出國報告（出國類別：出席國際會議）

2013 科學計算國際會議

服務機關：國立高雄第一科技大學營建工程系
姓名職稱：張太平教授
派赴國家：美國
出國期間：2013 年 7 月 22 日至 2013 年 7 月 25 日
報告日期：2013 年 9 月 13 日

摘要

個人參加之會議名稱爲 2013 科學計算國際會議 (The 2013 International Conference on Scientific Computing 簡稱 CSC’ 13)，此會議爲 The 2013 World Congress in Computer Science, Computer Engineering & Applied Computing (WORLD COMP’ 13) 所包含 22 個會議的其中一個會議。WORLD COMP’ 13 的 22 個會議同時平行舉行，且其中一些會議互相交流。 WORLD COMP’ 13 會議每一年舉辦一次，爲世界上最大之電腦計算及應用計算之會議之一。今年在美國內華達州拉斯維加斯舉行。2013 科學計算國際會議自 102 年 7 月 22 日至 102 年 7 月 25 日止，爲期共四天。此次會議所發表的論文約有二千多篇左右，參加會議的人員約二千多人。 除了一些美國學者、教授外， 有來自全世界的學者、教授，如德國、加拿大、英國、日本、東歐、北歐、法國、印度及我國和中國大陸等多國，參加此會議。個人除了發表自己的論文以外，並出席參加了許多演講。因此，本人於短短幾天之間，知道很多不同領域方面的研究新方向，覺得獲益不少。 另外幾位演講學者的演講非常精彩，內容均是較新的研究題材及領域，可啓發聽眾的思考及創新性。個人參加此會議目的在於學習與了解電腦計算及應用計算之研究新方向，希望可提昇個人及國家之工程與科學方面的學術水準。並且希望將來可與國際學者在工程與科學方面作進一步的研究合作。

目錄　　　　頁碼

(一). 參加會議目的

2013 科學計算國際會議在探討工程與科學方面的電腦計算及應用計算研究新方向包含複雜系統的多功能分析、複合材料及結構之力學行爲、塑性力學、計算及實驗力學、流體力學、微機電系統、醫學及生物之奈米工程、計算生物學及計算力學、智慧材料、計算固體力學及奈米力學、奈米材料等等。此次會議共分成 22 個主題，不過各主題依論文類別再細分爲多個場次(Session)，每場次計有五位至六位學者或專家參與發表論文。各主題皆固定在一小型會議室進行，與會的論文同時包含理論與實務兩方面。個人發表的論文主要探討利用隨機有限單元法研究受到移動外力及流體的雙層壁奈米碳管之非線性振動 (Nonlinear vibration of fluid-loaded double-walled carbon nanotubes subjected to a moving load based on stochastic FEM) 。主要屬計算科學及應用(Computational Science and Applications)領域。個人並參與了其他一些演講、以及一些 symposium 之場次，並與一些國際學者交換意見, 並且討論將來國際合作機會。個人參加此會議之目的及任務在於學習與了解這些與工程與科學方面的電腦計算及應用計算相關之研究新方向, 希望可提昇個人及國家之工程與科學方面的學術水準。並且希望將來可與國際學者在工程與科學方面作進一步的研究合作。個人在與一些國際學者交換與電腦計算及應用計算相關意見之後,覺得不僅個人發表自己之論文之外, 且讓這些國際學者知道個人是來自台灣, 個人出席 2013 科學計算國際會議之任務及目標已達成。

(二). 參加會議過程

個人參加之會議名稱爲 2013 科學計算國際會議 (The 2013 International Conference on Scientific Computing 簡稱 CSC’13)，此會議爲 The 2013 World Congress in Computer Science, Computer Engineering & Applied Computing (WORLD COMP’13) 所包含 22 個會議的其中一個會議。WORLD COMP’ 13 的 22 個會議同時平行舉行，且其中一些會議互相交流。 WORLD COMP’ 13 會議每一年舉辦一次，爲世界上最大之電腦計算及應用計算之會議之一。今年在美國內華達州拉斯維加斯舉行。美國內華達州拉斯維加斯爲全世界最大之賭城。擁有數百家大型旅館, 是美西渡假勝地。2013 科學計算國際會議自 102 年 7 月 22 日至 102 年 7 月 25 日止，爲期共四天。

此次 2013 科學計算國際會議主題主要在探討工程與科學方面的電腦計算及應用計算之研究新方向,並如何達成全球化共同合作。故其領域除了涵蓋工程與科學方面的電腦計算及應用計算外, 還包含、複合材料及結構之力學行爲、塑性力學、計算及實驗力學、流體力學、微機電系統、醫學及生物之奈米工程、計算生物學及計算力學、智慧材料、

計算固體力學及奈米力學、奈米材料及複雜系統的多功能分析等等。此次 2013 科學計算國際會議，爲 The 2013 World Congress in Computer Science, Computer Engineering & Applied Computing (WORLD COMP'13) 所包含 22 個會議的其中一個會議。WORLD COMP'13 屬大型會議型態, 但 2013 科學計算國際會議屬中小型會議型態，據大會主席報告，此次發表的論文約有二千多篇左右，參加會議的人員約二千多人。 除了一些美國學者、教授外， 有來自全世界的學者、教授，如德國、加拿大、英國、日本、東歐、北歐、法國、印度及我國和中國大陸等多國， 參加此會議。 本次會議並邀請一些國際著名的學者到會中演講，大部份的會議(Session)多有一場至數場主題學術性演講(Keynote Lectures or Theme Lectures)。每天皆有幾場大型學術性演講 (Plenary and Semi-plenary lectures) 。

此次會議共分成 22 個主題，不過各主題依論文類別再細分爲多個場次(Session)，每場次計有五位至六位學者或專家參與發表論文。各主題皆固定在一小型會議室進行，與會的論文同時包含理論與實務兩方面。由這些場次主題來看，可謂內容豐富，亦可見主辦者之用心。而固定會議室之安排，使得各主題之與會學者皆能持續地與其相關領域學者作深入討論，不致於奔波至不同會場聽取類似主題的論文報告。

個人發表的論文主要探討利用隨機有限單元法研究受到移動外力及流體的雙層壁奈米碳管之非線性振動 (Nonlinear vibration of fluid-loaded double-walled carbon nanotubes subjected to a moving load based on stochastic FEM) 。

個人發表的論文主要屬計算科學及應用(Computational Science and Applications)領域, 發表的論文被安排在會議第四天 7 月 25 日上午 8:20 至 10:20 之「Session 11-CSC: Computational Science and Applications」場次。該場次有六篇文章發表，每人計有 15 分鐘之發表與 5 分鐘之討論時間。此六篇文章皆與計算科學及應用相關，在此場次中，個人是第四位發表者。在此場次中依發表次序第一位發表者爲美國學著, 第二位發表者爲加拿大學著, 第三位發表者爲美國學著, 第四位發表者爲台灣學著即本人, 第五位發表者爲瑞士學著, 第六位發表者爲印度學著。個人發表論文之後, 大約有三位學者對個人發表之論文有興趣, 並詢問一些問題。個人並參與了其他一些演講、以及一些 symposium 之場次，並與一些國際學者交換意見, 並且討論將來國際合作機會。個人參加此會議之目的及任務在於學習與了解這些與工程與科學方面的電腦計算及應用計算相關之研究新方向，希望可提昇個人及國家之工程與科學方面的學術水準。並且希望將來可與國際學者在工程與科學方面作進一步的研究合作。個人在與一些國際學者交換與電腦計算及應用計算相關意見之後,覺得不僅個人發表自己之論文之外, 且讓這些國際學者知道個人是來自台灣, 個人出席 2013 科學計算國際會議之任務及目標已達成。

個人發表的論文內容爲探討利用隨機有限單元法研究受到移動外力及流體的雙層壁奈米碳管之非線性振動 (Nonlinear vibration of fluid-loaded double-walled carbon nanotubes subjected to a moving load based on stochastic FEM) 。

我們不僅考慮幾何非線性之效應，我們並且考慮凡德瓦(Van der Waals)力之非線性效應。此外，我們並利用非局部彈性理論來研究雙層壁奈米碳管之非線性振動行爲。我們利用漢米頓(Hamilton)理論來推導含有流體之雙層壁奈米碳管的非線性控制方程式。我們假設雙層壁奈米碳管的彈性楊氏係數對位置而言是隨機的,以真正描述雙層壁奈米碳管的隨機材料性質。利用微擾法及有線單元法，我們可求解非線性微分方程式。我們可以求出雙層壁奈米碳管的一些統計動態效應，如:位移振幅之平均值及標準偏差，我們並且研究流體速度及小尺寸係數對雙層壁奈米碳管之統計動態反應之影響。我們可以推導出以下結論:位移振幅之平均值及標準偏差隨著小尺寸係數之增加而非線性的增加，且隨著流體速度的增加而增加。並且，小尺寸係數對於雙層壁奈米碳管之位移振幅的平均值，標準偏差及變化係數(COV)有顯著之影響。

(三). 與會心得

個人發表的論文題目爲: “利用隨機有限單元法研究受到移動外力及流體的雙層壁奈米碳管之非線性振動”(Nonlinear vibration of fluid-loaded double-walled carbon nanotubes subjected to a moving load based on stochastic FEM) 。

個人除了發表自己的論文以外,並出席參加了許多演講。 此次發表的論文包羅萬象， 除了有電腦計算及應用計算相關之文章外，還有複雜系統的多功能分析、複合材料及結構之力學行爲、塑性力學、計算及實驗力學、流體力學、微機電系統、醫學及生物之奈米工程、計算生物學及計算力學、智慧材料、計算固體力學及奈米力學、奈米材料等等。因此，本人於短短幾天之間，知道很多不同領域方面的研究新方向，覺得獲益不少。 另外幾位演講學者的演講非常精彩，內容均是較新的研究題材及領域，可啓發聽眾的思考及創新性。

(四). 攜回資料名稱及內容

1. 大會議程。如附件 1。
2. 大會論文集(光碟及紙本) 。

(五). 與會建議

個人參加此會議已多次，最近幾年大會會議地點均在美國內華達州拉斯維加斯舉行。 個人已向大會建議是否明年可以更換大會會議地點。

(六). 附件

1. 大會議程。
2. 個人發表的論文全文。

CSC'13 + MSV'13 + CGVR'13 CONFERENCE SCHEDULES

The 2013 International Conference on
Scientific Computing (CSC'13)
+
The 2013 International Conference on
Modeling, Simulation and Visualization Methods (MSV'13)
+
The 2013 International Conference on
Computer Graphics & Virtual Reality (CGVR'13)

Because of topical overlap between CSC'13, MSV'13, and CGVR'13 tracks, the schedules of these conferences have been merged into one comprehensive schedule. It is hoped that this would encourage the participants of the three conferences to explore cross-fertilization of ideas.

There are also a number of other sessions (not listed as part of these three tracks) that are of potential interest to CSC'13, MSV'13, and CGVR'13 participants (sessions belonging to other joint conferences.) Therefore, you are encouraged to also check the schedules of other joint conferences. In particular, sessions in FCS'13, FECS'13, ICOMP'13, IPCV'13, and PDPTA'13 conferences discuss topics that are within the scope of CSC'13, MSV'13, and CGVR'13; these have been scheduled so that selected CSC'13, MSV'13, and CGVR'13 attendees can also participate in them.

Note that each conference is divided into a number of topical sessions. These sessions are not necessarily scheduled in the same room/location. Therefore, conference attendees are to check the location of the session(s) they wish to attend; The conference room numbers (Locations) appear in this document.

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03:00 - 09:00pm: REGISTRATION (LOCATION: Cohiba 5)

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July 22 July 22 July 22 July 22 July 22 July 22 July 22 July 22 July 22
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6:30am - 5:00pm: REGISTRATION (LOCATION: Cohiba 5)

08:30 - 08:45am: Congress Opening Remarks - July 22, Monday:
Professor Hamid R. Arabnia (Chair, Steering Committee & Coordinator)
University of Georgia, Georgia, USA
(LOCATION: Tropicana Theater)

08:50 - 09:45am: Keynote Lecture 1 - July 22, Monday:
Accessing and Computing Meaning
Professor Victor Raskin
Distinguished Professor of English and Linguistics and Professor of Computer Science (courtesy), Purdue University, Indiana, USA
(LOCATION: Tropicana Theater)

09:55 - 10:50am: Keynote Lecture 2 - July 22, Monday:
Visualization and Data Mining for High Dimensional Datasets
Professor Alfred Inselberg
Professor, School of Mathematical Sciences, Tel Aviv University, Israel; Senior Fellow, San Diego Supercomputing Center; Inventor of the multidimensional system of Parallel Coordinates and author of textbook "Parallel Coordinates: VISUAL Multidimensional Geometry", (praised by Stephen Hawking among others.)
(LOCATION: Tropicana Theater)

11:00 - 11:40am: Keynote Lecture 3 - July 22, Monday:
How Intellectual Property is Changing the Global Economic Landscape, and What Universities and Companies Must Do to Prepare
Dr. Sandeep Chatterjee
Chief Executive Officer (CEO), Shuv Gray LLC, USA;
Named Young Global Leader for 2011 by the World Economic Forum for his "professional accomplishments, commitment to society and potential to contribute to shaping the future of the world."
(LOCATION: Tropicana Theater)

11:45 - 11:55am: Announcement; Information talk - July 22, Monday:

Directory of Published Papers - a database
Laurance Baschkin
InterDok Media Services, USA
(LOCATION: Tropicana Theater)

12:00 - 01:00pm: LUNCH (On Your Own)

SESSION 1-CSC: NOVEL SCIENTIFIC & ENGINEERING ALGORITHMS & APPLICATIONS + COMPLEX SYSTEMS + MEDICAL SCIENCE
Co-Chairs: TBA
July 22, 2013 (Monday); 01:00pm - 03:00pm
(LOCATION: Montecristo 4)

01:00 - 01:20pm: A Combined Algorithm for Analyzing Structural Controllability and Observability of Complex Networks
Luis Ubeda, Carlos Herrera, Iker Barriales, Pedro J. Zufiria, and Mariluz Congosto
ETSI Telecomunicacion, Universidad Politecnica de Madrid, Spain;
Massachusetts Institute of Technology, USA;
Universidad Carlos III de Madrid, Spain

01:20 - 01:40pm: Block Length Optimization in Data Deduplication Technique
Matrazali Noorafiza, Itaru Koike, Hiroto Yamasaki, Abdulhashim Rizalhasrin, and Toshiyuki Kinoshita
Graduate School of Computer Science, Tokyo University of Technology, Japan

01:40 - 02:00pm: Design of an Efficient Object-Oriented Software for an FPGA-based Scan Probe Microscope Controller
Adam Kollin, Steffen Porthun, Darrin Hanna, Charles Otlowski, Aarin Covyeau, Michael Lohrer, Katherine LaBelle, Jason Gorski
RHK Technology, Inc., Troy, Michigan, USA;
Schaefer Technologie GmbH, Langen, Germany;
Oakland University, Rochester, Michigan, USA

02:00 - 02:20pm: The Development and Validation of the Creep Damage Constitutive Equations for P91 Alloy
Xin Yang, Qiang Xu, Zhongyu Lu
Teesside University, Middlesbrough, UK;
University of Huddersfield, Huddersfield, UK

02:20 - 02:40pm: Neural Network Binary Multiplier
Han Huang, Fangyue Chen, Luxia Xu
Hangzhou Dianzi University, Hangzhou, Zhejiang, P. R. China

02:40 - 03:00pm: The Development of Finite Element Analysis Software for Creep Damage Analysis
Dezheng Liu, Qiang Xu, Zhongyu Lu, Donglai Xu, Feng Tan
Teesside University, Middlesbrough, UK;
University of Huddersfield, Huddersfield, UK

03:00 - 03:20pm: BREAK

SESSION 2-MSV: SIMULATION AND NUMERICAL METHODS
Co-Chairs: TBA
July 22, 2013 (Monday); 03:20pm - 06:00pm
(LOCATION: Montecristo 4)

03:20 - 03:40pm: Anti-Symmetry and Logic Simulation
Peter M. Maurer
Baylor University, Waco, Texas, USA

03:40 - 04:00pm: Fire and Flame Simulation using Particle Systems and Graphical Processing Units
T. S. Lyes and K. A. Hawick
Massey University, Auckland, New Zealand

04:00 - 04:20pm: Modulo 10M Calculator Increases Simulation Precision
Scott Imhoff, Palak Thakkar, Thomas Wang, Kendy Hall
Raytheon Company, Intelligence and Information Systems, Colorado, USA

04:20 - 04:40pm: Interactive Simulation and Visualisation of Falling Sand Pictures on Tablet Computers
B. Pearce and K. A. Hawick
Massey University, Auckland, New Zealand

04:40 - 05:00pm: Fast Fluid Simulation on Three-Dimensional Parameterized Structured Grids

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                     Vitor Barroso, Waldemar Celes, Marcelo Gattass
                     Department of Informatics - Tecgraf, PUC-Rio, Brazil

05:00 - 05:20pm:     Integration of Numerical Simulation Data with Immersive
                     3D Visualization
                     Dong Fu, John (Jack) Moreland, Litao Sheng, Bin Wu,
                     and Chenn Q. Zhou
                     Center for Innovation through Visualization and Simulation
                     (CIVS), Purdue University Calumet, Hammond, USA

05:20 - 05:40pm:     HumMod-Golem Edition: large scale model of integrative
                     physiology for virtual patient simulators
                     Jiri Kofranek, Marek Matejak, Pavol Privitzer, Martin Tribula,
                     Tomas Kulhanek, Jan Silar, Rudolf Pecinovsky
                     Charles University in Prague, Lab. of Biocybernetics, Prague,
                     Czech Republic; Creative Connections, Ltd., Czech Republic

05:40 - 06:00pm:     FREE SLOT


06:00 - 09:00pm:     TUTORIALS + PANEL DISCUSSIONS
                     (Please see the lists at the begining of this book)

09:10 - 11:30pm:     CONFERENCE RECEPTION DINNER / SOCIAL
                     July 22 - Monday; 09:00pm - 11:45pm
                     (LOCATION: Pavilion)


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July 23 July 23 July 23 July 23 July 23 July 23 July 23 July 23 July 23
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6:45am - 5:00pm:     REGISTRATION (LOCATION: Cohiba 5)


SESSION 3-MSV:       SIMULATION AND NUMERICAL METHODS + MODELING
                     Co-Chairs: TBA
                     July 23, 2013 (Tuesday); 08:00am - 10:20am
                     (LOCATION: Montecristo 4)

08:00 - 08:20am:     Simulation and Monitoring of a University Network for
                     Bandwidth Efficiency Utilization
                     Samuel N. John, Charles U. Ndujuiba, Robert Okonigene,
                     and Ndeche Kenechukwu
                     Covenant University, Ogun State, Nigeria

08:20 - 08:40am:     EpiViz: A Visual Simulation of an Epidemic Model Using a
                     Cellular Automaton
                     Matthew J. Farmer and Tina V. Johnson
                     Midwestern State University, Texas, USA

08:40 - 09:00am:     Numeric Simulation Tool of the Weaving Process
                     J. Vilfayeau, F. Boussu, D. CrePin, D. Soulat, P. Boisse
                     ENSAIT, GEMTEX, Roubaix, France;
                     LAMCOS, UMR CNRS, INSA Lyon, Villeurbanne, France;
                     University Lille Nord de France, Lille, France

09:00 - 09:20am:     Effective Early Stage Model-Based Testing for an IT UI
                     Application
                     Xin Bai and Alexander Ivaniukovich
                     Microsoft Corporation, One Microsoft Way, Redmond,
                     Washington, USA

09:20 - 09:40am:     Survey of Techniques to Increase Accuracy of Touch Screen Devices
                     Xiaoyuan Suo
                     Webster University, Saint Louis, MO, USA

09:40 - 10:00am:     Translating MOKA Based Knowledge Models into a Generative CAD
                     Model in CATIA V5 Using Knowledgeware
                     Lohith ML, Laxmi Prasanna, Devaraja Holla Vaderahobli
                     Infosys Limited, Washington, USA

10:00 - 10:20am:     FPGA Synthesis of Glucose-Insulin Feedback System
                     SouravDutta and Nazeih M. Botros
                     Southern Illinois University Carbondale, Illinois, USA


10:20 - 11:00am:     POSTER/DISCUSSION SESSION A-CSC-MSV-CGVR
                     July 23, 2013 (Tuesday)
                     (LOCATION: Cohiba 8-9)
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O. Effective Parallel Simulation of Coupled Processes in CO2 Sequestration in Porous and Fractured Formations
Yu-Shu Wu, Ronglei Zhang, P. H. Winterfeld
Petroleum Engineering Dept., Colorado School of Mines, Colorado, USA
O. Simulation of a Remote Sensing System for Fire Detection
Carsten Paproth and Anko Borner
Optical Information Systems, German Aerospace Center, DLR, Berlin, Germany
O. Numerical Simulation of Supersonic Combustion Using Liquid Hydrocarbon Fuel
Tsung Leo Jiang, Jui-Chi Cheng, Hsiang-Yu Huang
Department of Aeronautics and Astronautics, National Cheng Kung University, Tainan City, Taiwan, ROC
O. ...

SESSION 4-CGVR: VIRTUAL REALITY + GRAPHICS + ANIMATION & RELATED METHODS
Co-Chairs: TBA
July 23, 2013 (Tuesday); 11:00am - 02:20pm
(LOCATION: Montecristo 4)

11:00 - 11:20am: Plasma Visualization in Parallel Using Particle Systems on Graphical Processing Units
T. S. Lyes and K. A. Hawick
Massey University, Auckland, New Zealand

11:20 - 11:40am: The Component Entity System for Virtual Environments
Justin Ehrlich
Western Illinois University, Macomb, Illinois, USA

11:40 - 12:00pm: Data Structures Learning - A Visually Assisted Approach
Loay Alzubaidi and Ammar El Hassan
Prince Muhammad bin Fahd University, Saudi Arabia

12:00 - 12:20pm: Generation and Rendering of Fractal Terrains on Approximated Spherical Surfaces
J. M. Willemse and K. A Hawick
Massey University, Auckland, New Zealand

12:20 - 01:20pm: LUNCH (On Your Own)

SESSION 4-CGVR: Continued ... VIRTUAL REALITY + GRAPHICS + ANIMATION & RELATED METHODS
(LOCATION: Montecristo 4)

01:20 - 01:40pm: BodySpeech: A configurable full body animation system for speaking avatars
Adso Fernandez-Baena, Marc Antonijoan, Raul Montano
Grup de Tecnologies Media (GTM), La Salle - Universitat Ramon Llull, Barcelona, Spain

01:40 - 02:00pm: Animating TTS Messages in Android Using OpenSource Tools
Ronald Yu, Tong Lai Yu, Ihab Zbib
University of California, Irvine, California, USA;
California State University, San Bernardino, California, USA

02:00 - 02:20pm: A Pipeline From COLLADA to WebGL for Skeletal Animation
Jeffery McRiffey, Ralph M. Butler, Chrisila C. Pettey
Middle Tennessee State University, Murfreesboro, Tennessee, USA

SESSION 5-MSV: VISUALIZATION, GRAPHICAL USER INTERFACE, TOOLS & TECHNIQUES
Co-Chairs: TBA
July 23, 2013 (Tuesday); 02:20pm - 04:20pm
(LOCATION: Montecristo 4)

02:20 - 02:40pm: Visualization of Mobility-density Relation in a Modified Percolation Agent-based Model
Bruce Paizen, Jay Kraut, Marcia R. Friesen, Robert D. McLeod
University of Manitoba, Canada; Associated Engineering Group Ltd.; Laboratory for Surgical Modeling, Simulation and Robotics, Health Sciences Centre, Winnipeg, Manitoba, Canada

02:40 - 03:00pm: Triangular Prism Element Optimization for Mesh Visualization of Printed Circuit Boards
Karen Daniels and Shu Ye
University of Massachusetts Lowell, Massachusetts, USA

03:00 - 03:20pm: BREAK

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03:20 - 03:40pm:  VisualNet: General Purpose Visualization Tool for Wireless
                  Sensor Networks
                  Saad Rizvi and Ken Ferens
                  University of Manitoba, Winnipeg, Manitoba, Canada

03:40 - 04:00pm:  Effective Visualization Tool for Job Searching
                  Yilin Gu, Andries H. Smith, Jong Kwan Lee, Xinyue Ye,
                  and Soo K. Kim
                  Bowling Green State University, Ohio, USA;
                  Clarion University of Pennsylvania, PA, USA

04:00 - 04:20pm:  Development of the Web-Based Structure and Form Analysis
                  System (SAFAS) for Architectural Education
                  Mehdi Setareh, Felipe Bacim, Nicholas Polys, Brett Jones
                  Virginia Tech, Blacksburg, Virginia, USA


SESSION 6-CSC:    SCIENTIFIC & ENGINEERING ALGORITHMS & APPLICATIONS + COMPLEX
                  SYSTEMS + MEDICAL SCIENCE
                  Co-Chairs: TBA
                  July 23, 2013 (Tuesday); 04:20pm - 06:00pm
                  (LOCATION: Montecristo 4)

04:20 - 04:40pm:  A Random Number Based Method for Monte Carlo Integration
                  Jin Wang
                  Valdosta State University, Valdosta, Georgia, USA

04:40 - 05:00pm:  Implementing Universal CNN Neuron
                  Luxia Xu, Fangyue Chen, Han Huang
                  Hangzhou Dianzi University, Hangzhou, Zhejiang, P. R. China

05:00 - 05:20pm:  Practical Guidance on the Application of R-K Integration Method
                  in Finite Element Analysis of Creep Damage Problem
                  Feng Tan, Qiang Xu, Zhongyu Lu, Donglai Xu, Dezheng Liu
                  Teesside University, Middlesbrough, UK;
                  University of Huddersfield, Huddersfield, UK

05:20 - 05:40pm:  On the Exact Explicit Solutions of a Generalized (2+1)-Dimensional
                  Zakharov-Kuznetsov-Benjamin-Bona-Mahony Equation
                  Khadijo Rashid Adem and Chaudry Masood Khalique
                  International Institute for Symmetry Analysis and Mathematical
                  Modelling, North-West University, Mafikeng Campus, South Africa

05:40 - 06:00pm:  Intuitionistic Fuzzy Bi-Ideal of a Ring
                  P.K.Sharma and Aradhna Duggal
                  P.G. Department of Mathematics, D.A.V.College, Jalandhar City,
                  Punjab , India; Department of Mathematics, S.G.G.S. Khalsa
                  College, Mahil Pur, Punjab, India


06:00 - 09:00pm:  TUTORIALS + PANEL DISCUSSIONS
                  (Please see the lists at the begining of this book)


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6:45am - 5:00pm:  REGISTRATION (LOCATION: Cohiba 5)


SESSION 7-CSC:    SCIENTIFIC & ENGINEERING ALGORITHMS & APPLICATIONS +
                  COMPLEX SYSTEMS + MEDICAL SCIENCE
                  Co-Chairs: TBA
                  July 24, 2013 (Wednesday); 08:00am - 09:40am
                  (LOCATION: Montecristo 4)

08:00 - 08:20am:  FREE SLOT

08:20 - 08:40am:  Emergent Properties, Identical Elements in a Recursive Loop
                  and Systems with Unobservable Energy
                  Guido Massa Finoli
                  IT Advisor, Rome, Italy

08:40 - 09:00am:  A Review of Creep Deformation and Rupture Mechanisms of Low
                  Cr-Mo Alloy for the Development of Creep Damage Constitutive
                  Equations Under Lower Stress
                  Qihua Xu, Qiang Xu, Zhongyu Lu, Yongxin Pang, Michael Short
                  University of Huddersfield, Huddersfield, UK;
                  Teesside University, Middlesbrough, UK
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09:00 - 09:20am: Review of Creep Deformation and Rupture Mechanism of P91 Alloy for the Development of Creep Damage Constitutive Equations Under Low Stress Level
Lili An, Qiang Xu, Donglai Xu, Zhongyu Lu
Teesside University, Middlesbrough, UK;
University of Huddersfield, Huddersfield, UK

09:20 - 09:40am: New Exact Solutions of a Coupled Korteweg-de Vries Equation
D. M. Mothibi and C. M. Khalique
North-West University, Mafikeng Campus, Mmabatho, South Africa

SESSION 8-CSC: SIMULATION, MODELING, & VISUALIZATION METHODS
Co-Chairs: TBA
July 24, 2013 (Wednesday); 09:40am - 12:20pm
(LOCATION: Montecristo 4)

09:40 - 10:00am: Multi-Species Screening in Anti-Ferromagnetic Pair-Annihilation Model Simulations
K. A. Hawick
Massey University, Auckland, New Zealand

10:00 - 10:20am: Application of LabVIEW and SoildWorks-based Simulation Technique to Hybrid Motion Blending of a 6-axis Articulated Robot
Dong Sun Lee, Won Jee Chung, Jun Ho Jang
Changwon National University, South Korea

10:20 - 11:00am: POSTER/DISCUSSION SESSION B-CSC-MSV-CGVR
July 23, 2013 (Tuesday)
(LOCATION: Cohiba 8-9)

O. Robust Synchronization of a Uncertain Complex Dynamical Network with Markovian Jumping Topology via Pinning Sampled-data Control
J. H. Park, T. H. Lee, H. Y. Jung, J. H. Lee
Yeungnam University, Republic of Korea; Robotics Research Division, Daegu-Geongbuk Institute of Science & Technology, Daegu, Republic of Korea
O. Camera Tracking for Implementation of Augmented Reality
Boo-Gyum Kim, Jong-Soo Choi, Jin-Tae Kim
Solutionix Co., Ltd, Seoul, Korea; Chung-Ang University, Seoul, Korea; Hanseo University, Chungnam, Korea
O. ...

SESSION 8-CSC: Continued ... SIMULATION, MODELING, & VISUALIZATION METHODS
(LOCATION: Montecristo 4)

11:00 - 11:20am: Application of Simulation-X Based Simulation Technique to Notch Shape Optimization for a Variable Swash Plate Type Piston Pump
Jun Ho Jang, Won Jee Chung, Dong Sun Lee, Young Hwan Yoon
Changwon National University, South Korea

11:20 - 11:40am: Parallelization of a Multi-physics Code
William Dai, A. J. Scannapieco, Frederick Cochran, James Painter, and Chong Chang
Los Alamos National Laboratory, Los Alamos, New Mexico, USA

11:40 - 12:00pm: Global Sensitivity Analysis of Dam Erosion Models
Mitchell L. Neilsen and Ronald D. Tejral
Kansas State University, Manhattan, Kansas, USA;
Hydraulic Engineering Research Unit, USDA Agricultural Research Service, Stillwater, Oklahoma, USA

12:00 - 12:20pm: Persistence of Plummer-Distributed Small Globular Clusters as a Function of Primordial-Binary Population Size
Jack K. Horner
Los Alamos, New Mexico, USA

12:20 - 01:20pm: LUNCH (On Your Own)

SESSION 9-CGVR: VIRTUAL REALITY + GRAPHICS + RELATED METHODS
Co-Chairs: TBA
July 24, 2013 (Wednesday); 01:20pm - 02:20pm
(LOCATION: Montecristo 4)

01:20 - 01:40pm: Facial Expression Recognition Using Adaptive Templates
Antoinette Attipoe, Jie Yan
Bowie State University

01:40 - 02:00pm: Proposal of the Digital Art Watching System Letting

Picture and Visitor Fuse in Real Time
Koji Fujita and Takayuki Fujimoto
Graduate School of Engineering, Toyo University, Japan

02:00 - 02:20pm: Mixed Presence - A Platform to Showcase a Virtual and Live Event
Madhvi Kamra and Ratnamala Manna
Innovation Lab, Tata Consulting Services, India

SESSION 10-MSV: VISUALIZATION, GRAPHICAL USER INTERFACE, TOOLS & TECHNIQUES
Co-Chairs: TBA
July 24, 2013 (Wednesday); 02:20pm - 05:00pm
(LOCATION: Montecristo 4)

02:20 - 02:40pm: MARWind: Mobile Augmented Reality Wind Farm Visualization
John Moreland, Qiuhao Zhang, Gerald Dekker, Chenn Zhou
Purdue University Calumet, Hammond, USA

02:40 - 03:00pm: How Data can become Data a Movie Star?
Hans-Peter Bischof
Rochester Institute of Technology, Rochester, NY, US

03:00 - 03:20pm: BREAK

03:20 - 03:40pm: Integration of Augmented Reality with Computational Fluid Dynamics for Power Plant Training
John Moreland, Jichao Wang, Yanghe Liu, Fan Li, Litao Shen, Bin Wu, and Chenn Zhou
Purdue University Calumet, USA

03:40 - 04:00pm: Monitoring of Mixing Process by Visualization of Stirred Bio-diesel Production Reactor Using Electrical Capacitance Tomography
Syed F.A. Bukhari and Adesoji A. Adesina
Sir Syed University of Engineering & Technology, Karachi, Pakistan; Reactor Engineering & Technology Group, School of Chemical Engineering, University of New South Wales, Sydney, NSW, Australia

04:00 - 04:20pm: FREE SLOT

04:20 - 04:40pm: FREE SLOT

04:40 - 05:00pm: FREE SLOT

06:00 - 09:00pm: TUTORIALS + PANEL DISCUSSIONS
(Please see the lists at the begining of this book)

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6:45am - 5:00pm: REGISTRATION (LOCATION: Cohiba 5)

SESSION 11-CSC: COMPUTATIONAL SCIENCE AND APPLICATIONS
Co-Chairs: TBA
July 25, 2013 (Thursday); 08:00am - 11:20am
(LOCATION: Montecristo 4)

08:00 - 08:20am: FREE SLOT

08:20 - 08:40am: An Effective Method for Managing Voluminous Data: Reducing Data to Significant Size for Efficient Results
Haydar Teymourlouei
Bowie State University, Bowie, Maryland, USA

08:40 - 09:00am: A Computational Model for Cultural Intelligence
Zhao Xin Wu
University of Quebec in Montreal, Montreal, QC, Canada

09:00 - 09:20am: Power Spectra of Ionospheric Scintillation
G. V. Jandieri and A. Ishimaru
Georgian Technical University, Tbilisi, Georgia; University of Washington, Seattle, Washington, USA

09:20 - 09:40am: Nonlinear Vibration of Fluid-loaded Double-walled Carbon Nanotubes Subjected to a Moving Load Based on Stochastic FEM
Tai-Ping Chang and Quey-Jen Yeh

National Kaohsiung First University of Science and Technology,
Kaohsiung, Taiwan; National Cheng-Kung University, Tainan, Taiwan

09:40 - 10:00am: A Framework for Scientific Data Management in the Cloud
Verena Kantere
University of Geneva, Switzerland

10:00 - 10:20am: Pulsatile Flow of Hershel-Bulkley Fluid in Tapered Blood Vessels
R. Ponalagusamy
National Institute of Technology, Tiruchirappalli, India

10:20 - 10:40am: BREAK

10:40 - 11:00am: Classical Dynamic Ising Model
M. George, C. Turquois, F. F. Yepiz, Jr.
Southwestern College, Chula Vista, California, USA;
University of California, San Diego, La Jolla, California, USA

11:00 - 11:20am: Flow of a Micropolar Fluid Through a Stenosed Artery with Radially Variable Viscosity
A. K. Banerjee, R. Ponalagusamy, R. Tamil Selvi
National Institute of Technology, Tiruchirappalli, India

SESSION 12-CSC-MSV: TOPICS IN SCIENTIFIC COMPUTING + MODELING, SIMULATION & VISUALIZATION METHODS:
LATE BREAKING PAPERS AND POSITION PAPERS + LATE PAPERS
Co-Chairs: TBA
July 25, 2013 (Thursday); 11:20am - 04:00pm (at the latest)
(LOCATION: Montecristo 4)

NOTE: We anticipate a large number of speaker no-shows for this track; this is due to potential delay in obtaining US visa, non registration, ... In cases of no-shows, the presentations can be moved up in order to close time gaps in the session. Each talk can be 15 to 20 minutes long. The 60-minute lunch break is at 12:40pm.

O. The Transformation of Web Pages Towards a Consistent Layout to Gauge the Change in User Performance
Gautham Krishna Mamidi and Ratvinder Singh Grewal
Department of Computational Sciences, Laurentian University, Sudbury, Canada
O. Fast Detection and Visualization with Parallel Coordinates of Automated Living Context-Awareness Environments
Pei Ling Lai ,Jin Liang Yang, Ching-Pu Chen, Shih Chung Chen, and Alfred Inselberg
Southern Taiwan University of Science and Technology, Taiwan;
School of Mathematical Sciences, Tel Aviv University, Israel
O. Procedural Generation of Terrain Within Highly Customizable JavaScript Graphics Utilities for WebGL
T. H. McMullen and K. A. Hawick
Massey University, Auckland, New Zealand
O. Predicting Hysteresis Loss in Hip Joint Implants
Mohammad Hodaei and Kambiz Farhang
Southern Illinois University Carbondale, Illinois, USA
O. Structured Fuzzy Based Methodological Approach Towards Sustainability Performance Assessment
C. Bokhoree and P. O. St Flour
University of Technology, Mauritius
O. Heart Disease Risk Detection with Competitive Learning and Adaptive Fuzzy Inference System, A Mobile Application
S. M. Farshchi
Tehran Institute for Scientific Methodology, Tehran, Iran
O. An HHT-based Supercomputing Engine Design for Non-linear and Non-Gaussian Signal Processing Applications
Chia-Ching Chou and Wai-Chi Fang
National Chiao Tung University, Hsinchu, Taiwan, ROC
O. Neighbourhood and Number of States Dependence of the Transient Period and Cluster Patterns in Cyclic Cellular Automata
K. A. Hawick
Massey University, Auckland, New Zealand
O. Fast Operations for Certain Two Alphabet Circulant Matrices
Gene Awyzio and Jennifer Seberry
Centre for Information Security Research, Faculty of Engineering and Information Sciences, University of Wollongong, NSW, Australia
O. Using the Centinel Data Format to Decouple Data Creation from Data Processing in Scientific Programs
Clarence Lehman and Adrienne Keen
University of Minnesota, Saint Paul, Minnesota, USA;
London School of Hygiene and Tropical Medicine, London, UK

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O. Modeling and Simulation of Standard II Missiles Intercepting a
   Low Target
   Jinyong Yu and Junwei Lei
   Naval Aeronautical & Astronautical University, Yantai, P. R. China
O. From Turing Machine to Hypercomputational Systems and Quantum
   Theory, A Conceptual Review
   Sam Farshchi
   Tehran Institute for Scientific Methodology, Tehran, Iran
O. Completeness Relation Connected With Spectral Expansion On The Entire
   Axis Of The Green Function For a Two-Layer Medium in Fundamental
   Functions of a Self-Adjoint Sturm-Liouville Operator
   E. G. Saltykov
   Lomonosov Moscow State University, Moscow, Russia
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Nonlinear Vibration of Fluid-loaded Double-walled Carbon Nanotubes Subjected To A Moving Load Based on Stochastic FEM

Tai-Ping Chang[1] **and Quey-Jen Yeh**[2]

[1] *Department of Construction Engineering, National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan*

[2] *Department of Business Administration, National Cheng-Kung University, Tainan, Taiwan*

Abstract - *This paper adopts stochastic FEM to study the statistical dynamic behaviors of nonlinear vibration of the fluid-conveying double-walled carbon nanotubes (DWCNTs) under a moving load by considering the effects of the geometric nonlinearity and the nonlinearity of van der Waals (vdW) force. The Young's modulus of elasticity of the DWCNTs is considered as stochastic with respect to the position to actually characterize the random material properties of the DWCNTs. Besides, the small scale effects of the nonlinear vibration of the DWCNTs are studied by using the theory of nonlocal elasticity. Based on the Hamilton's principle, the nonlinear governing equations of the fluid-conveying double-walled carbon nanotubes under a moving load are formulated. The stochastic finite element method along with the perturbation technique is adopted to study the statistical dynamic response of the DWCNTs. Some statistical dynamic response of the DWCNTs such as the mean values and standard deviations of the non-dimensional dynamic deflections are computed and checked by the Monte Carlo Simulation, meanwhile the effects of the nonlocal parameter and aspect ratio on the statistical dynamic response of the DWCNTs are investigated. It can be concluded that the nonlocal solutions of the dynamic deflections get larger with the increase of the nonlocal parameters due to the small scale effect, and as the aspect ratio increases, the small scale effect has less effect on the maxima non-dimensional dynamic deflections of the DWCNT*s.

Keywords: Nonlinear vibration; Double-walled carbon nanotubes; Stochastic FEM; Perturbation technique; Small scale effect.

1 Introduction

Since the landmark paper published by Iijima [1], carbon nanotubes (CNTs) have attracted worldwide attention due to their potential use in the fields of chemistry, physics, nano-engineering, electrical engineering, materials science, reinforced composite structures and construction engineering. Carbon nanotubes (CNTs) are used for a variety of technological and biomedical applications including nanocontainers for gas storage and nanopipes conveying fluids [2-8]. Some important applications of carbon nanotubes (CNTs) are such as nanotubes conveying fluids [3,7-8], different types of fluid flows like water [9], dynamic flow of methane, ethane and ethylene molecules [10] and the diffusive transport of light gases [11] had been reported, and the effects of these fluids on the mechanical properties of CNTs had been investigated. Natsuki et al. [12] adopted a simplified Flügge shell model to investigate the wave propagation of single- and double-walled CNTs conveying fluid. The single-elastic beam model [13-14] and the multiple-elastic beam model [15-19] were also broadly adopted to study the dynamic behaviors of fluid-conveying single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs). The vibration frequencies of the linear system and the system's stability related to the internal moving fluid were investigated. Moreover, the nonlocal elasticity theory was incorporated into the elastic beam model to study the small scale effect on the dynamics of SWCNT conveying fluid [20]. Chang and Liu [21-22] studied small scale effects on the flow-induced instability of double-walled carbon nanotubes (DWCNTs) by using the nonlocal elasticity theory. More recently, Chang [23-24] investigated the thermal-mechanical vibration and instability of fluid-conveying single-walled carbon nanotubes (SWCNTs) based on nonlocal elasticity theory. Generally speaking, the beam models mentioned above are linear; however, the vdW forces in the interlay space of MWCNTs are essentially nonlinear. Furthermore, the slender ratios are normally large if the beam models are adopted, that is, the large deformation will occur. Therefore, it is quite essential to consider two types of nonlinear factors, namely, the geometric nonlinearity and the nonlinearity of vdW force in investigating the dynamic behaviors of fluid-conveying MWCNTs. Kuang et al. [25] investigated the dynamic behaviors of double-walled carbon nanotubes (DWCNTs) conveying fluid by considering two types of nonlinearities mentioned above. Due to the rapid process of nanotechnology, the motion of neutral atoms and nanoparticles in nanotubes has been of remarkable interest [26]. Carbon nanotubes are utilized as molecular channels for the transportation of nanoparticles, such as water and protons [27]. In the process of these applications, carbon nanotubes might be subjected to moving load, and this causes the transverse vibration of carbon nanotubes. Therefore, it is quite necessary to investigate the dynamic behavior of carbon nanotubes under moving loads. So far, most researchers have studied static, buckling or free vibration analysis of nanotubes or nanobeams based on the local or nonlocal elasticity theory, forced vibration of DWCNTs under moving loads is rarely investigated. Until recently, Simsek [28] performed the vibration analysis of a SWCNT under action of a moving harmonic load based on nonlocal elasticity theory. Kiani and Wang [29] adopted nonlocal elasticity theory to investigate the interaction of a single-walled carbon nanotube with a moving nanoparticle.

Salvetat et al. [30] measured the flexural Young's modulus and shear modulus using AFM test on clamped–clamped nanoropes, getting values with 50% of error. Information related to statistical distributions of experimental data is also rare, and the important study from Krishnan et al. [31] provides one of the few examples available of histogram distribution of the flexural Young's modulus derived from 27 CNTs. The Young's modulus was estimated observing free-standing vibrations at room temperature using transmission electro-microscope (TEM), with a mean value of 1.3 TPa -0.4 TPa/+0.6 TPa. Pronouncedly, in [32], stochastically averaged probability amplitude for the vibration modes is computed to obtain the root-mean-square vibration profile along the length of the tubes. Uncertainty is also associated to the equivalent atomistic-continuum models adopted extensively in particular by the engineering and materials science communities. Hence, to be realistic, the Young's modulus of elasticity of carbon nanotube (CNTs) should be considered as stochastic with respect to the position to actually describe the random property of the CNTs under certain conditions. In the present study, we investigate the statistical dynamic behaviors of nonlinear vibration of the fluid-conveying double-walled carbon nanotubes (DWCNTs) under a moving load by considering the effects of the geometric nonlinearity and the nonlinearity of van der Waals (vdW) force. The Young's modulus of elasticity of the DWCNTs is considered as stochastic with respect to the position to actually characterize the random material properties of the DWCNTs. In addition, the small scale effects on the nonlinear vibration of the DWCNTs are studied by using the theory of nonlocal elasticity. Based on the Hamilton's principle, the nonlinear governing equations of the fluid-conveying double-walled carbon nanotubes under a moving load are formulated. The stochastic finite element method along with the perturbation technique is adopted to study the statistical response of the DWCNTs; in particular, the Newton-Raphson iteration procedure in conjunction with Newmark scheme is utilized to solve the nonlinearity of the dynamic governing equation of the DWCNTs. The effects of the nonlocal parameter and aspect ratio on the statistical dynamic response of the DWCNTs are investigated.

2 Nonlinear beam model for fluid-conveying DWCNTs under a moving load

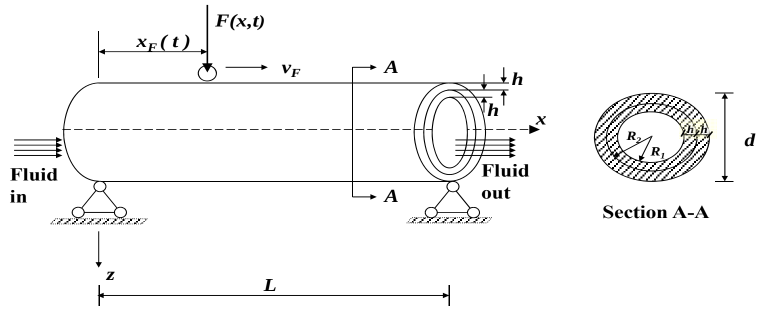

Fig. 1. Fluid-conveying DWCNTs under a moving load

In Fig. 1, the double-walled carbon nanotubes (DWCNTs) is modeled as a double-tube pipe which is composed of the inner tube of radius R_1 and the outer tube of radius R_2. The thickness of each tube is h, the length is L, and Young's modulus of elasticity is E. It is noted that the Young's modulus of elasticity E is assumed as stochastic with respect to the position to actually describe the random material property of the DWCNTs. The internal fluid is assumed to flow steadily through the inner tube with a constant velocity U. Besides, the boundary conditions of the DWCNTs are assumed as simply-supported at both ends. Based on the theory of Euler–Bernoulli beam and a nonlinear strain–displacement relationship of Von Karman type, the displacement field and strain–displacement relation can be written as follows:

$$\begin{aligned} \bar{u}_i(x,z,t) &= u_i(x,t) - z\frac{\partial w_i}{\partial x} \\ \bar{w}_i(x,z,t) &= w_i(x,t) \\ \varepsilon_i &= \frac{\partial \bar{u}_i}{\partial x} + \frac{1}{2}\left(\frac{\partial \bar{w}_i}{\partial x}\right)^2 \end{aligned} \tag{1}$$

where x is the axial coordinate, t is time, $\bar{u}_i$ and $\bar{w}_i$ denote the total displacements of the ith tube along the x coordinate directions, u_i and w_i define the axial and transverse displacements of the ith tube on the neutral axis, ε_i the corresponding total strain, and the subscript i = 1 and i = 2. Notice that tube 1 is the inner tube while tube 2 is the outer tube.

Based on Eq. (1), the potential energy V stored in a DWCNTs and the virtual kinetic energy T in the DWCNTs as well as the fluid inside the DWCNTs can be individually determined.

Based on Hamilton's principle, the variational form of the equations of motion for the DWCNTs can be given by

$$\int_{t_0}^{t_1} \left(\delta V - \delta T - \delta \Psi \right) dt = 0 \tag{2}$$

where $\delta\Psi$ is the virtual work due to the vdW interaction and the interaction between tube 1 and the flowing fluid.

Based on Eq. (2) and the formulations derived by Chang [22, 24], the coupled nonlinear governing equations for the vibration of DWCNTs conveying fluid based on nonlocal elasticity theory are given as follows:

$$\begin{aligned}
&\frac{\partial^2}{\partial x^2}\left\{\left[E(x)I_1 - (e_0 a)^2 MU^2\right]\frac{\partial^2 w_1}{\partial x^2}\right\} - 2(e_o a)^2 MU \frac{\partial^4 w_1}{\partial x^3 \partial t} - (e_o a)^2 (M+m_1)\frac{\partial^4 w_1}{\partial x^2 \partial t^2} \\
&+MU^2 \frac{\partial^2 w_1}{\partial x^2} - \int_0^L \left(\frac{\partial w_1}{\partial x}\right)^2 \left(\frac{E(x)A_1}{2L} + \frac{MU^2}{2L}\right) dx \frac{\partial^2 w_1}{\partial x^2} + \frac{3MU^2}{2}\left(\frac{\partial w_1}{\partial x}\right)^2 \frac{\partial^2 w_1}{\partial x^2} + \\
&(M+m_1)\frac{\partial^2 w_1}{\partial t^2} + 2MU \frac{\partial^2 w_1}{\partial x \partial t} - MU \frac{\partial w_1}{\partial t}\frac{\partial w_1}{\partial x}\frac{\partial^2 w_1}{\partial x^2} \qquad (3) \\
&= \left(1\text{-}(\mathrm{e}_0 a)^2 \frac{\partial^2}{\partial x^2}\right)\left(c_1 (w_2 - w_1)\right) + c_3 \left\{\left[\left(1\text{-}(\mathrm{e}_0 a)^2 \frac{\partial^2}{\partial x^2}\right) w_2\right] - \left[\left(1\text{-}(\mathrm{e}_0 a)^2 \frac{\partial^2}{\partial x^2}\right) w_1\right]\right\}^3
\end{aligned}$$

$$\begin{aligned}
&\frac{\partial^2}{\partial x^2}\left\{\left[E(x)I_2\right]\frac{\partial^2 w_2}{\partial x^2}\right\} + m_2 \frac{\partial^2 w_2}{\partial t^2} - (e_0 a)^2 m_2 \frac{\partial^4 w_2}{\partial x^2 \partial t^2} - \int_0^L \left(\frac{\partial w_2}{\partial x}\right)^2 \left(\frac{E(x)A_2}{2L}\right) dx \frac{\partial^2 w_2}{\partial x^2} \\
&= -(1\text{-}(\mathrm{e}_0\mathrm{a})^2 \frac{\partial^2}{\partial \mathrm{x}^2})(c_1 (w_2 - w_1)) - c_3 \left\{\left[\left(1\text{-}(\mathrm{e}_0\mathrm{a})^2 \frac{\partial^2}{\partial \mathrm{x}^2}\right) w_2\right] - \left[\left(1\text{-}(\mathrm{e}_0\mathrm{a})^2 \frac{\partial^2}{\partial \mathrm{x}^2}\right) w_1\right]\right\}^3 \\
&+\left(1\text{-}(\mathrm{e}_0\mathrm{a})^2 \frac{\partial^2}{\partial \mathrm{x}^2}\right) F_0 \delta(x - x_F) \qquad (4)
\end{aligned}$$

It is noted that the scale $e_0 a$ in the Eq. (3-4) will lead to small scale effect on the response of structures in nano-size. In Eqs. (3-4), it is assumed that the small scale effects on the nonlinear terms due to geometrical nonlinearity are neglected since they are normally small compared with those on the linear terms.

3 Solution by finite element method

In the present study, the finite element method is adopted to determine the solutions to Eqs. (3-4). Using the finite element formulation, we can obtain the governing matrix equation of the structure after assembly as follows:

$$[\mathbf{M}]\ddot{\mathbf{W}} + [\mathbf{C}]\dot{\mathbf{W}} + \mathbf{R}(\mathbf{W}) = \mathbf{P} \tag{5}$$

where $[\mathbf{M}]$ is the global consistent mass matrix of the structure, $[\mathbf{C}]$ is the global damping matrix of the structure, $\dot{\mathbf{W}}$ is the global velocity vector of the structure, $\ddot{\mathbf{W}}$ is the global acceleration vector of the structure, $\mathbf{W}$ is the global displacement vector of the structure, $\mathbf{P}$ is the global external force vector of the structure and $\mathbf{R}(\mathbf{W})$ is the global vector of restoring forces of the structure that depends on the displacement field. Based on equation (5), the governing equation of the structure at time $t+\Delta t$ is given by

$$[\mathbf{M}]\ddot{\mathbf{W}}^{t+\Delta t} + [\mathbf{C}]\dot{\mathbf{W}}^{t+\Delta t} + \left[\mathbf{K}_T^t\right]\Delta\mathbf{W} = \mathbf{P}^{t+\Delta t} - \mathbf{R}\left(\mathbf{W}^t\right) \tag{6}$$

The above equation can be solved by any direct time integration method even it is nonlinear. In order to improve the solution accuracy, it is necessary to carry out the equilibrium iteration in each time step. In this study, the Newton-Raphson method in conjunction with Newmark scheme is adopted to perform the numerical analysis.

4 Perturbation technique

In this study, only the Young's modulus of elasticity *E* is assumed to be stochastic in position, the geometric shapes and sizes of the structure and the moving load and the fluid load are assumed to be deterministic. Applying the perturbation technique, the randomly fluctuating Young's modulus of elasticity *E* can be assumed as:

$$E(x) = E^{(0)}\left[1 + \alpha(x)\right] = E^{(0)} + E^{(0)}\alpha(x) \tag{7}$$

where $E^{(0)}$ is the mean value of the Young's modulus of elasticity, $\alpha(x)$ is random variable with zero mean, and $E^{(0)}\alpha(x)$ is homogeneous stochastic field representing the fluctuation of the Young's modulus of elasticity around its mean value. Assuming the random variable α is uniform within the element, then the stochastic nodal displacement vector can be expanded about α by using Taylor series as:

$$\mathbf{W}^{t+\Delta t} = \mathbf{W}^{(0)t+\Delta t} + \sum_{i=1}^{NE} \mathbf{W}_i^{(1)t+\Delta t}\alpha_i + \frac{1}{2}\sum_{i=1}^{NE}\sum_{j=1}^{NE} \mathbf{W}_{ij}^{(2)t+\Delta t}\alpha_i\alpha_j + \ldots \tag{8}$$

$$\Delta\mathbf{W} = \Delta\mathbf{W}^{(0)} + \sum_{i=1}^{NE} \Delta\mathbf{W}_i^{(1)}\alpha_i + \frac{1}{2}\sum_{i=1}^{NE}\sum_{j=1}^{NE} \Delta\mathbf{W}_{ij}^{(2)}\alpha_i\alpha_j + \ldots \tag{9}$$

where the superscript (0) represents the mean value term, both i and j denote the element numbers, NE is the total number of the element and Σ means the merging with respect to element. Similarly, the restoring force vectors and the tangent stiffness matrix can be written in similar fashion. Then applying the perturbation technique to equation (6), the higher order terms are truncated, and comparing equal order terms for the random variable α, the zero, first, and second order equations for the problem are obtained, respectively. The solutions of these equations are achieved successively by using the procedures described in the previous section. The statistical dynamic responses of DWCNTs can be obtained after calculating the zero, first and second order equations. For example, at any fixed time, both expected value of deflection and autocorrelation of the deflection between two different points p and q can be obtained based on the first order approximation by neglecting the third term in equation (8) as follows:

$$E\left[\mathbf{W}\right]=\mathbf{W}^{(0)} \tag{10}$$

$$\begin{aligned}\mathbf{R}_{\mathbf{W}}\left(x_p,x_q\right)&=E\left[\left(\mathbf{W}-E\left[\mathbf{W}\right]\right)\left(\mathbf{W}-E\left[\mathbf{W}\right]\right)^T\right]\\&=\sum_{i=1}^{NE}\sum_{j=1}^{NE}\mathbf{W}_{pi}^{(1)}\mathbf{W}_{qj}^{(1)}E\left[\alpha_i\alpha_j\right]\end{aligned} \tag{11}$$

$$E\left[\alpha_i\alpha_j\right]=\mathrm{R}_\alpha\left(x_i-x_j\right)=\mathrm{R}_\alpha\left(\Delta x\right) \tag{12}$$

where $E[\bullet]$ is the expectation and the $R_\alpha\left(\Delta x\right)$ is the autocorrelation function of random variable α assuming that the Gaussian stochastic process of the Young's modulus of elasticity E is homogeneous with respect to the position, x_p and x_q are the coordinate at the center of the element p and q. Based on equation (11), the stochastic process of deflection is assumed to be homogeneous with respect to position as well, $R_{\mathbf{W}}\left(x_i,x_j\right)$ can be replaced by $R_{\mathbf{W}}\left(\Delta x\right)$. Therefore, the autocorrelation $R_{\mathbf{W}}\left(\Delta x\right)$ can be computed readily provided that the spectra density of the Young's modulus of elasticity is given.

5 Numerical examples and discussion

In the numerical computations, the simply supported boundary condition is considered for the DWCNTs conveying fluid. The inner and the outer tubes are assumed to have the same Young's modulus, the same thickness and the same mass density. The numerical values of the parameters are adopted as follows: Mean value of Young's modulus E=1 Tpa, tube thickness h=0.34 nm, mass density $\rho=2300Kg/m^3$, the mass density of water flow is $\rho_f=1000Kg/m^3$, the inner radius $R_1=0.7nm$ and the outer radius $R_2=1.04nm$, the standard deviation of random variable α is assumed as $\sigma_\alpha=0.1$. The length of the DWCNTs is considered as a variable for the different values of the aspect ratio L/d. In the present study, the nonlocal parameter is chosen as $0\le e_0a\le 2.0nm$ to investigate the small scale effects on the dynamic responses. For a constant velocity of the moving load, the non-dimensional dynamic deflection is normalized as the ratio between the dynamic deflection and the static deflection, which is $D=F_0L^3/48E^{(0)}I$, of a beam under a point load F_0 at the middle point of the beam. In the following numerical computations, the internal fluid velocity of the DWCNTs is assumed as $U=400\,m/\sec$, the non-dimensional velocity $\bar{V}=0.2$ is assumed for the moving load and the aspect ratio $L/d=10$ is considered, unless they are specified otherwise. In Figs. 2-3, the mean values and standard deviations of the non-dimensional dynamic deflections of the DWCNTs are depicted. Fig. 2 presents the mean value of the non-dimensional dynamic deflections $w_2(L/2,t)/D$ versus the non-dimensional time T for various values of the nonlocal parameter e_0a. As it can be seen from Fig. 2, the numerical results based on the present study are checked by Monte Carlo Simulation, they are in excellent agreements. Fig. 3 presents the standard deviation of the non-dimensional dynamic deflections $w_2(L/2,t)/D$ with respect to the normalized dimensional time T for various values of the nonlocal parameter e_0a. Once again, the numerical results based on the present study are in good agreements with those estimated by Monte Carlo Simulation except that the results from Monte Carlo Simulation are slightly larger than those from the present study. Fig. 4 presents the mean values of the maximum non-dimensional dynamic deflections $w_2(x,t)/D$ versus the aspect ratio L/d for various values of the nonlocal parameter e_0a at the constant moving load velocity $\bar{V}=0.2$. As it can be detected from the figure, the maxima non-dimensional dynamic deflections computed by using the nonlocal model are larger than those of the local (classical) model thanks to the small scale effect. Based on the results in Fig. 5, the maxima non-dimensional deflections get larger as the nonlocal parameter increases, and the effect of the nonlocal parameter depends on the aspect ratio.

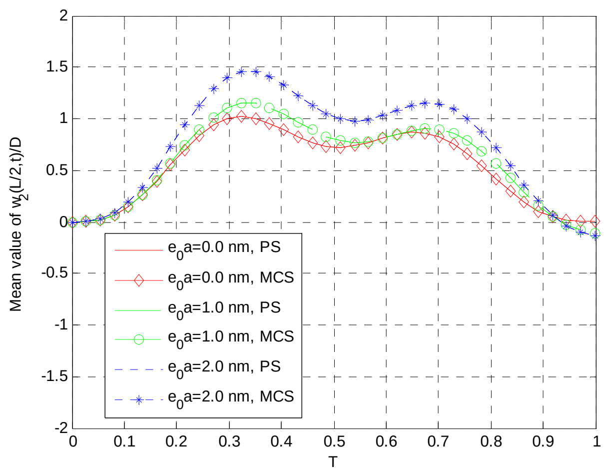

Fig. 2. Mean value of $w_2(L/2,t)/D$ versus dimensionless time T. PS=Present study, MCS=Monte Carlo Simulation.

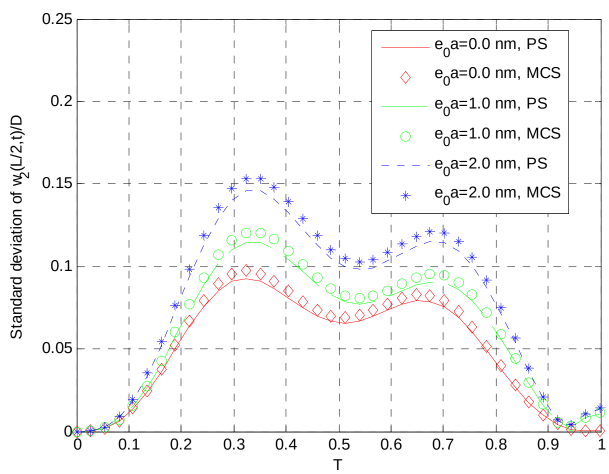

Fig. 3. Standard deviation of $w_2(L/2,t)/D$ versus dimensionless time T. PS=Present study, MCS=Monte Carlo Simulation.

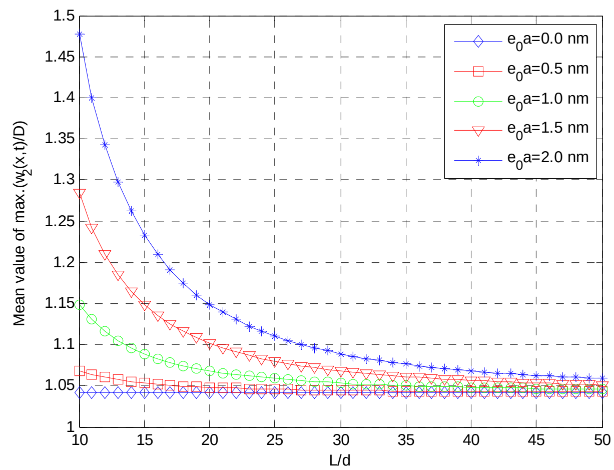

Fig. 4. Mean values of maxima non-dimensional deflections versus the aspect ratio L/d for $\bar{V}=0.2$.

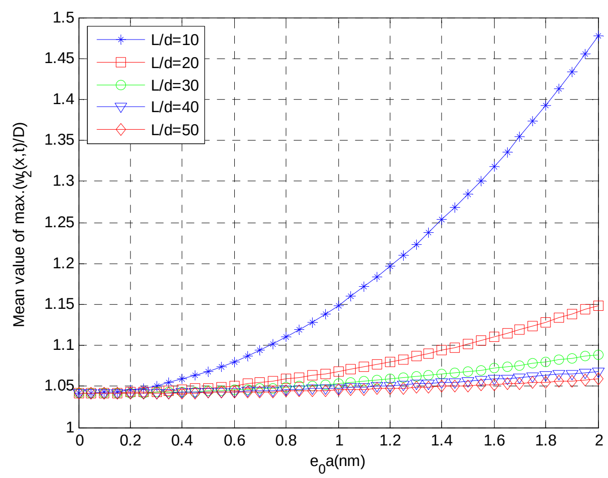

Fig. 5. Mean values of maxima non-dimensional deflections versus the nonlocal parameter e_0a for $\bar{V}=0.2$.

6 Conclusions

This paper investigates the statistical dynamic behaviors of nonlinear vibration of the fluid-conveying double-walled carbon nanotubes (DWCNTs) under a moving load by considering the effects of the geometric nonlinearity and the nonlinearity of van der Waals (vdW) force. The Young's modulus of elasticity of the DWCNTs is considered as stochastic with respect to the position to actually characterize the random material properties of the DWCNTs. In addition, the small scale effects of the nonlinear vibration of the DWCNTs are studied by using the theory of nonlocal elasticity. Based on the Hamilton's principle, the nonlinear governing equations of the fluid-conveying double-walled carbon nanotubes under a moving load are formulated. The stochastic finite element method along with the perturbation technique is adopted to study the statistical response of the DWCNTs; in particular, the Newton-Raphson iteration procedure in conjunction with Newmark scheme is utilized to solve the nonlinearity of the dynamic governing equation of the DWCNTs. Some statistical results obtained by the perturbation technique and those from the Monte Carlo simulation approach show good agreements. Some statistical dynamic response of the DWCNTs such as the mean values and standard deviations of the non-dimensional dynamic deflections are calculated, meanwhile the effects of the nonlocal parameter and aspect ratio on the statistical dynamic response of the DWCNTs are investigated. It can be concluded that the nonlocal solutions of the dynamic deflections get larger with the increase of the nonlocal parameters due to the small scale effect. It is noted that the computed stochastic dynamic response plays an important role in evaluating the structural reliability of the DWCNTs.

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7 References

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