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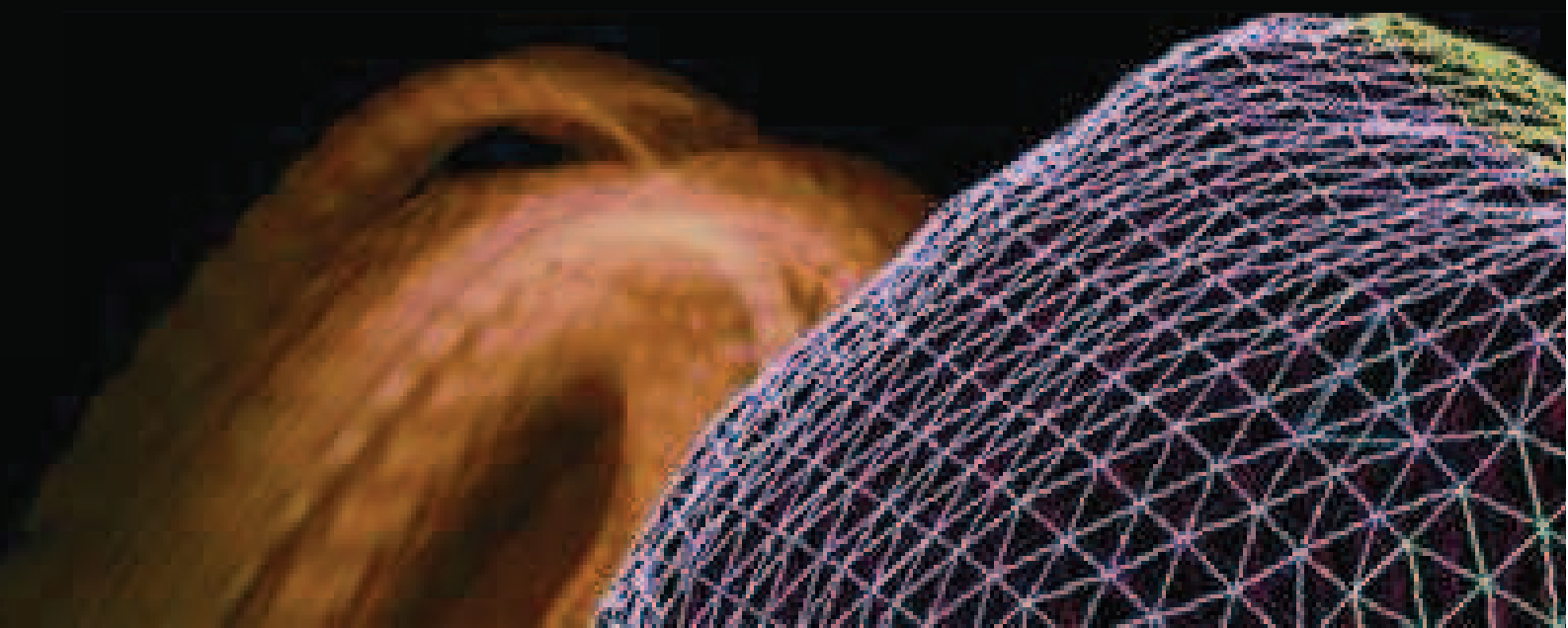
MULTIPHYSICS 2011

15 - 16 December 2011
Barcelona, Spain



MULTIPHYSICS 2011

15-16 December 2011
Barcelona, Spain

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General Information

Scope of Conference

Understanding real physics and performing multiphysics simulation are extremely important to analyse complex systems in order to better design and manufacture engineering products.

The objective of the conference is to share and explore findings on mathematical advances, numerical modelling and experimental validation of theoretical and practical systems in a wide range of applications.

The scope of the conference is to address the latest advances in theoretical developments, numerical modelling and industrial application which will promote the concept of simultaneous engineering. Typical combinations would involve a selection from subject disciplines such as Acoustics, Electrics, Explosives, Fire, Fluids, Magnetic, Soil, Structures and Thermodynamics.

Registration Desk : Karin Bolton

Registration Pack – Collection Hours

Registration packs should be collected from the Registration Desk. Collection Hours are as follows:

Thursday, 15th December	09:30-17:30
Friday, 16th December	09:30-17:30

Special Events

- Thursday 20:30
  Conference Banquet

Timing of Presentations

Each presentation will be allocated 18 minutes. A good guide is 15 minutes for presentation with 3 minutes left for questions at the end.
Good timekeeping is essential, speakers are asked to keep strictly to 18 minutes per presentation.

Language

The official language of the conference is English.

Audiovisual

The lecture room will be preset with the following:
One laptop, one LCD projection and cables, one screen, and one microphone.
Delegates are requested to bring presentations on CD or memory stick.

Paper Publication

Selected papers are reviewed and published in 'The International Journal of Multiphysics'.

Sponsorship

The Conference Board would like to thank the sponsors for their support.

Keynote Speaker

Dr Basem Alzahabi
Professor & Associate Department Head, Mechanical Engineering
Interim Director, The Office of International Programs, Kettering University, USA

BIOGRAPHY

Dr. Basem Alzahabi obtained his B.S. in Civil Engineering in 1981 from the University of Damascus. In 1984 Dr. Alzahabi attended the University of Michigan where he subsequently earned three graduate degrees, a Ph.D. in Structural Mechanics in 1996, a M.S. in Applied Mechanics in 1988, and a M.S. in Structural Engineering in 1986.

Prior to joining Kettering University in July of 1998, Dr. Alzahabi spent eleven intensive years in industry. At the Ford Motor Company, Optimal CAE Inc., Novi, MI, and Automated Analysis Corporation, Ann Arbor, MI.

Internationally, Dr. Alzahabi participated in collaborative research and educational activities with many international institutions, including the Technical University of Belfort, France (1999), Wessex Institute of Technology, England (2004), the University of Maribor, Slovenia (2005), Alhosn University, Abu Dhabi, United Arab Emirates (2010), and Balamand University, Tripoli, Lebanon (2010).

Dr. Alzahabi had worked as a consultant with MSC.Software, Santa Ana, CA, Hyundai Motor Company, KOREA, and TACOM in Warren, MI. Dr Alzahabi has participated as an NSF panel reviewer, and served as a member of the International Editorial Board on “Optimum Design of Structures and Materials in Engineering” and AIAA (SMC) Committee on Standards.

Dr. Alzahabi has won multiple teaching awards, where the last one was the 2011 Kettering University “Outstanding Teaching Award”.

MULTIPHYSICS 2011

PROGRAMME

TIME	Thursday 15 December 2011	Friday 16 December 2011
09:30 - 11:00	**Registration & Keynote Address**	**Session 2.1** *Impacts & Explosions*
11:00 - 11:30	**Coffee Break**	
11:30 - 13:00	**Session 1.2** *Advanced Development in Multiphysics*	**Session 2.2** *Magnetics & Acoustics*
13:00 - 14:00	**Lunch**	
14:00 - 15:30	**Session 1.3** *Hydrodynamics & Aerodynamics*	**Session 2.3** *Fluid Structure Thermal Interactions*
15:30 - 16:00	**Tea Break**	
16:00 - 17:30	**Session 1.4** Cold Climate Technology	Close
20:30	**Banquet**	

Full Programme

Thursday 15 December 2011

09:30 – 10:00 **Registration**

10:00 – 11:00 **Keynote Address**

Chair: M Moatamedi, Narvik University College, Norway

Multiphysics in Automotive Engineering

Basem Alzahabi, Department of Mechanical Engineering, Kettering University, USA

11:00-11:30 **Coffee Break**

Thursday 15 December 2011

11:30-13:00 Session 1.2
Advanced Development in Multiphysics

Chair: Riccardo Rossi, Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE); UPC, Barcelonatech, Spain

Coupled Multiphysics Effects in Cylindrical Quantum Dots with Multiband Models

Roderick Melnik and Sanjay Prabhakar (M2NeT Lab, Witfrid Laurier University Waterloo, Canada

The Over-Barrier Resonnant States and Multii-Channel Scattering in Multiple Qantum Wells

A.F.Polupanov and A.N.Kruglov, Kotel'nikov Institute for Radio-Engineering and Electronics of the Russian Academy of Sciences, Moscow, Russia

A New Type of Finite Elements over General Partitions of Multidimensional Domains

Lubomir T. Dechevsky, Faculty of Technology, Narvik University College, Narvik, Norway

Stresses Developed in Riveted and Riveted-Bonded Joints due to Thermal Process Using Finite Element Method

Essam A. Al-Bahkali, Department of Mechanical Engineering, King Saud University, Saudi Arabia

Influence of Mesio-distal Implant Inclination and Bone Quality on Mechanical Behaviour of Artificial Tooth in the Posterior Mandible

Franci Gačnik, Zoren Ren, University of Maribor and Nataša Ihan-Hren, University of Ljubljana, Slovenia

13:00-14:00 Lunch

Thursday 15 December 2011

14:00-15:30 Session 1.3
Hydrodynamics and Aerodynamics

Chair: Edmund Chadwick, University of Salford, UK

Numerical Simulation of Surface Flows Around a Droplet in an Oscillating Pressure Field
Tadashi Watanabe, Japan Atomic Energy Agency, Japan

A Method for Finding a Near-Optimal Tree Shape Water Distribution Network by Adding Non-User Points
Liang Xia, Dong-mei Pan, Ming-yin Chan and Shi-ming Deng, Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong

Oscillatory Flow Due to a Flapping Wing
Rabea Elmazuzi and Edmund Chadwick, University of Salford, UK

An Extension of Thin Aerofoil Theory to Aid Aircraft Design
Apostolis Kapoulas, University of Salford, UK

The Unpredictable Aerodynamics of the Jabulani World Cup Football
Edmund Chadwick, Thurai Rahulan and Yu Wang, University of Salford, UK

15:30-16:00 Coffee Break

Thursday 15 December 2011

16:00-17:30 Session 1.4
Cold Climate Technology

Chair: Lubomir T. Dechevsky, Faculty of Technology, Narvik University College, Narvik, Norway

Experimental Field Measurements of Atmospheric Ice Accretion on Structures
Mohamad Y Mustafa, Mohammad S. Virk and Qusai Z Al-hamdan, High North Technology Centre, Department of Technology, Narvik University College, Narvik, Norway

Multiphysics Modeling of Atmospheric Ice Accretion on Circular Overhead Power Line Conductors in Tandem Arrangement
Muhammad S. Virk, High North Technology Centre, Department of Technology, Narvik University College, Narvik, Norway

Effect of Atmospheric Ice Accretion on the Dynamic Behaviour of Wind Turbine
Willian Tiu and Muhammad S. Virk, North Technology Centre, Department of Technology, Narvik University College, Narvik, Norway

Atmospheric Ice Detection and Measurement Using Image Processing Based Techniques in the Visible and Infrared Spectrums
Mohamad Y Mustafa and Muhammad S Virk, North Technology Centre, Department of Technology, Narvik University College, Narvik, Norway

CFD Flow Analysis Through Wind Shields in Mountanous Terrain
Kevin Chow, William Tiu, Narvik University College, Narvik, Norway

20:30 Conference Banquet

Friday 16 December 2010

09:30-11:00 Session 2.1
Impacts and Explosions

Chair: Zoran Ren, University of Maribor, Slovenia

Sterilization of Bacillus Cereus in the Rice Powder Using the Instantaneous High Pressure

Takemoto Ayumi, Miyafuji Yoshitaka**, Shimojima Ken**, Higa Katsuya**, Higa Osamu**, Kudoh Yasufumi***, Mimaki Nami***, Watanabe Toshiaki****, Itoh Shigeru****
*Shock Wave and Condensed Matter Research Center, Kumamoto University
**Okinawa National College of Technology ***Kumamoto Industrial Research Institute
****Department of Ocean Mechanical Engineering, National Fisheries University, Japan*

A Computational Simulation of the Shock Wave Induced by Underwater Gap Discharge

Yoshikazu Higa(1), Shuhei Shinzato(2), Tatsuhiro Tamaki(3), Hirofumi Iyama(4) and Shigeru Itoh(5) : (1) Dept. Mech. Sys. Engng., Okinawa Nat. Coll. Tech. (2) Creat. Sys. Engng., Adv. Course, Okinawa Nat. Coll. Tech. (3) Dept. Media Info. Engng., Okinawa Nat. Coll. Tech. (4) Dept. Mech. Intel. Sys. Engng., Kumamoto Nat. Coll. Tech (5) President, Okinawa Nat. Coll. Tech.

Explosive Evaporating Phenomena of Cryogenic Fluids by Direct Contacting Normal Temperature Fluids

Toshiaki Watanabe ; Dept of Ocean Mech. Eng., National Fisheries Univ., Japan, Hironori Maehara : Shock Wave and Condensed Matter Research Center, Kumamoto Univ., Japan Shigeru Itoh : Okinawa National College of Tech., Japan

Study of the Suitable for Rice-Powder Manufacturing System with Disintegrator Using the Underwater Shock Wave

K Shimojima, Y Miyafuji, K Naha, H Fukuoka, S Tanaka, H Maehara, R Matsubara, O Higa, K Higa, T Matsui, S Itoh, Japan

FSI in Petroleum and Nuclear Industry

R Messahel, M Moatamedi, Narvik University College, Norway, M Souli, University of Lille, France

11:00-11:30 Coffee Break

Friday 16 December 2011

11:30-13:00 Session 2.2
Magnetics and Acoustics

Chair: Essam A. Al-Bahkali, King Saud University, Saudi Arabia

Finite Element Calculation of High Frequency Acoustic Resonances in HID Lamps

Bernd Baumann [1], Marcus Wolff [1], John Hirsch [2], Ricardo Valdivia Barrientos [3], Ulrich Stein [1]

1) Hamburg University of Applied Sciences, Germany 2) Philips Lighting, Eindhoven, The Netherlands 3) National Institute of Nuclear Research, Salazar, Ocoyoacac, Mexico

Design Process of Interdigital Transducer Aided by Multiphysics FE Analyses

Adam Martowicz, Michal Manka, Mateusz Rosiek, Tadeusz Uhl; AGH University of Science and Technology, Department of Robotics and Mechatronics, Krakow, Poland

A Study of Coupled Magnetic Fields for an Optimum Torque Generation

Nurulasikin Mohd Suhadis, School of Aerospace Engineering, Universiti Sains Malaysia and Renuganth Varatharajoo, Department of Aerospace Engineering, Faculity of Engineering, Universiti Putra Malaysia

Time Delay of Spark Generated by High-Voltage Electric Discharge in Flowing Water

Osamu Higa, Okinawa NCT, Ryo Matsubara, Okinawa NCT, Katsuya Higa, Okinawa NCT, Yoshitaka Miyafuji, Okinawa NCT, Takashi Gushi, Okinawa NCT, Yukimasa Omine, Okinawa NCT, Kazuyuki Naha, Okinawa NCT, Ken Shimojima, Okinawa NCT, Hiroshi Fukuoka, Nara NCT, Hironori Maehara, Kumatoto Univ., Shigeru Tanaka, Kumamoto Univ., Takumi Matsui, Okinawa NCT, Shigeru Itoh, Okinawa NCT. Japan

Atmospheric Icing Sensors – A Step into Icing Electromagnetism

Umair N Mughal, Muhammad S. Virk, High North Technology Centre, Department of Technology, Narvik University College, Narvik, Norway

13:00-14:00 Lunch

Friday 16 December 2011

14:00-15:30 Session 2.3
Fluid Structure Thermal Interactions

Chair: Mhamed Souli, University of Lille, France

Integration of an Arbitrary 1D Battery Model into 3D Coupled Electro-Thermal Finite Element Simulations
Michael Koplenig and Thomas Heubrandtner, Virtual Vehicle Research and Test Center, Graz, Austria

Experimental and Numerical Study on a Sleeping Thermal Manikin in a Mixed Ventilation System Room
Pan Dongmei, Xia Liang, Chan Mingyin, Deng Shiming, Department of Building Services Engineering, Hong Kong

On the Simulation of Rock-Fill Dam Behaviour in Overspill Conditions

Riccardo Rossi, Antonia Larese, E Oñate, Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE) and UPC, Barcelonatech, Spain

Tracking of Pressure Waves in Two Phase medium using CFD-DEM Simulations
H. A. Khawaja and S.A. Scott, Department of Engineering, University of Cambridge, UK

Qualitative Analysis of Accuracy in Voidage Computations in CFD-DEM Simulations
H. A. Khawaja and S.A. Scott, Department of Engineering, University of Cambridge, UK

FSI For Sloshing Tank Applications
M Souli, University of Lille, France

15:30-16:00 Coffee Break

16:00 Close of Conference

SESSION 1.1

KEYNOTE ADDRESS

THURSDAY, 15 DECEMBER 2011
10:00 – 11:00

CHAIR

M Moatamedi
Narvik University College
Norway

Thursday, 15 December 2011
10:00 – 11:00

Keynote Address

Multiphysics in Automotive Engineering

Bassem Alzahabi
Kettering University
USA

Abstract

The automotive industry has been facing an increasing pressure to satisfy customer demand to design vehicles with improved characteristics in vehicle dynamics, quietness, fuel economy, crashworthiness and occupant safety just to name a few. The dual requirements of managing cost and reducing product time-to-market has meant that Computer Aided Design and Engineering (CAD and CAE) applications have been universally embraced in automotive design.

Advances in numerical simulation techniques in general and in Multiphysics in particular have made computer simulations an important tool for investigating vehicle behavior. Faster, cheaper and more readily interpreted Multiphysics simulations allow the manufacturer to understand the behavior of their vehicle, and its components, before it is even produced for the first time.

In this presentation, I shall highlight some of those advances and applications that made Multiphysics simulation an integral part Automotive Engineering. And one application of particular interest is the aerodynamic noise generated by unsteady airflows outside of a vehicle and the airflow around the vehicle is determined by the shape of the vehicle. The high noise source regions of the vehicle are predicted so that the noise, vibration, and harshness (NVH) performance of the vehicle can be improved by further modification of the vehicle geometry.

SESSION 1.2

ADVANCED DEVELOPMENT IN MULTIPHYSICS

THURSDAY 15 DECEMBER 2011
11:30 – 13:00

CHAIR

Riccardo Rossi
Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE); UPC, Barcelonatech, Spain

COUPLED MULTIPHYHSICS EFFECTS IN CYLINDRICAL QUANTUM DOTS WITH MULTIBAND MODELS

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Authors and Affiliations
Roderick Melnik and Sanjay Probhakar (M2NeT Lab, Witfrid Laurier University, Waterloo, Canada

In this contribution we develop two new coupled multiphysics models for the analysis of properties of cylindrical quantum dots. They are multiband models based on 6x6 and 8x8 Hamiltonians, respectively. The influence of magneto-thermo-electromechanical effects on the band structures of such quantum dots has been accounted for. First, the 6x6 model has been applied to study coupled effects in the band structures of low dimensional semiconductor nanostructures (LDSNs) such as wurtzite AlN/GaN quantum dots in cylindrical coordinates in the presence of applied magnetic field along z-direction. The results of such calculations will be demonstrated, in particular ground and first excited states will be provided for electrons and holes, along with the conduction and valence band diagrams. An algorithm for the solution of the resulting model has been based on the finite element method, and by using this algorithm eigenvalues and wave functions of cylindrical quantum dots of various sizes have been obtained. Then, the analysis have been carried out with a more general 8x8 model and the results obtained with these two models have been compared for different types of quantum dots. Details of the methodology of solution and appropriate boundary conditions have also been provided. A special attention has been given to the case of applied magnetic field along z-direction where we have found localized eigenstates and wave functions in the conduction and valence bands for which our results open new possibilities for the design of such optoelectronics devices where the combination of electron-hole pairs can be used as tuning parameters.

Keywords: quantum dots, multiband multiphysics models, coupled effects

THE OVER-BARRIER RESONANT STATES AND MULTI-CHANNEL SCATTERING IN MULTIPLE QUANTUM WELLS

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We demonstrate an explicit numerical method for accurate calculation of the scattering matrix and its poles, and apply this method to describe the multi-channel hole scattering in the multiple quantum-wells structures. The S-matrix is continued analytically to the unphysical region of complex energy values. The results of calculations show that at all realistic values of parameters there exists one or more S-matrix poles corresponding to the over-barrier resonant states critical for the effect of the absolute reflection of holes in the energy range where only the heavy ones may propagate over barriers in the structure. Hole states are described by the Luttinger Hamiltonian matrix. In contrast to the single quantum-well case, at some parameters of a multiple quantum-wells structure the number of S-matrix poles may exceed that of the absolute reflection peaks, and at different values of parameters the absolute reflection peak corresponds to different resonant states. The imaginary parts of the S-matrix poles and hence the lifetimes of resonant states as well as the widths of resonant peaks of absolute reflection depend drastically on the quantum-well potential depth. In the case of shallow quantum wells there is in fact a long-living over-barrier resonant hole state. When the magnitude of the quantum-well depth decreases, the residual resonance peak of absolute reflection be-comes extremely narrow (against the background of almost unity transmission at all energies except this narrow interval), shifting towards the energy value where the light-hole channel is opened, and then vanishes. The energy of the absolute reflection in this case almost coincides with the real part of the S-matrix pole energy.

Keywords: numerical method, S-matrix poles, resonant states, multi-channel scattering, quantum wells.

A NEW TYPE OF FINITE ELEMENTS OVER GENERAL PARTITIONS OF MULTIDIMENSIONAL DOMAINS

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I shall discuss the properties of a recently introduced type of finite elements/volumes (FE/FV) on general partitions of domains in 2, 3 and more dimensions. The numerical solution via these FE is smooth (possibly even infinitely smooth), that is, the FE 'link' smoothly together on the boundaries of the partition subdomains, even when these boundaries are very irregular and non-smooth (e.g. Lipschitz-a, where 0<a<1). They can also be used for the generation of divergence-free FV scalar/vector fields in CFD. In the context of multiphysical problems and other problems of computational physics, these new FE/FV can, for example, be of interest in the development of software packages for scientific computing such as NAG or COMSOL.

Keywords: finite element, finite volume, spline, B-spline, exponential, rational, expo-rational, generalized, general simply connected partition of a multidimensional domain, smooth convex resolution of unity, scattered-point set in a multidimensional domain, Hermite interpolation, numerical analysis, computational physics

STRESSES DEVELOPED IN RIVETED AND RIVETED-BONDED JOINTS DUE TO THERMAL PROCESS USING FINITE ELEMENT METHOD

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Rivets are used in most design application such as joining together two plates. A full understanding of these joints is an essential in most of automobile and aerospace industry. When a rivet is heated before being placed in the hole, it is identified as hot-driven rivet. After the rivet colds, it will press the connected parts strongly and the rivet pole expands to fill the hole. Thus, the rivet head becomes under high concentration of stresses, which the rivet has to resist. The sharp corner beneath the head may cause the head to be failed. Tearing between the rivet holes, shearing, or crushing of either the rivet and the material joined are considered to be the major tension connection failures.

A three-dimensional finite element modeling for austenitic stainless steel AISI 304 annealed condition sheets of 1.0 mm thickness are developed using ABAQUS® software. This includes riveted and riveted-bonded joints models. Both models undergo thermal heat caused by hot-driven rivet process and then are subjected to an axial load up to the failure point. The developed FE models were based on elastic-plastic properties and ductile fracture limit criteria. In addition, the adhesive layer was modeled based on traction separation. A detailed experiments were conducted to evaluate these quantities and provide the FE developed models with these necessary data. The thermal stresses developed in riveted and riveted-bonded joints are assessed and reported. The present work shows that introducing an adhesive layer to riveted joints, vastly reduces the stresses developed in these joints. A complete load-displacement curve for each joining model is obtained and compared with the finite element models without including the effect of thermal process.

Keywords: Rivet, Riveted-Bonded, Thermal Stresses, Load-Displacement Curve

INFLUENCE OF MESIO-DISTAL IMPLANT INCLINATION AND BONE QUALITY ON MECHANICAL BEHAVIOUR OF ARTIFICIAL TOOTH IN THE POSTERIOR MANDIBLE

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Franci Gačnik, Zoran Ren (University of Maribor) and Nataša Ihan-Hren (University of Ljubljana), Slovenia

The selection of the appropriate alignment of an implant is vital for long-term successful operation of artificial tooth. It is known, that the most optimal implant inclination corresponds with inclination of the natural tooth root, which was replaced by dental implant. Lack of bone availability (lower bone density) in the posterior segments of the upper and lower jaw, along with the presence of anatomical landmarks such as the maxillary sinus and the mandibular nerve, sometimes necessitate inclined insertion of implants. Implant inclination leads to multiaxial loading of dental implant, which causes marginal bone resorption and in time results in implant loosening. By using computational simulations it is much easier to understand the mechanical behaviour of artificial teeth supported by dental implants and periodontal tissues under the influence of different external loadings. To use computational simulations it is necessary to determine the mechanical properties of components, which comprise the computational model. Mechanical properties of artificial materials are fairly easy to determine and are usually modeled using elastic constitutive models. However, mechanical properties of biological materials (i.e. bone tissue) are difficult to evaluate and can be best modelled as the combination of viscoelastic and poroelastic constitutive models. The aim of this study was to analyse the mechanical behaviour of artificial tooth in the posterior mandible by means of parametric computational simulations using the finite element method (FEM), where the masticatory load, dental implant inclination, thickness of cortical bone tissue layer and bone porosity were varied. The compiled results for the first time provide much better insight into expected artificial tooth behaviour in relation to some varying influential parameters.

Keywords: Artificial tooth, Dental implant, Implant inclination, Mechanical properties, Bone tissue, Computational simulation.

SESSION 1.3

HYDRODYNAMICS & AERODYNAMICS

THURSDAY 15 DECEMBER 2011
14:00 - 15:30

CHAIR

Edmund Chadwick
University of Salford, UK

NUMERICAL SIMULATION OF SURFACE FLOWS AROUND A DROPLET IN AN OSCILLATING PRESSURE FIELD

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A levitated liquid droplet is used to measure material properties of molten metal at high temperature, since the effect of container wall is eliminated for precise measurement. The levitation of liquid droplet is controlled by using electrostatic, magnetic or ultrasonic forces in the vertical direction, and rotation around the vertical axis, which is used to stabilize the droplet, is controlled by the acoustic force perpendicular to the axis. It is thus important to know the behavior of droplet in an oscillating pressure field. The streaming flows associated with ultrasonic levitator have been studied experimentally and theoretically. The recirculation flow region was predicted to appear theoretically in a surface layer around the droplet. The thickness of this recirculation region is, however, so small that an experimental observation is difficult. In this study, the surface flows around a droplet in an oscillating pressure field are simulated numerically. Incompressible Navier-Stokes equations are solved using the level set method. In the level set method, the level set function, which is the distance function from the two-phase interface, is calculated by solving the transport equation. The effect of compressibility is taken into account as the density perturbation. The oscillating pressure field is modeled using the Arbitrary-Lagrangian Eulerian method, where the computational grid points are moved with the oscillation frequency. Detailed transient flow fields around the droplet are calculated by performing parallel computations with 256 processors, and the flow phenomena in the surface layer around the droplet are discussed. It is found that the oscillating flow appears in the surface layer, and the phase of the oscillation in the surface layer was shifted from that in the outer layer away from the droplet.

Keywords: droplet, surface flow, oscillating pressure field

A METHOD FOR FINDING A NEAR-OPTIMAL TREE SHAPE WATER DISTRIBUTION NETWORK BY ADDING NON-USER POINTS

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Liang Xia, Dong-mei Pan, Ming-yin Chan and Shi-ming Deng
Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong

This paper proposed an approach to find out a near-optimal tree shape water distribution network by adding non-user points. It minimized the total pumping power requirement (PPR) for delivering water from a supplier point to multiple users through the network. An equation was derived for evaluating the total PPR under the constraint of total flow volume for the network. The relationship between the total PPR and structure of the network was deducted by using the equation. The procedures of the method for formulating a near-optimal tree shape network were reported. The approach was applied in two case studies. One and two non-user points were added for shaping the near-optimal networks for the two case studies, leading to 31% and 28% PPR saving compared to the radial shape networks, respectively.

Keywords: Water distribution network, near-optimal, non-user points, tree shape

OSCILLATORY FLOW DUE TO A FLAPPING WING

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Rabea Elmazuzi and Edmund Chadwick, Salford University, UK

Flapping wings are subject to oscillating motion; we consider uniform flow past a flapping wing of an object such as a bird or ornithopter. Far from the wing the resulting flow consists of both steady and time-periodic components. By Fourier expansion series the time-periodic components can be decomposed into time-harmonic terms. The steady Green's functions are given by the steady oseenlets which are well- known. However, the time-harmonic Green's functions given by the oscillatory oseenlets are not.

We obtain the oscillatory oseenlets for flapping velocity and pressure using potentials. The Green's integral representation has been presented which enables time-periodic Oseen flow to be modelled. And the total force generated on the wing by the oseenlets is calculated.

Keywords: Oscillatory Oseen flow, time-harmonic Green's functions, potential velocity

AN EXTENSION OF THIN AEROFOIL THEORY TO AID AIRCRAFT DESIGN

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Unlike using a CFD package, Thin aerofoil theory is an excellent tool for aiding aircraft design, in particular to help decide upon the required camber and chord of an aerofoil section. This is because the theory directly relates changes of these design parameters to important physical responses such as lift. However, the theory holds only to a thinness ratio of the thickness to the camber lengths. However, by considering a novel matched asymptotic approach which matches near-field Euler flow to far-field Oseen flow, then higher order approximations are found. These terms then help the designer model the wing shape to a much higher level of accuracy. The matching leads to a new Green's integral representation, and the approximations are then found by applying the Taylor series approximation. The first term in this approximation yields standard thin aerofoil theory, and the subsequent terms give the extension to standard thin aerofoil theory enabling more accurate design.

Keywords: thin aerofoil theory, aerodynamics

THE UNPREDICTABLE AERODYNAMICS OF THE JABULANI WORLD CUP FOOTBALL

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This research is set in the context of the world cup 2010, and forthcoming major football tournaments. The manufacturers (Adidas) of the footballs for these competitions aim to produce balls which fly quickly through the air so as to produce exciting goals and play. One way of doing this is to reduce the drag experienced by a football in flight, which can be achieved by reducing the size and effect of the low momentum boundary layer of air. The Jabulani football does precisely this, by having a round but roughened surface shape, which generates a fast turbulent boundary layer which has high momentum delaying the point at which the boundary layer separates. However, the authors believe that designing in this boundary layer effect has had unforeseen consequences in the way the ball moves through the air under the effect of spin. This is because it is possible to have a turbulent boundary layer on one side of the ball and a laminar boundary layer on the other side of the ball, aerodynamically similar to the effect of swing and reverse swing of the cricket ball. Of critical importance triggering the effect is the type of surface roughness,and the forward and rotational velocities of the ball.

Keywords: aerodynamics, surface roughness, boundary layer

SESSION 1.4

COLD CLIMATE TECHNOLOGY

THURSDAY 15 DECEMBER 2011
16:00 - 17:30

CHAIR

Lubomir T. Dechevsky
Faculty of Technology, Narvik University College, Narvik
Norway

EXPERIMENTAL FIELD MEASUREMENTS OF ATMOSPHERIC ICE ACCRETION ON STRUCTURES

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Ice accretion on structures is a common phenomenon in cold regions. It occurs when supercooled water droplets come in contact with exposed surface of a structure, which results in instantaneous freezing of those particles, consequently the accumulation of ice on the structure. Ice accretion on structures can occur onshore or offshore and can be classified into: In-cloud icing which is rime or glaze or precipitation icing which can be wet snow or freezing rain. In the case of offshore structures, sea spray can be added as a main reason of icing. This phenomenon can cause hazardous working conditions and frequently results in reduced productivity and can hinder human activity. The main difficulty with meteorological measurements under cold and icing conditions is ice accumulation on the measuring instrumentation themselves which interferes with the measurement procedures and causes complete or limited disability of the instrumentation.
Experimental observations and field measurements of atmospheric ice accretion on both onshore and offshore structures using advanced atmospheric ice measurement systems are the main aims of this research work, which is part of the ColdTech project at Narvik University College, Norway. The experimental data which will be statistically analyze will be used to define useful empirical relations to better understand and estimate atmospheric ice growth on structures in different atmospheric conditions. The derived empirical relations will help in improving the existing numerical models for better prediction of the atmospheric ice accretion on streamline and complex structures, and the acquired data can be used to set up an early warning system comprising physical advanced instrumentation for meteorological measurements and ice detection and measurement equipment to predict icing incidents before or just when they occur and to predict ice severity via modelling techniques so that proper mitigation methodologies can be implemented at the proper time and location.

MULTIPHYSICS MODELING OF ATMOSPHERIC ICE ACCRETION ON CIRCULAR OVERHEAD POWER LINE CONDUCTORS IN TANDEM ARRANGEMENT

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Atmospheric ice accretion on overhead power line conductors is one of the major problems in planning and constructing power transmission lines in the cold regions like arctic and alpine. Atmospheric ice accretion occurs; when freezing rain drops, snow particles or super cooled water droplets come into contact with the exposed surface of overhead conductors. Numerical study of atmospheric ice accretion on circular over head power line conductors includes the computation of mass flux of icing particles as well as determination of the icing conditions, which can be numerically simulated by means of integrated thermo-fluid dynamic models.

In this research work, multiphysics based numerical study of atmospheric ice accretion on circular over head power line conductor in tandem arrangement was carried out at both rime and glaze ice conditions. Initially the numerical model for single cylinder was validated with the experimental data obtained from CIGELE atmospheric icing research wind tunnel (CAIRWT), where a good agreement was found between experimental and numerical results. Later a detailed parametric study was carried out to understand the effect of different operating and geometric parameters on rate and shape of atmospheric ice growth on circular over head conductors in tandem arrangement. Analyses showed a considerable change in the rate and shape of ice growth with the change in droplet size and the operating temperatures, whereas a decrease in the ice loads on the rear cylinder is observed with the increase of distance between the circular conductors in tandem arrangement.

Keywords: Atmospheric ice, Circular conductors, Droplet diameter, Temperature

EFFECT OF ATMOSPHERIC ICE ACCRETION ON THE DYNAMIC BEHAVIOUR OF WIND TURBINE

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Interest in renewable energy, particularly solar and wind energy, has been increasing in recent years due to the rising oil prices and stringent regulations to control harmful emissions. Cold climate regions enjoy good availability of wind resources although their solar resources are fairly limited. However, one major problem tends to limit the operation of wind turbines in these regions which is the problem of atmospheric icing. Atmospheric icing on wind turbines creates additional loading on the components of the wind turbine and hence affects the structural integrity and lifetime of the turbine, especially on certain components such as turbine blades and tower. Furthermore, the problem of sever icing events leads to availability loss due to increased turbine faulting.
In this paper it is intended to present the results of investigations concerning the vibrational behavior of wind turbine blades under uneven ice accretion conditions. The fundamental natural frequencies of the iced blade were deduced using a modal analysis within ANSYS then they were compared to the natural frequencies of the uniced blades. A wind turbine blade with a proper icing profile was chosen. A constant cross section cantilever beam model was created using Rhinoceros to represent a simplified wind turbine blade, which has been chosen for the current study. A generic icing profile was used as an additional load on the blade. According to initial numerical results, the natural frequency of the first mode was slightly higher than the value reported by the manufacturer, which can be attributed to slight variations in basic assumptions regarding the profile of the blade.

Keywords: Wind turbine, Atmospheric Icing, Vibrations, Natural frequency

ATMOSPHERIC ICE DETECTION AND MEASUREMENT USING IMAGE PROCESSING BASED TECHNIQUES IN THE VISIBLE AND INFRARED SPECTRUMS

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Atmospheric icing on structures is a natural phenomenon used to describe the process of ice or snow accretion on structures exposed to the atmosphere. The resulting effect of atmospheric icing on structures may induce huge losses by provoking extended system failures and damages. The main function of an ice detection sensor is to detect and indicate the rate of an icing event. No available ice detector is capable of performing both these functions simultaneously and distinguishing between rime and glaze ice up till now. Depending on the type of accreted ice, glaze or rime, de icing power requirements will be different, therefore it is important for ice detection sensor to distinguish between rime and glaze ice. Therefore, the availability of a reliable real time ice detection and measurement system will not only help in acquiring more accurate qualitative and quantitative data on icing but will consequently help in avoiding probable damage to structures and can also reduce the running cost of the needed ice protection and mitigation systems (Anti-icing and de-icing systems). Image processing based techniques have been used for many years to detect atmospheric icing, where visual observation was the first tool used to detect icing. With recent advancements of image processing techniques together with the availability of super computers, it has become possible to automate image analysis as a tool for the detection and measurement of ice accretion on structures in both the visible and the infrared spectra. This technique is based on the continuous processing of the images of the object under observation to detect changes in its physical appearance or temperature (In the case of thermal imaging), those images are then compared to the original shape of the object and variations in volume or other parameters are computed. This work will present an intensive literature review of atmospheric ice detection and measurement using image processing based techniques in both the visible and the infrared spectrums. Also this work will describe the design of the experimental set up to validate and experiment these ice detection and measurement techniques while
results will be reported in subsequent publications.

Keywords: Atmospheric Icing, Infrared, Thermal imaging, Image processing

CFD FLOW ANALYSIS THROUGH WIND SHIELDS IN MOUNTANOUS TERRAIN

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The effectiveness of shielding against snow drift is paramount in the arctic regions. Such shielding could be used for the protection of personnel working in oilrigs or to ensure access to vital installations such as wind turbines are not blocked due to accumulation of snow. The design of shielding can vary from wooden slatted configurations to metal plates with punched elliptical holes. The main challenge to carrying out numerical flow analysis for such applications is the fact that such obstructions constitute a bluff body and furthermore compounded by having to model the 'micro' flow through the gaps/perforations. This is complicated further by the fact that this wind shields are located in sites where the direction of the airflow is non-uniform and is affected heavily by the nature of the terrain. Therefore to get a reasonable correlation with real life field conditions, it is necessary to consider a relatively large volumetric domain typically 30 million cubic metres whilst at the same time having to extract the flow around perforations which typically could have a cross-section of 0.01 sq. metre. Clearly the traditional approach of detailed meshing around the shielding is not practical and instead a porous panel method with an associated pressure drop assumption needs to be adopted. The work presented in this paper will look at the accuracy of this method and also how wind tunnel tests are used to validate the method.

Keywords: CFD, Terrain Modelling, Porous Panel, Snow Drift

SESSION 2.1

IMPACTS AND EXPLOSIONS

FRIDAY 16 DECEMBER 2011
09:30 – 11:00

CHAIR

Zoran Ren
University of Maribor
Slovenia

STERILIZATION OF BACILLUS CEREUS IN THE RICE POWDER USING THE INSTANTANEOUS HIGH PRESSURE

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The instantaneous high pressure, that is, the shock wave divides into the penetration wave and the reflected wave on the surface of the density difference.The shock wave divides into the penetration wave and the reflected wave at the surface of the density difference. The reflected wave caused on a high density side brings the pull stress from negative pressure. And, the high-speed destruction phenomenon that is called spalling destruction is caused. The shock wave exceeds the sound velocity, so it makes the instantaneous high pressure within several micro second.
Moreover, frictional heat is not caused because it is an instantaneous phenomenon. Because this high-speed destruction phenomenon destroys the body of the bacillus, the bactericidal effect is expected. In addition, there is an expectation as the means of non-heating sterilization because heat is not generated. Bacillus cereus that is the soil bacterium causes the food poisoning of the farm products heating cooking food. In this research, the sterilization experiment using the shock wave loading to the rice powder that added Bacillus cereus (NBRC 15305) is reported.

Keywords: shock wave, spalling destruction, milling, food processing

A COMPUTATIONAL SIMULATION OF THE SHOCK WAVE INDUCED BY UNDERWATER GAP DISCHARGE

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A shock wave propagation generated by electrical discharge in water is a phenomenon used in many applications not only mechanical engineering but medical and chemical treatment. In this study, to clarify the characteristic phenomena of the shock wave induced by underwater gap discharge, we developed a numerical model using Smoothed Particle Hydrodynamics (SPH) method. A series of computational simulations have been performed for a pseudo-ellipsoid vessel with different axis. Then the propagation and convergence in the vessel have been also observed.

Keywords: underwater shock wave, gap discharge, Smoothed Particle Hydrodynamics, pseudo-ellipsoid vessel

EXPLOSIVE EVAPORATING PHENOMENA OF CRYOGENIC FLUIDS BY DIRECT CONTACTING NORMAL TEMPERATURE FLUIDS

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Cryogenic fluids have characteristics such as thermal stratification and flashing by pressure release in storage vessel. The mixture of the extreme low temperature fluid and the normal temperature fluid becomes the cause which causes pressure vessel and piping system crush due to explosive boiling and rapid freezing. In recent years in Japan, the demand of cryogenic fluids like a LH2, LNG is increasing because of the advance of fuel cell device technology, hydrogen of engine, and stream of consciousness for environmental agreement. These fuel liquids are cryogenic fluids. On the other hand, as for fisheries as well, the use of a source of energy that environment load is small has been being a pressing need. And, the need of the ice is high, as before, for keeping freshness of marine products in fisheries. Therefore, we carried out the experiments related to promotion of evaporating cryogenic fluids and generation of ice, in the contact directly of the water and liquid nitrogen. From the results of visualizaiton, phenomena of explosive evapolating and ice forming were observed by using video camera.

Keywords: Cryogenic Fluid, Evaporating, Ice Forming, Direct Contacting

STUDY OF THE SUITABLE FOR RICE-POWDER MANUFACTURING SYSTEM WITH DISINTEGRATOR USING THE UNDERWATER SHOCK WAVE

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Self-sufficiency in food is very low (about 40%) in Japan. Therefore, the rice powder is paid to attention, because it can be processed to the udon(noodle) and bread etc. On the other hand, energy is very necessary for manufacturing the rice-powder with immersing, crushing, and dryness. Therefore, we developed low energy rice-powder manufacturing device. This device is the disintegrator for manufacturing the rice-powder using the underwater shock wave by the electrode. But the manufacturing efficiency has not been cleared. The purpose of this study is to investigate the most suitable configuration of the disintegrator for manufacturing the rice-powder using the underwater shock wave. Experimental conditions to manufacture the rice-powder (particle size is 100ƒÊm) is clarified using this device. Moreover, the manufacturing efficiency of the rice-powder, the relation between the number of the shock wave generation and the grain degree of rice-powder is clarified.

Keywords: underwater shock wave, rice powder, disintegrator

FSI IN PETROLEUM AND NUCLEAR INDUSTRY

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Fluid Structure Interaction (FSI) becomes more and more the focus of computational engineering in Petroleum and Nuclear Industry in the last years. These problems are computer time consuming and require new stable and accurate coupling algorithms to be solved. For the last decades, the new development of coupling algorithms, and the increasing of computer performance have allowed to solve some of these problems and some more physical applications that has not been accessible in the past; in the future this trend is supposed to continue to take into account more realistic problem. In this presentation, numerical simulation using FSI capabilities in LS-dyna, of hydrodynamic ram pressure effect occurring in nuclear industry is presented.

Keywords: Fluid Structure Interaction, Ram Pressure Effect, LS-dyna

SESSION 2.2

MAGNETICS & ACOUSTICS

FRIDAY 16 DECEMBER 2011
11:30 – 13:00

CHAIR

Essam A. Al-Bahkali
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FINITE ELEMENT CALCULATION OF HIGH FREQUENCY ACOUSTIC RESONANCES IN HID LAMPS

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High intensity discharge (HID) lamps operated at high frequencies suffer from arc instabilities caused by acoustic resonances. Arc instabilities result in light flickering, reduction of lamp lifetime and even lamp destruction. Therefore, HID-lamps are operated far below the optimal frequency range and bulky, hence power consuming and expensive, electronic ballasts are required.
Much effort has been put into a better understanding of the nature of the acoustic resonance phenomenon in HID-lamps. Here a 2-dimensional axisymmetric Finite Element model for the calculation of the acoustic response function is described. It is based on a static coupled field problem including differential equations for charge, momentum and energy conservation for the calculation of basic plasma properties and an eigenmode expansion for the evaluation of the acoustic pressure field. The method is applied to the parameters of a prototype lamp. In addition, the strength of acoustic resonances is estimated by measuring the lamp voltage and the flicker level over a large frequency range for the vertically operated prototype lamp. Numerical and experimental results are in good agreement.

Keywords: acoustic resonances, plasma, HID lamp

DESIGN PROCESS OF INTERDIGITAL TRANSDUCER AIDED BY MULTIPHYSICS FE ANALYSES

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In modern engineering the measurement-related activities behind the structural health monitoring (SHM) stand for key issues. Their relevance results from the need of long, low-cost and safe operation of monitored mechanical structures. Amongst all measurement techniques which are known in the area of non-destructive testing, the techniques based on the Lamb waves propagation have recently appeared as promising ones for damage detection. The Lamb waves are type of ultrasonic guided waves which can propagate in thin-walled structures, e.g. plates, shells or pipes. The specificity of their properties allows for effective applications in SHM systems. The Lamb waves can travel over long distances with very little amplitude loss. Hence the monitoring of large areas carried out with the use of relatively small number of sensors is feasible. Piezoelectric interdigital transducers (IDT) mounted on monitored structures are the most commonly applied electromechanical components for narrow band Lamb waves generation. The main advantages of IDT are selectivity and directivity of generated guided waves which allows for both localization of damage, even of small size, and decrease of electrical energy consumption. The work is devoted to a design process of chosen IDT placed on the aluminium plate taking into account its usefulness for planned SHM application. Fully coupled numerical analyses in ANSYS Multiphysics software have been performed considering both structural dynamics and properties of piezoelectric material. The process of design improvement has been preceded by sensitivity analysis. In the study several geometry properties of IDT have been assumed to vary during the search for the best electrode pattern. Applied search criterion considers simultaneous expected increase of the amplitude of antisymmetric mode A0 and the reduction of the amplitude of undesirable symmetric mode S0 of generated Lamb waves.

Keywords: interdigital transducer, Lamb waves, structural health monitoring, multiphysics, finite element method, sensitivity analysis, design improvement

A STUDY OF COUPLED MAGNETIC FIELDS FOR AN OPTIMUM TORQUE GENERATION

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Magnetic torquers are specifically designed to generate a magnetic field onboard the satellites for their attitude control. A control torque is generated when the magnetic fields generated by the magnetic torquers couple with the geomagnetic fields, whereby the vector of the generated torque is perpendicular to both the magnetic fields. In this paper, two control algorithms for a momentum bias satellite implementing two and three magnetic torquers onboard have been developed. The structured algorithms are for an optimum torque generation and eventually controlling the satellite attitudes (roll/yaw) and nutation using a roportional (P) controller as well as managing the excess angular momentum via a proportional-integral (PI) controller. The eveloped control algorithms were tested using the complex and simplified geomagnetic field models for a LEO satellite mission in a nominal attitude operation. Their attitude torque generation performances were compared and it is found that the optimum torques can be generated by both the developed control algorithms. However, the system with three magnetic torquers provides a better torque generation compartment and consequently gives a better attitude performance (0.5 deg).

Keywords: Coupled magnetic fields, magnetic torquer, magnetic attitude control system

TIME DELAY OF SPARK GENERATED BY HIGH-VOLTAGE ELECTRIC DISCHARGE IN FLOWING WATER

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We have been developing a rice-powder manufacturing device using underwater shock waves generated by a high-voltage electric discharge. In the generation, underwater shock waves are generated by momentary expansion and compression of plasma-bubbles between two electrodes. The rice is crushed by gHopkinson effect and Spall fracture h caused by shock waves passing through the rice grain. In this device, these electrodes are melted by a heat emitted by the electric discharge process. Therefore, the water is always circulated in the filter device to remove these particles of melted electrodes. When the water was circulated, the time delay of spark became longer. The purpose of this study is to clarify the cause of the time delay of the spark. We show the voltage-current characteristic of dielectric breakdown in flowing water, the image photographs of the spark obtained by high-speed camera and the results of numerical analysis. The image photographs showed that the dielectric breakdown occurred after the gas-bubbles between these electrodes were connected. Therefore, it can be considered that the longer time delay was due to the flow of water between these electrodes disturbing the connection of gas-bubbles.

Keywords: underwater shock wave, electric discharge, dielectric breakdown, time delay of spark

ATMOSPHERIC ICING SENSORS – A STEP INTO ICING ELECTROMAGNETISM

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Sensors are actually an extension to the human capability to obtain further knowledge beyond the natural limitations, governed by our nervous system. Water is a basic need of biosphere/life and ice is a solidified form of this need. The present need for power has forced the meteorologist by the push of major oil companies and investors towards the arctic regions and hence they all need more intelligent icing detection systems. De-icing can be done once the physical parameters of ice as like density, thickness and load are found. Our motive is to introduce the use of some electromagnetic and vibrational properties of ice to find the desired parameters. This paper is a study to link existing atmospheric icing sensors with the properties they deliver and propose some new methods/ideas to improve their outputs both qualitatively and quantitatively. Atmospheric Ice is a complex mineral with a variable dielectric constant, but precise calculation of this constant may form the basis for measurement of its other properties as thickness and strength using some electromagnetic methods. So if we use time domain spectroscopy, then we can measure both the reflection and transmission characteristics of atmospheric ice in a particular frequency range.

Keywords: Atmospheric ice, Sensors, Dielectric constant, Electromagnetic

SESSION 2.3

FLUID STRUCTURE THERMAL INTERACTIONS

FRIDAY 16 DECEMBER 2011
14:00 – 15:30

CHAIR

Mhamed Souli
University of Lille
France

INTEGRATION OF AN ARBITRARY 1D BATTERY MODEL INTO 3D COUPLED ELECTRO-THERMAL FINITE ELEMENT SIMULATIONS

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Over the past decade rechargeable batteries have become an important power source in automotive applications as well as for consumer electronics. Consequently high effort was put into the modeling of the electrical behavior of these batteries. Besides the electrical properties also the thermal characteristics of a battery cannot be neglected, as higher temperatures and uneven temperature distributions (i.e. hot spots) are known to have an impact on performance, lifetime and safety of a battery. Due to the complexity of the problem, mainly 1D battery models have been developed, which inherently cannot give detailed information on the developing spatial distribution of temperature in realistic 3D structures. In this work a general approach is presented which offers the usage of an arbitrary 1D battery model in the context of a coupled electro-thermal finite element simulation of a fully assembled 3D structure of a battery. To achieve this, both thermal and electrical characteristics of a 1D battery model (i.e. electrochemical, empirical or equivalent circuit models) are integrated into the finite element solution procedure. In contrast to most published approaches, a coupled finite element approach for the thermal and electrical problem in the 3D battery domain is addressed. To demonstrate the potential of this method the distribution of the relevant electrical and thermal quantities in a fully coupled finite element simulation of a commercially available cylindrical battery are shown. Obtained results from this simulation are in good accordance with available measurement data. For future development this approach offers a helpful instrument in optimizing the spatial design of a battery to systematically influence its thermal properties. Furthermore, because of the 3D modeling of the structure in question, this method allows a detailed analysis of different cooling concepts.

Keywords: Coupled electro-thermal simulation, battery model, finite element analysis, 3D modeling

EXPERIMENTAL AND NUMERICAL STUDY ON A SLEEPING THERMAL MANIKIN IN A MIXED VENTILATION SYSTEM ROOM

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This paper reports an experimental and numerical study on a sleeping thermal manikin in a room equipped with a mixed ventilation system. In the experimental work, heat loss from the sleeping thermal manikin was measured under different conditions. The supply air temperature was in a range of 17 degree centigrade to 27 degree centigrade. Apart from the heat loss of the sleeping thermal manikin, the velocity distributions and temperature distributions were also measured in the experiments for subsequent analysis. A numerical model was developed to predict the heat loss from the sleeping thermal manikin. The numerical model was then validated by the experimental results. The results show that thermal comfort levels can be predicted by using a CFD model with a high degree of agreement.

Keywords: Computational fluid dynamics; Mixed ventilation system; Sleeping computational thermal manikin; numerical study

ON THE SIMULATION OF ROCK-FILL DAM BEHAVIOUR IN OVERSPILL CONDITIONS

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The availability of increasing computing power, together with the maturity of computational techniques allow new, previously untractable, problems to be faced. One of such problem is the simulation of rock fill dams subjected to the action of water, including both the effect of filtration and of overspill conditions. The challenge is to include in the simulation both the flow inside and in the surrounding of the dam body and the non-linear behaviour of the rock fill, taking in account the possibility of different failure modes. In the current work a lagrangian meshless description is used for the description of the dam body, while an eulerian approach is adopted in describing the flow of water. The two solvers are coupled in the framework of an in-house general purpose code. The numerical predictions are compared to experimental data. The structural discretization is described by a Mohr-Coulomb type failure model, and a non-linear Ergun model is used for the description of the drag induced by the action of the water on the rock particles. A stabilized equal-order model is used to guarantee a locking-free behaviour for the dam, so to allow a correct representation of both mass sliding modes and of local failures.

Keywords: FSI, PFEM, dam engineering, Kratos

TRACKING OF PRESSURE WAVES IN TWO PHASE MEDIUM USING CFD-DEM SIMULATIONS

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In this work, the pressure waves in the two phase mixture have been explored using CFD-DEM (Computational Fluid Dynamcis' Discrete Element Modelling). In this method volume averaged Navier Stokes, continuity and energy equations are solved for fluid. The particles are simulated as individual entities; their behaviour is captured by Newton's laws of motion and classical contact mechanics. Particle-fluid interaction is captured using the drag laws given in the literature. Experiments have proved that pressure waves move at the speed of sound in a two phase system [Roy, Davidson and Tuponogov (1990)]. In this work, pressure waves are tracked in a fluidised bed consisting of 150000 particles of 150 micron diameter (Geldart-A type) using CFD-DEM simulations. The waves were introduced by injecting the fluid high enough in the fluidised bed. The excess gas creates bubbles resulting in pressure fluctuations. These perturbations are tracked down in the bed at different heights. The resulting signals are cross-correlated to find the speed of the waves. It has been found that the waves move at the speed of sound in a two phase medium. There is also brief discussion of damping in the pressure waves within a fluidised bed by analyzing the strength of the signals.

Keywords: CFD-DEM, fluidised bed, pressure waves

QUALITATIVE ANALYSIS OF ACCURACY IN VOIDAGE COMPUTATIONS IN CFD-DEM SIMULATIONS

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CFD-DEM (Computational Fluid Dynamics' Discrete Element Modelling) is a simulation technique for modelling two phase flow, for example the fluidised bed. In this technique volume averaged fluid equations (mass, momentum and energy conservation) are solved to model the fluid using the Eulerian method (domain divided in cells). The particles are modelled as individual entities and their movements are solved using the Langrangian method (particle tracking). The fluid and particles are coupled using drag equations. The voidage (space occupied by the fluid in the cells) is a very important parameter in solving volume averaged and drag equations. In CFD-DEM simulations, voidage is computed using cubic approximation to reduce the usage of computational power at the boundaries of the cells. The cubic approximation is the ratio of the volume of the cube multiplied with the volume of the particle. This approximation introduces an error in the voidage computation. In this work, the error has been estimated by finding out the actual volume of the spherical particle and the estimated value using cubic approximation. The result shows the range of error at a given value of volume value computed using cubic approximation. These results have been extended to the scale of volume of fluid cell to analyse its impact towards volume averaging. Also, comments are made on the accuracy of CFD-DEM simulations and a solution is suggested to reduce the error.

Keywords: CFD-DEM, voidage, accuracy

FSI FOR SLOSHING TANK APPLICATIONS

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For the investigation of nonlinear dynamic behavior of cylindrical steel liquid containment tanks, explicit finite element code LS-DYNA will be used for modelling the effects of structure-fluid-soil interaction between tank, contained liquid and underlying soil. Both pure Lagrangian and coupled Lagrangian and Eulerian (Arbitrary Lagrangian Eulerian-ALE) algorithms incorporated into LS-DYNA will be employed to analyze the seismic behavior of the system. As a preliminary study for the numerical analysis, the flexibility of the tank shell and the underlying foundation will be neglected, and the effects of impulsive and convective hydrodynamic pressures exerted by the fluid contents will be investigated for a 3-D tank structure. .

Keywords: FSI, Sloshing Tank

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