in the Information Science and Technology domain, awarded on December 18, 2008. He is member of several conference scientific committees and also member of scientific and technical committee and editorial review boards of some journals. He is the Editor in Chief of a book. His main scientific areas of interest are: digital media (audio, video and image) signal processing and analysis, pattern recognition, computer vision, multimedia information storage, indexing and retrieval, partial differential equations (PDE) and biometric authentication using voice, face and digital fingerprint recognition.

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Plenary Lecture 5

Formalizing Nonfunctional Characteristics in Software Architecture – A Way to Achieve System Dynamism

Associate Professor Aleksandar Dimov
Department of Software Engineering
Faculty of Mathematics and Informatics
University of Sofia "St. Kliment Ohridski"
Bulgaria
E-mail: aldi@fmi.uni-sofia.bg

Abstract: Software architecture is widely accepted as a key mean to achieve reusability and understandability about complex software intensive systems. Moreover recent trends in the area recognize that architecture could also serve as a way to attain autonomous computing, i.e. dynamic change into a running software system without human intervention. There exist numerous fundamental ways to achieve dynamism in software architectures – constructive, adaptive and intelligent dynamism. Most of approaches follow the proposed by IBM in 2002 autonomic software architecture. Main layer in dynamic software architecture is represented by the so-called autonomic managers – specific software modules that manage other software components using a control loop. We present a brief overview of the decision algorithms for autonomous manager implementation and argue that a promising way is to implement such algorithms based on nonfunctional characteristics of software system and its building blocks. Non-Functional Characteristics (NFC), also known as quality parameters are used to define additional constraints and requirements on how software should perform its functionality. In this respect in order to implement dynamic software architecture it is of great importance to study and acquire better knowledge of formal description of NFC in software architectures. However, most of these characteristics are not well studied in software engineering nowadays. Even most of them are not formalized. Even a quick glance in one of the best studied NFC, namely – software reliability, show that reliability modeling techniques are very difficult to apply in practice and hence in analyzing and designing dynamic architectures. The conclusion of this talk is that research in formalization of NFC is one of the key factors for future software engineering.

Brief Biography of the Speaker: Aleksandar Dimov, PhD is an associate professor in Software Engineering and Software Architecture at the Sofia University “St. Kl. Ohridski” in Bulgaria. He received and MsC degree in Automation and Control theory at the Technical University of Sofia in 2001. He got his PhD degree in 2006 in topic of Software Architecture and further in 2009 continued with one year post doctoral research at the School of Innovation and Design at Mälardalen University in Sweden.
His main research interests include Quality characteristics of software systems; Software reliability; Embedded software systems; Software architectures; Formal modelling of software systems; Service-oriented architecture and Cloud computing. Aleksandar Dimov has published more than 50 papers in various areas of Software Engineering, including modeling of software architecture, software reliability and etc.

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