NORTH ATLANTIC UNIVERSITY UNION

Editors
Nikos Mastorakis
Dana Simian
Valeriu Prepelita

Recent Advances in Systems Science & Mathematical Modelling

- Proceedings of the 3rd International Conference on Mathematical Models for Engineering Science (MMES '12)
- Proceedings of the 3rd European Conference of Systems (ECS '12)

Paris, France, December 2-4, 2012

ISBN: 978-1-61804-141-8

Recent Advances in Systems Science & Mathematical Modelling

RECENT ADVANCES in SYSTEMS SCIENCE and MATHEMATICAL MODELLING

Proceedings of the 3rd International Conference on Mathematical Models for Engineering Science (MMES '12)

Proceedings of the 3rd European Conference of Systems (ECS '12)

Paris, France
December 2-4, 2012

Published by WSEAS Press
www.wseas.org

ISBN: 978-1-61804-141-8

RECENT ADVANCES in SYSTEMS SCIENCE and MATHEMATICAL MODELLING

Proceedings of the 3rd International Conference on Mathematical Models for Engineering Science (MMES '12)

Proceedings of the 3rd European Conference of Systems (ECS '12)

Paris, France
December 2-4, 2012

Published by WSEAS Press
www.wseas.org

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.

ISBN: 978-1-61804-141-8

North Atlantic University Union

RECENT ADVANCES in SYSTEMS SCIENCE and MATHEMATICAL MODELLING

Proceedings of the 3rd International Conference on Mathematical Models for Engineering Science (MMES '12)

Proceedings of the 3rd European Conference of Systems (ECS '12)

Paris, France
December 2-4, 2012

Table of Contents

ISBN: 978-1-61804-141-8

ISBN: 978-1-61804-141-8

ISBN: 978-1-61804-141-8

ISBN: 978-1-61804-141-8

Plenary Lecture 1

Handling the Boundary and Transmission Conditions in Some Linear Partial Differential Equations

Professor Franck Assous
Dept of Maths & Comput. Sc.
Ariel University Center
40700, Ariel, Israel
also with:
Bar-Ilan University
52900, Ramat-Gan, Israel
E-mail: franckassous@netscape.net

Abstract: The efficient numerical treatment of boundary conditions is constantly an interesting subject that can have many applications. These conditions can be treated as essential boundary conditions or for instance, by introducing Lagrange multipliers. Another approach which is of interest is related to the Nitsche Method. Several years ago, J. Nitsche introduced a way to impose weakly essential boundary conditions in the scalar Laplace operator. In this talk, we propose first a review of this approach for the Laplace problem. Then, we introduce a generalization of the Nitsche formulation to some linear partial differential equations. For example, we will consider the Maxwell equations for electromagnetic fields, where the boundary conditions involved are related to the tangential and the normal trace of the electromagnetic field. We will also consider the equations of elasticity. We will propose a variational formulation for easily handling interface conditions in multilayer material. In each case, numerical results will be shown to illustrate the method.

Brief Biography of the Speaker:
Prof. Franck Assous received a Ph.D. degree in Applied Mathematics from the University of Paris (France). He then received the French "Habilitation a Diriger les Recherches" degree from the University of Toulouse (France). He worked more than 14 years at the Atomic French Agency (CEA) as a senior researcher. In parallel, he was teaching at the ENSTA School of Engineers (Paris) as an Assitant Professor, then at the Versailles University as an Associate Professor. He is currently working in Israel, where he is Professor of Applied Mathematics at the Ariel University Center (Israel), and at the Bar-Ilan University (Israel). His research project include numerical methods for Partial Differential Equations, with a particular interest for problems arising from models in the field of computational electromagnetism, plasma physics, elasticity. He is also interested in inverse problem in wave propagation problems.

ISBN: 978-1-61804-141-8

Plenary Lecture 2

Optimization Method based on Genetic Algorithms using Parameterized Active Schedules for Project Scheduling with Limited Resources

Professor Jorge Magalhaes-Mendes
Department of Civil Engineering
ISEP - Institute of Engineering
IPP - Polytechnic of Porto
Rua Dr. Antonio Bernardino de Almeida
431 – 4200-072 Porto
PORTUGAL
E-mail: jjm@isep.ipp.pt

Abstract: A project can be depicted by a graph where the activities are numerically numbered. Associated with each activity is a set of possible durations with specific resource requirements. If resources are available in limited quantities each time period, the resources are considered renewable (e.g., machines or manpower).
As the number of project activities increases and thus the complexity of their sequential ordering, the need for organized planning and scheduling increases too. This need further increases when a large number of project activities are considered relative to the uniqueness of each construction project in terms of the dynamic plant and nonstandardized nature of the work. So, finding feasible schedules which efficiently use scarce resources is a challenging task within project management.
This type of problem belongs to the class of NP-hard optimization problems, therefore justifying the indispensable use of heuristic or metaheuristic solution procedures when solving large problem instances.
The optimization methods presented combines genetic algorithms and a schedule generator scheme which generates parameterized active schedules. The chromosome representation of the problem is based on random keys. Parameterized active schedules are constructed using a priority-rule heuristic in which the priorities of the activities are defined by the genetic algorithm.

Brief Biography of the Speaker:
J. Magalhaes-Mendes was born in Mancelos (Amarante, Portugal) on January 17, 1963. He received the PhD in Mechanical Engineering and Industrial Management at the University of Oporto, in 2004 and the licentiate degree in Applied Mathematics from the same university. He has also a M.S. degree in Civil Engineering by University of Aveiro and a M.S. degree in Systems and Automation by University of Coimbra.
Since its first graduate university has divided his work between the academy and in various organizations usually related to the construction industry. In these organizations was manager of a metal construction company where he developed a system of planning and control works, manager in a municipal company and technical advisor in a foundation of the municipal council of the Oporto city.
After obtained his Ph.D. has given priority to academic work. He has been Associate Professor of the School of Engineering of Polytechnic of Oporto since January of 2010, where he teaches the courses of organization and management of works and construction management. He has published about 65 papers in the European Journal of Operational Research, Computers & Operations Research, Journal of Heuristics, WSEAS Journals, invited book chapters and several national and international conferences. His research interest includes construction management, project management, genetic algorithms, and operational research and supply chain management.

ISBN: 978-1-61804-141-8

Plenary Lecture 3

Studies and Researches Regarding a Mathematical Model of Superfinishing Manufacturing Process

Associate Professor Badea Lepadatescu
Transilvania University of Brasov
Faculty of Technological Engineering and Industrial Management
Department of Manufacturing Engineering
ROMANIA
E-mail: lepadatescu@unitbv.ro

Abstract: In the paper are shown the recent researches regarding the modeling of manufacturing process of superfinishing. To achieve this goal were taking into consideration modeling of process parameters that influence the surface quality of parts and establishing of a new mathematical model for superfinishing manufacturing process. Also, based on these researches, are presented some achievements regarding the use of some equipments and machines in practical use in different shops and factories during the contracts that we had device a test results obtained in our researches when were used different process parameters and also are shown some of our projects that were applied in different factories during the contracts that we had.

Brief Biography of the Speaker:
Badea Lepadatescu is currently an Associate Professor at the Faculty of Technological Engineering and Industrial Management of Transylvania University of Brasov, Romania. He obtained his doctoral degree in 1998 in the area of machining through superfinishing process. After he graduated he worked five years as design engineer at Roman truck factory in the field of manufacturing processes where he designed many devices and special machine tools especially for superfinishing process. Started on 1982 he worked as research engineer at Transilvania University of Brasov, and after 1997 he is teaching at Department of Manufacturing Engineering. His main academic interests include Tolerance and Dimensional Control, Manufacturing Engineering Processes, Automation Processes, and Renewable Energy Sources. The research accomplishments are reflected through publications in a five books and authored or co-authored over 120 papers published at international conferences. He has extensive experience in both experimental and theoretical research work having more than 50 contracts with factories to design and produce machine tools for machining processes. Also in the field of Renewable Energy Sources together with a team he made two wind turbines, one with horizontal axis for taking water, and one with vertical axis to produce electric energy. He has been speaker to international conferences, has moderated forums, organized symposia, workshops and sessions at major international conferences.

ISBN: 978-1-61804-141-8

Plenary Lecture 4

The Solutions to the Boundary Layer Problems on the Half-Line

Professor Gabriella Bognar
Department of Analysis
Faculty of Mechanical Engineering and Informatics
University of Miskolc
Hungary
E-mail: matvbg@uni-miskolc.hu

Abstract: Fluid flow considerations are important in a wide variety of manufacturing processes, e.g., in extrusion, casting and crystal growing. Because of the importance of materials processing, considerable effort has been devoted at the transport phenomena in such processes. For the mathematical modeling the governing equations for fluid flow and the associated heat transfer are derived from the basic conservation principles for mass, momentum and energy. It follows from the complexity of these equations and the boundary conditions that analytical methods can be used to obtain solutions only in a few cases. These solutions are valuable since they provide results that can be applied for verifying numerical models and they give physical insight into the basic mechanisms.
We introduce the similarity analysis to the boundary flow over a flat surface in non-Newtonian fluids. The governing partial differential equations of mathematical models are transformed to boundary value problems for similar ordinary differential equations. We are studying the behavior of the solutions to different problems: boundary layer flow past a stationary surface or boundary layer flow over a solid surface continuously moving in a fluid.

Brief Biography of the Speaker:
Professor Bognar received the M.Sc. in Mechanical Engineering from University of Miskolc, Miskolc, Hungary, Ph.D. and 'Candidate' degree in mathematics from the Hungarian Academy of Sciences. Since her graduation she has been teaching different subjects of mathematics for undergraduate, graduate and doctoral students at University of Miskolc. She was conferred the postdoctoral lecture qualification (Dr. habil) in 2006. Her research interests include boundary and eigenvalue problems of nonlinear ordinary and partial differential equations. Gabriella Bognar has authored/edited 11 books, and published over 80 research papers. She also serves as the Vice Dean for Research and International Affairs at the Faculty of Mechanical Engineering and Informatics, University of Miskolc.

ISBN: 978-1-61804-141-8

Plenary Lecture 5

Universe Simulators Based on the Variability of Linear and Time Measurement Standards

Professor Vitaly O. Groppen
Scientific-Research Institute of Applied and Theoretical Informatics
North-Caucasian Institute of Mining and Metallurgy
Vladikavkaz, Russia
E-mail: groppen@mail.ru

Abstract: The proposed approach is based on the combination of differential equations reflecting linear and time measurement standards variability and of the Hubble Law used for new Universe simulators development, permitting us on the one hand to predict some important features of the Universe, such as spontaneous growth of distance between two resting objects detected by an observer at one of these objects, and on the other hand giving us new interpretation of known facts, such as galaxies scatter and acceleration, constancy of any solid body linear dimensions in time and so on.

Brief Biography of the Speaker:
Vitaly Groppen graduated from the North-Caucasian Institute of Mining and Metallurgy, Russia in 1967. In the 1960s he worked as an Assistant Professor at the Department of Industrial Electronics in the North-Caucasian Institute of Mining and Metallurgy, Vladikavkaz, North Ossetia, Russia. In 1973 he graduated from postgraduate courses in the Institute of Control Science of the Russian Academy of Sciences (Moscow, 1970 – 1973) and worked as the Head of Computing Centre of North-Caucasian Institute of Mining and Metallurgy (1973 – 1980) and as an assistant (1973 – 1976) and as Associate Professor (1976 -1988) at the Department of Mathematics in the same institution. In the 1980s he continued his research as a Senior Specialist of the Data Processing Department in the Dresden Technical University (German Democratic Republic, Dresden, 1980), and in the Leipzig Technical Higher School (German Democratic Republic, Leipzig, 1985). Since 1987 until 1989 he is a Professor and the Head of the Department of Mathematics in the North-Caucasian Institute of Mining and Metallurgy, North Ossetia, Russia, but from 1989 until now – founder and head of the Automated Data Processing Department in the same Institution. In the 1990s he was a visiting Lecturer in the Catalonia Technical University (Barcelona, Spain, 1990) and in the LG Research Centre (Seoul, Republic Korea, 1995). Since 1999 he is member of European Mathematical Society and since 2008 he is the Director of the Scientific-Research Institute of Applied and Theoretical Informatics (Vladikavkaz, North Ossetia, Russia). His research interests are focused on mathematical modeling, astronomy, physics, optimization theory and its' applications, graphs theory, discrete programming, theory of games, taxonomy, solutions making theory, computer aided images processing, optimal program codes design. He is the author of about 120 papers, 5 patents and 7 monographs.

ISBN: 978-1-61804-141-8

Plenary Lecture 6

Mathematical Method for Estimation the Temperature Field Changes by Vertical Heat Exchangers during Real Time Exploitation of Ground Source Heat Pump Systems

Professor Ioan David
Politehnica University Timisoara
Departament of Hydrotechnics
Romania
&
University of Applied Sciences
Facgbereich Bauwesen, Südanlage, Giessen
Germany
E-mail: Ioan.David@gmx.net

Abstract: In actually context of the general need to increase the share of alternative energy sources, the near surface geothermal energy i.e. the natural energy reservoir of the earth (up to 200-300m) which can be exploited to heating or cooling using ground source heat pump (GSHP) systems, have an important place. The performance of such an system depends basically on the temperature difference between heat source which is the natural ground outside of the heat exchangers borehole and the refrigerant which is recycled in the heat exchangers through the heat pump. Extraction of earth heat by heat pump leads to changes in initial temperature T0 from the outer wall of the heat exchanger borehole where the temperature will be namely TB< T0 in case of heating systems, and TB> T0 in case of cooling systems. An important characteristic of the real time exploitation of GSHP systems is its intermittent work in daily cycles (i.e. working time of tWh ours followed of a break time of tBh ours)which is integrated in yearly cycles (i.e. tWm working months in year with daily cycles followed of a break time of tBm months). The temperature change can reaches even 8 -150C during a daily cycle and several 0C during long time exploitation (i.e. several decades). These temperature changes can have a negative influence on the system performance directly and due to interference effects between the heat exchanger boreholes. Additionally the changed average temperature in a more or less extended area of the GSHP system during long time exploitation can move through transported by groundwater and so can arise a form of heat pollution of the ground.
In the present paper mathematical methods and formulas are proposed for estimating the evolution of temperature field changes on the borehole wall and in the neighbourhood area of the GSHP system during its real time exploitation. In opposite to the numerical modeling which is vary laborious for parameter analysis and need large running time, especially by long time exploitation of GSHP systems, the proposed methods, based on analytical solutions of the heat transfer equation have the advantage of an rapid analysis of the influence of different geometrical and physical parameters of the heat exchanger boreholes in interaction with the underground environment where they are located.

Brief Biography of the Speaker:
Prof. Ioan DAVID, graduated at the University "Politehnica" of Timisoara-Romania in Civil Engineering (1964) and graduated at the Vest University Timisoara in Mathematics (1972). In 1973 he obtains a PhD (i.e. Dr. Eng) in Theoretical and Applied Fluid mechanics at the “Politehnica” University of Timisoara. In 1976 become "Alexander von Humbold" scientific postdoctoral fellow at the Technical University Darmstadt, Germany. In 1990 becomes full professor for Hydraulic and Numerical Methods in civil engineering and PhD scientific coordinator at the “Politehnica” University of Timisoara. From 1993 till 2005 professor for Groundwater Modelling and Numerical Methods in Fluid Mechanics at the Technical University Darmstadt, Germany.
http://www.iib.tu-darmstadt.de/mitarbeiter_iib/mitarbeiter_28.de.jsp
From 2006 professor at the “Politehnica” University in Timisoara and also teaching as visiting professor at the University of Applied Science Giessen, Germany in the same subjects and Renewable Energies.
Prof. David is author of about 200 Papers published in Proceedings of International Conferences and Journals, 16 books and 3 patents in the field of Mathematical Modelling in Water and Environmental Engineering. Examples of

books published in Germany: Groundwater Hydraulic (Grunwasserhydraulik), Vieweg-Wiesbaden, 1998; Mathematical-Numerical Modelling of Technical Sytems.(Mathematisch Numerische Modellierung technischer Systeme), Couvillier Verlag Göttuingen, 2005.
http://www.google.de/search?hl=de&tbo=p&tbm=bks&q=inauthor:%22Ioan+David%22
He is member of several professional organizations/associations:
• Research Group “Computational Engineering”, Technical University of Darmstadt, Germany, http://www.rc.ce.tu-darmstadt.de/forschungszentrum_ce_rc/mitglieder_rc/mitarbeiter_details_rc_8903.de.jsp
• Consulting Engineer in Germany, http://www.ingkh.de/index.php?id=176&nr=63709;
• Hungarian Academy of Sciences (MTA - external corporation member); http://www.mta.hu/index.php?id=2800&LANG=h&TID=101138&cHash=aca7122ff9
• Editor in Chief of the Scientific Bulletin of "Politehnica" University of Timisoara, Transactions on Hydrotechnics; http://buletinulstiintific.hidro.upt.ro/contact.htm, • Editorial Board of the Romanian National Journal “HIDROTEHNICA”, Bucharest;
• American Romanian Academy of Arts and Sciences (ARA), vice president (2005-2009), general secretary ARA 2009-. http://www.meca.polymtl.ca/ion/ARA-AS/executive.htm
• General Association of the Engineers in Romania (AGIR);
Professionally Distinctions: Award for Scientific Research and Excellence in Academic Lectureship, Romanian Ministry of Education and Research; Diploma awarded by the German Foundation "Alexander von Humbold"; Academic title Honorary Professor of the Technical University of Darmstadt (Germany)(1999). Technical skills and competences: Implementation and solution of many planning and research projects at national and international level, using advanced mathematical and numerical modeling in some fields of the water and environmental engineering (e.g. Groundwater flow and pollutant transport, Open channel and river hydraulic, Complex hydro-technical plants, heat transfer modeling by geothermal energy exploitation systems etc.). Recent Projects: - “Establishing measures to rehabilitate the polluted groundwater altered du to landfill in collaboration with Grontmij Nederland, Dutch consultancy company (Water, civil engineering), Dutch Ministry of Economic Affairs (EVD, 2007-2008);
- “Integrated modelling of the sustainability of geothermal system” in the framework of Social Renewing Operative Programme in Hungary (TÁMOP-4.2.2/08/1): 2010-2011, innovative research teams from basic research to applied research (Hungary, Italy, New Zeeland and Romania): http://www.georen.unideb.hu/media/document/raport-ii-p1-david-transmis.pdf
-“Development of knowledge centres for life-long learning by involving of specialists and decision makers in flood risk management using advanced Hydroinformatics tools”, as Coordinator of an International EU Project -LEONARDO DA VINCI Transfer of Innovation (2012-2013), Project partnership: Romania, Hungary and DHI enterprise, Czech Republic

Plenary Lecture 7

Measurement Standards Variability and Gravity Control

Professor Vitaly O. Groppen
Scientific-Research Institute of Applied and Theoretical Informatics
North-Caucasian Institute of Mining and Metallurgy
Vladikavkaz, Russia
E-mail: groppen@mail.ru

Abstract: The proposed approach is based on the combination of differential equation reflecting linear measurement standards variability and of the Hubble Law used for new Universe simulators development, describing gravity and inertia as manifestations of reaction forces. Also this approach on the one hand permits us to predict some important features of the Universe, such as spontaneous growth of distance between two resting objects detected by an observer at one of these objects, and on the other hand it gives us new interpretation of known facts, such as galaxies scattering, constancy of any solid body linear dimensions in time, as well as constancy of mass of stable physical objects. Presented are results and conditions of gravity control experiments based on the developed models.

Brief Biography of the Speaker:
Vitaly Groppen graduated from the North-Caucasian Institute of Mining and Metallurgy, Russia in 1967. In the 1960s he worked as an Assistant Professor at the Department of Industrial Electronics in the North-Caucasian Institute of Mining and Metallurgy, Vladikavkaz, North Ossetia, Russia. In 1973 he graduated from postgraduate courses in the Institute of Control Science of Russian Academy of Sciences (Moscow, 1970 – 1973) and worked as the Head of Computing Centre of North-Caucasian Institute of Mining and Metallurgy (1973 – 1980) and as an assistant (1973 – 1976) and as Docent (1976 -1988) at the Department of Mathematics in the same institution. In the 1980s he continued as Senior Specialist of the Data Processing Department in the Dresden Technical University (German Democratic Republic, Dresden, 1980), and in the Leipzig Technical Higher School (German Democratic Republic, Leipzig, 1985). Since 1987 until 1989 he is Professor and Head of the Department of Mathematics in the North-Caucasian Institute of Mining and Metallurgy, North Ossetia, Russia, but from 1989 until now – founder and head of the Automated Data Processing Department in the same Institution. In the 1990s he was a visiting Lecturer in the Catalonia Technical University (Barcelona, Spain, 1990) and in the LG Research Centre (Seoul, Republic Korea, 1995). Since 1999 he is member of European Mathematical Society and since 2008 he is the Director of the Scientific-Research Institute of Applied and Theoretical Informatics (Vladikavkaz, North Ossetia, Russia). His research interests are focused on mathematical modeling, astronomy, physics, optimization theory and its' applications, graphs theory, discrete programming, theory of games, taxonomy, solutions making theory, computer aided images processing, optimal program codes design. He is the author of about 118 papers, 5 patents and 7 monographs.

ISBN: 978-1-61804-141-8

Plenary Lecture 8

Hierarchical Knowledge-Based Fuzzy Models for Systems Described in Linguistic Categories

Professor Anna Walaszek-Babiszewska
Department of Control and Computer Engineering
Opole University of Technology
POLAND
E-mail: a.walaszek-babiszewska@po.opole.pl

Abstract: The fuzzy sets theory offers description for imprecisely formulated dependencies, values of variables, functions, relations and the imprecise values of truth. Knowledge-based systems applied in medicine, economy or in natural sciences require specific knowledge, which is derived from human experts. Knowledge is often expressed in linguistic categories, in a form of a collection of sentences. Mathematical methods proposed in the lecture use both, empirical data and experts' knowledge to create hierarchical knowledge-based fuzzy models of the tested systems. The probability of fuzzy event is also used to valuate rules in the model. Some exemplary calculations will be presented.

Brief Biography of the Speaker:
Anna Walaszek-Babiszewska, at present, is a professor at the Opole University of Technology, in Poland. Her research interests include: methods of artificial intelligence, knowledge-based systems, stochastic and fuzzy modeling, systems identification and applications in technological and managerial situations.
She published her last book on: "Fuzzy Modeling in Stochastic Environment" in 2011.

ISBN: 978-1-61804-141-8

Plenary Lecture 9

Global Navigation Satellite Systems Applications in Modern Aviation and Terrestrial Applications

Professor Krzysztof A. Cyran
Director of the Virtual Flying Laboratory (VFL)
Poland
E-mail: krzysztof.cyran@polsl.pl

Abstract: Global navigation satellite systems (GNSS) have become present in virtually all areas of social, commercial and private life. This technology became an essential component for modern navigation on land, water and air. Its use extended also to map making and land surveying and today's uses of it go further beyond the preliminary applications. Currently, we can talk about multiconstellation GNSS. It is composed not only of American GPS, but also of additional constellations used for corrections of the signal, such as for example: Wide Area Augmentation System (WAAS) in the USA, or European Geostationary Navigation Overlay Service (EGNBOS) in Europe. It is also well known that European Union decided to launch its own GNSS program called Galileo, however it is still far from operational phase. Recently, Russia implemented its own GNSS called GLONASS and China develops system called BeiDou (Chinese name of the Big Dipper constellation used for navigation, and hence, having metaphoric meaning: Compass).

The plenary lecture presents applications of contemporary multiconstellation GNSS in aviation and terrestrial applications based research performed within the EGALITE project (www.egalite-project.eu) funded by European Union, whose foundations arose from EDCN (EGNOS Data Collection Network) and the ability offered by innovative Virtual Flying Laboratory (VFL) at Silesian University of Technology. The project started with enhancements of a software package for gathering in MS SQL database the high-throughput satellite navigation data, which is integrated with 3D visualization module GPS3D Viewer. The software package is also integrated with PEGASUS, a program authorized by EUROCONTROL organization. The database and the GPS3D Viewer are designed and functionally extended using the most recent software development technologies for continuous storing, administrating and post-processing of the EGNOS signal data. Their operation within distributed, Pan-European EDCN system has already made possible detection of important but rare events, such as sudden accuracy degradation, subject for further identification by EUROCONTROL, an organization responsible for the safe use of satellite navigation in European civil aviation. Additionally to single constellation signal, the more accurate localization can be achieved in Ground Based Augmenting System (GBAS) or Satellite Based Augmenting System (SBAS). The example of the first is the European Positioning (EUPOS) network delivering correction signals by radio, the example of the second is WAAS in the USA or EGNOS, a common project of European Union, European Space Agency (ESA) and European Organization for the Safety of Air Navigation (EUROCONTROL).

In the interdisciplinary EGALITE project, the innovative technologies originated from ICT are studied, varying from the on-ground precise positioning using GNSS and other sensors (for example in inertial navigation) as well as application of GNSS to vertical guidance in aviation in order to increase safety of the close-to-ground operations of helicopters. In such approach, it is necessary to consider the interplay of many qualitatively different factors, which act simultaneously and cause significant errors in positioning. The group of external factors such as architecture of GNSS systems in multiconstellation approach, influences the positioning accuracy by laws of physics, dynamics ionosphere and troposphere, and electromagnetic phenomena. The corrections of time scales caused by relativistic effects resulting both from Einstein's special and general (gravitational) theories of relativity have to be considered as well in any GNSS constellation. Additionally, internal factors, such as construction of the receivers, their ability of making use of augmentation signals, and computational algorithms applied are important for the final result of position measuring. Although mathematical models for positioning are generally known, the implementation of innovative computational algorithms can increase the accuracy in accordance with EUROCONTROL recommendations for the SBAS/EGNOS augmentation and the ionospheric range correction RCL1/L2.

As mentioned above, the performed research is using the capabilities of the Virtual Flying Laboratory (VFL) at SUT. It is an exceptional interdisciplinary laboratory, where cutting-edge technologies from aviation are combined with the newest trends in ICT, in particular, virtual reality and visualization, and with satellite navigation systems GNSS. VFL is co-financed by European Union from the European Regional Development Fund within the Project considered as a

winner among more than 100 others in Silesia, the most industrial region in Poland. It is equipped with 14 professional flight simulators, including full-size cockpit simulators: two cockpit simulators: ELITE Evolution S812 and ELITE Evolution S923 equipped with 3-channel visualization technology, are compliant with JAR-STD 3A (Evolution S923 is additionally capable for MCC); two others, manufactured by FLYIT (FAA approved: PHS for helicopter and PAS for aircraft), are installed in mobile class-room platforms with heating and air-condition. Due to mobility, it is possible to move them to distant places where research and/or demonstration field experiments are planned. The instrumentation includes a full IFR panel with all engine and fuel gauges, engine/rotor RPM, AH, ALT, ROC, T&B, HSI, VOR, ADF, and Transponder. Engine gauges can be selected as reciprocating or turbine. The software includes Jeppesen 20,000 airport database, with associated Navaids, and the entire earth surface with accurate elevation/obstructions. Software for PHS provides an accurate flight model including translation lift, ground effect, torque, auto-rotation for selectable 6 helicopter models: Piston R-22, R-44 (VFR-IFR), Schweizer 300 (VFR-IFR), Enstrom 280FX, Turbine-MD 500, Bell 206 (IFR). In stationary simulators such airplanes as Cessna 172RG, Piper Seneca III, Piper Arrow IV and King Air B200 are available. For all cockpit simulators, professional instructor command centres are supplied. Through command center, the operator can select any meteorological weather condition including precipitation, change clouds and wind direction and intensity at multiple elevations, record and replay flights, move a map, make a flight review, or print a flight path. Additionally, the professional GARMIN GNS430 original GNSS simulation devices are installed in stationary cockpit simulators, which, due to vertical navigation function, make possible to define various approaches, manoeuvres, and procedures based on GNSS. Particular problem of integration of flight simulator installed in VFL with the GNSS-based guidance system is described in more detail in a regular paper written by my collegues and me: O. Antemijczuk, D. Sokolowska, K.A. Cyran, “Integration of the MS ESP flight simulator with GNSS-based guidance system”, and presented at this conference separately.

Brief Biography of the Speaker:

Krzysztof A. Cyran graduated at Silesian University of Technology (SUT), Gliwice, Poland where he received his MSc degree in computer science (1992), PhD degree (with honours) in technical sciences (2000) and his DSc degree (habilitation) in technical sciences with specialty in computer science (2012). His PhD dissertation addresses the problem of automatic image recognition and his DSc dissertation concerns artificial intelligence, branching processes and coalescent methods in evolution of humans and early life. He has been an author and co-author of more than 100 publications with around 200 citations. Since 2012 he is an Associate Professor in the Institute of Informatics at SUT. Prof. Cyran (in 2003-2004) was a Visiting Scholar in Department of Statistics at Rice University in Houston, USA. After return from USA, he was the Vice-Head of the Institute of Informatics at SUT. Since 2011, he is the Director of the Virtual Flying Laboratory (VFL), the exceptional laboratory equipped with 14 professional flight simulators. The VFL has been co-funded by European Union, following favourable evaluation of Prof. Cyran’s and Ms. Sokołowska’s initiative to establish such laboratory in SUT to be a basis for performing research in the field of multiconstellation Global Satellite Navigation Systems (GNSS), including GPS, EGNOS and Galileo systems used in aviation. His current research interests are in image recognition and processing, artificial intelligence, digital circuits, decision support systems, rough sets, aviation and aeronautics, but he is interested also in computational population genetics and bioinformatics.

Prof. Cyran has been involved in numerous scientific grants awarded by Polish as well as European funds, including 7the Framework Program (7FP) of the European Union. In particular, he is the co-ordinator and the Scientist in charge in the EGALITE project. He is also local coordinator and Scientist in charge at SUT in SHERPA and HEDGE NEXT, the two others 7FP projects related to GNSS in aviation and implemented using professional VFL infrastructure. Prof. Cyran has received several awards of the Rector of the Silesian University of Technology for his scientific achievements, and he also has been rewarded by President of Poland for his scientific work at SUT. In 2004-2005 he was a member of International Society for Computational Biology. Currently he is a member of the Editorial Board of Journal of Biological Systems, member of the Scientific Program Committee of WSEAS international conferences in Malta (ECC’08), Rodos (AIC’08, ISCGAV’08, ISTASC’08) and multiconference in Crete (CSCC’08) as well as a reviewer for Studia Informatica and such journals indexed by Thompson Scientific as: Optoelectronic Review, Mathematical Biosciences and Engineering, Journal of Biological Systems, Neurocomputing, Mathematical Problems in Engineering, and Engineering Applications of Artificial Intelligence.

ISBN: 978-1-61804-141-8

Authors Index

ISBN: 978-1-61804-141-8