The 3rd Symposium on Computational Marine Hydrodynamics

(The 3rd CMHL Symposium 2019)

(第三届 CMHL 船舶与海洋工程计算水动力学专题研讨会)

Dec. 12-13, 2019

Mulan Building Room No. B808, Minhang Campus,

Shanghai Jiao Tong University

SJTU Computational Marine Hydrodynamics Lab (CMHL) was founded in 2006. To meet the requirements of marine structures design for digitization, refinement, intelligence and system synthesis, CMHL has long been devoted to the researches of advanced CFD methods for marine hydrodynamics, developments of CAE software and platform, as well as applications of CAE software for complex flows in the fields of integrated ship, marine structures, underwater vehicles, offshore renewable energy devices, etc.

CMHL Symposium is named after“CMHL”and held every year to provide a forum for promoting scientific advancement, technological progress, information exchange, and innovative cooperation among scientists, researchers, engineers, developers, modellers and users of CAE software for solutions of marine hydrodynamics and other related fields. It is an attractive event opening to scientists, scholars, engineers, students, developers and users from universities, institutes as well as industries to exchange ideas and share recent advances on computational marine hydrodynamics and applications of CFD simulations for naval architecture and ocean engineering.

The first CMHL Symposium was held on Dec. 27-28, 2018 and Prof. Changhong Hu from Kyushu University was invited to deliver one hour plenary lecture. The 2nd CMHL Symposium was held on May 7-8, 2019 and Prof. Frederick Stern from University of Iowa was invited to deliver one hour plenary lecture. The coming 3rd CMHL Symposium co-organized with ***Journal of Hydrodynamics*** and sponsored by ***Lloyd's Register Shanghai*** will be taken place on Dec. 12-13, 2019. Prof. Atilla Incecik, Prof. Changhong Hu and Prof. Aman Zhang are invited to deliver one hour plenary lecture, and Prof. Guiyong Zhang, Prof. Shiqiang Yan and researchers from CMHL are invited to present their outstanding and latest research results.

18:00-20:00 Thursday, Dec. 12, 2019 Reception Dinner

CMHL Symposium

09:00-17:35, Friday, Dec. 13, 2019, Mulan Building Room No. B808, SJTU

09:00-09:05 Opening Speech and Chair Prof. Decheng Wan

09:05-10:05 Plenary Lecture 1

Ocean Science and Engineering Research and Education for Sustainable Utilisation of Ocean Resources

Prof. Atilla Incecik, Faculty of Engineering, University of Strathclyde, UK

10:05-11:05 Plenary Lecture 2

Development of Unstructured Grid Free Surface Flow Solver

Prof. Changhong Hu, Kyushu University, Japan

11:05-12:05 Plenary Lecture 3

Underwater Explosion and Its Damage Characteristics on Underwater Structures

Prof. Aman Zhang, Harbin Engineering University, China

12:05-13:20 Lunch

13:30-14:15 Keynote Presentation 1

Immersed Smoothed Point Interpolation Method (IS-PIM) for Fluid-Structure Interaction Problems

Prof. Guiyong Zhang, Dalian University of Technology, China

14:15-15:00 Keynote Presentation 2

Advances in Multi-scale Multi-model Simulation for Ship Hydrodynamics

Prof. Shiqiang Yan, City University of London, UK

15:00-15:20 Tea Break

15:20-16:05 Keynote Presentation 3

Recent Advancement for High-Fidelity Simulation of Free Surface Flow

Associate Prof. Cheng Liu, Shanghai Jiao Tong University, China

16:05-16:50 Keynote Presentation 4

Vortex Identification and Visualization for Complex Ship and Ocean Engineering Flows

Dr. Weiwen Zhao, Shanghai Jiao Tong University, China

16:50-17:35 Keynote Presentation 5

Numerical Simulation of Typical Ship Energy Saving Techniques

Mr. Xiaosong Zhang, Shanghai Jiao Tong University, China

17:35-17:40 Closing Ceremony **Prof. Decheng Wan**

19:00-21:00 Friday, Dec. 13, 2019 **CMHL Dinner**

Invited Speakers

Prof. Atilla Incecik

Prof. Atilla Incecik is Associate Principal, Executive Dean of Engineering and Professor of Offshore Engineering at the University of Strathclyde, Glasgow. Professor Incecik has been responsible for the development of design and analysis tools and model testing of marine and offshore engineering systems during his research activities both in industry and academia. His current research includes development of dynamic load and response prediction tools for ships, offshore platforms and marine renewable energy devices.

Professor Incecik is Research Manager of Industrial Doctoral Centre for Offshore Renewable Energy (IDCORE) and an advisory professor at Shanghai Jiao Tong University, a visiting professor at Harbin Institute of Technology and Chair Professor at Zhejiang University. Professor Incecik was an honorary Doctor of Technology degree by Chalmers University of Technology, Sweden in May, 2019 in recognition of his on green shipping and environmental sustainability. Professor Incecik is Editor-in-Chief of Ocean Engineering Journal.

Plenary Lecture 1：Ocean Science and Engineering Research and Education for Sustainable Utilisation of Ocean Resources

Oceans and seas cover approximately 70 % of the earth's surface. They host a complex ecosystem which gives rise to a wealth of resources available for local and global consumption, and which must be sustainably managed. Oceans and seas regulate the world's climate, providing the largest interface between the ocean surface layers that store a large proportion of the incoming solar energy and the atmosphere. Oceans support an abundant and diverse web of life, which constitutes an integral part of the marine biological diversity. On the other hand; available evidence indicates that marine biodiversity is under growing pressure from different types of human activity. The primary causes of loss of marine biodiversity include pollution, climate change and increasing demands for biological resources as a result of the growth in the human population and world production, consumption and sea trade. Due to these unprecedented pressures, we are witnessing the degradation of habitats and the over-exploitation of biological resources, physical and chemical pollution as well as climate change. Conservation of oceans and sustainable use of marine biodiversity must therefore become an integral part of social and economic development in order to ensure that the variety of services oceans and seas provide will be available to support human needs in the long term. This can be achieved by

- Developing a better understanding of the oceans and seas
- Improving products and services for marine monitoring
- Increasing direct collaboration between the marine sciences and maritime technology

This presentation will start with the introduction to ocean engineering research activities at the University of Strathclyde. During the second part of the presentation the marine environmental impact sources will be described and the current impacts and mitigation will be detailed.

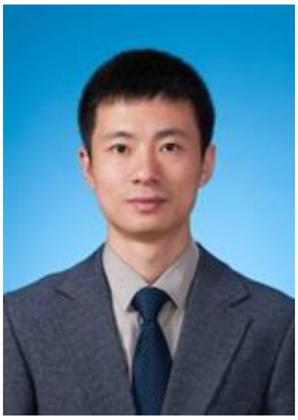
Prof. Changhong Hu

Changhong Hu is Professor of Ocean Engineering at Research Institute for Applied Mechanics (RIAM), Kyushu University, Japan. He received his B.S. in 1987, M.S. in 1990 and PhD in Marine Hydrodynamics in 1995 from Shanghai Jiao Tong University (SJTU). From 1995 he served as assistant, associate, and full professor at Kyushu University. In the academic year 2004 he worked in Norwegian University of Science and Technology (NTNU) as a visiting associate professor. From 2016 he became a guest professor of SJTU. His current research interests include next generation computational fluid dynamics methods for marine hydrodynamics, ocean renewable energy technologies, and hydrodynamics problems in ship and ocean engineering. Recently he has been involved in several national research projects of Japan on offshore wind and tidal current energy developments.

Plenary Lecture 2：Development of Unstructured Grid Free Surface Flow Solver

The objective of this research is to develop an efficient unstructured grid solver for accurate prediction of violent free surface motion and wave impact load on structures with complicated geometry. In our development, the finite volume approach is employed to discretize the governing equations. The pressure-velocity coupling is handled by using the Pressure-Implicit with Splitting of Operators (PISO) method. The free surface is treated by the volume of fluid (VOF) method. The unstructured multi-dimensional tangent hyperbolic interface capturing method (UMTHINC) is used for interface capturing. In this presentation, basic aspects of our code will be described, and the accuracy of the UMTHINC VOF method as well as its performance on wave impact loads prediction are investigated by using some numerical examples including a newly performed tank sloshing experiment.

Prof. Aman Zhang



A-Man Zhang, male, Ph.D, Professor and doctoral tutor at Harbin Engineering University, Changjiang Distinguished Professor, awardee of the National Science Fund for Distinguished Young Scholars, “Ten Thousand Talent Program” Leading Scientist, and awardee of the first Xplore Prize. He graduated as Bachelor from Dalian University of Technology in 2003 and Ph.D. from Harbin Engineering University in 2007, and researched at University College London as a visiting scholar in 2011. Research interests: Fluid-Structure Interaction, Explosion and Shock Dynamics, Bubble Dynamics. He has undertaken over 40 National Key Research and Development Projects and National Science Foundation Projects, etc. The research achievement has been awarded with 1 second prize of the National Technological Invention Award of China, 1 second prize of the National Science and Technology Progress Award of China, 1 second prize of the National Level Teaching Achievement Award of China, and 3 first prizes and 4 second prizes of provincial and ministerial level awards. He has published over 100 SCI articles on Journal of Fluid Mechanics, Physical Review Fluids, Physics of Fluids, Journal of Computational Physics, and CMAME, etc., including 7 ESI Highly Cited Papers, with over 2000 citations with in the recent 5 years. He has applied for over 20 invention patents, published 3 books and developed 1 naval standard. He is appointed as an associate editor of the SCI journal Computer Modeling in Engineering & Sciences and a member of the editorial board of multiple academic journals including Applied Ocean Research and Journal of Hydrodynamics, etc. In the recent 5 years, he has given Invited lectures at international academic conferences for over 10 times.

Plenary Lecture 3：Underwater Explosion and Its Damage Characteristics on Underwater Structures

Underwater explosions cause serious damage to structures in water, which is one of the most important topics in the field of ship and ocean engineering. It involves many difficult mechanical problems yet to be overcome, such as underwater explosion load, transient fluid-structure interaction method, and damage mechanism of underwater explosion to structure. Aiming at the above difficulties, an underwater explosion load model and a fluid-structure interaction model of underwater explosion damage to underwater structures were established, and an improved meshless method (SPH) and finite element method were developed to solve the model. Experimental research was carried out that verified the validity of the models and calculation methods. On this basis, the law of underwater explosion load and the damage characteristics of underwater explosion to underwater structures were studied, and the damage mechanism of underwater explosion shock wave, bubble and the subsequent water flooding to structures were revealed. This work serves as reference to study related to underwater explosion and structural damage.

Prof. Guiyong Zhang

Prof. Guiyong ZHANG received his PhD degree in Mechanical Engineering from National University of Singapore in 2007. In 2014, he won the prestigious and competitive “Recruitment Program of Global Youth Experts”, and currently he is working as a Professor and serving as Head of School of Naval Architecture and Ocean Engineering at Dalian University of Technology, China. His research interests include the key mechanical problems in ship and ocean engineering, including fluid-structure interaction and structure dynamic response, and the development of high-tech ship technology. He has published the academic book about S-PIM (Smoothed Point Interpolation Methods — G Space Theory and Weakened Weak Forms, World Scientific, Singapore, 2013) and authored more than 80 SCI-indexed journal papers, which have earned more than 900 citations from others. He is currently serving as a general Council member of International Chinese Association for Computational Mechanics (ICACM), and a committee member of the International Ship and Offshore Structure (ISSC). In 2010, he was awarded the “APACM (Asia-Pacific Association for Computational Mechanics) Award for Young Investigators in Computational Mechanics" and in 2018 he has won the second prize of China Marine Engineering Science and Technology Award as well as the ICACM (International Chinese Association for Computational Mechanics) Fellows Award.

Keynote Presentation 1：Immersed Smoothed Point Interpolation Method (IS-PIM) for Fluid-Structure Interaction Problems

The talk is about the development of the immersed smoothed point interpolation method (IS-PIM) for fluid-structure interaction (FSI) problems. Besides the introduction of immersed scheme and fluid solver, the presentation will be particularly focusing on the solid solver, i.e. the smoothed point interpolation method (S-PIM), the implementation of FSI boundary conditions, as well as the influence of these issues on the numerical simulation results.

Prof. Shiqiang Yan

Prof. Shiqiang Yan is reader in hydrodynamics at department of civil engineering, City University of London, UK. He has published over 31 papers in internationally prestigious journals, 44 peer-reviewed conference papers and 1 book chapter in total; Total Citation 786, H-index 13. He is playing an important role in some international-leading numerical methods, including (1) the Quasi Arbitrary Lagrangian Eulerian Finite Element Method, which is most efficient among those with similar accuracy; (2) The enhanced Spectral Integral Method (ESBI); (3) Meshless Local Petrov-Galerkin Method based on Rankine Solution (MLPG-R) and (4) hybrid method combining several wave models. He is making a number of world-leading achievements in research, e.g. modelling 3D overturning waves and their interaction with multiple floating bodies; wind-wave-current interactions. He is now a vice-chair of the International Hydrodynamic Committee, International Society of Ocean and Polar Engineering (ISOPE), fellow of the Higher Education Academy, UK since 2016, and referees for several international journals, e.g. Water, Air,& Soil Pollution, Ocean Engineering, Marine Pollution Bulletin and proceedings of ISOPE annual conference.

Keynote Presentation 2：Advances in Multi-scale Multi-model Simulation for Ship Hydrodynamics

Numerical modelling for wave-structure interaction often needs to consider multiple physics with considerable different spatial-temporal scales. For example, the characteristic spatial scales for turbulent mixing and bubbles in ~ cm, vortex shedding in ~m, wave length in ~100 m and wind wave generation in ~ km; the characteristic temporal scales for impacts in ~ms, water wave periods in ~s, internal waves in ~ minutes, tide and tidal current in ~ hours to days. Furthermore, the viscous effects may be important during the wave breaking or violent impact on structures but are less significant during the wave propagation. Hybrid modelling coupling different numerical methods, including the potential theory and computational fluid dynamics based on the Navier-Stokes models, has shown its superiority over single-model simulation in terms of the robustness and accuracy. The presentation will introduce the multi-scale multi-model framework being developed at City, University of London, which consists of various hybrid models coupling potential theory and CFD by using either the space/time domain splitting or the function splitting approaches. It then concentrates on the recent development of the qaleFOAM, which coupling the fully nonlinear potential theory with OpenFOAM using the space splitting approach, and its applications to ship hydrodynamics, including FPSO in focusing waves, gap resonance for multi-structures, motion responses of floating structures in extreme waves and the wave added resistance of trimaran.

Associate Prof. Cheng Liu

Dr. Cheng Liu is an associate porfessor of of Computational Marine Hydrodynamics Laboratory (CMHL) at SJTU. He completed his doctorate at Kyushu University with a dissertation about an immersed boundary treatment for complex geometry and the interaction with free surface flow. Since then he worked as post-doctor and assistant professor in Research Institute for Applied Mechanics, Kyushu University, where he has specialized in computational hydrodynamics of floating offshore wind turbines and wake interaction analyzing of multiple current tidal turbines. In 2018, he joined the School of Naval Architecture, Ocean & Civil Engineering and worked as a tenure-track associate professor. The focus of his research is the development of adaptive mesh refinement strategy and its application in compressible multi-phase flow, compressible turbulence flow, incompressible flow and the interaction with rigid body, free surface flow with floating body and surface tension driven flow. His publication covers various aspect of computational fluid dynamics and hydrodynamics. Many of his recent works are online in refereed journals including Journal of Computational Physics, Computer Physics Communications, and International Journal for Numerical Method in Fluid etc. He is now conducting 3 research projects such as National Natural Science Foundation of China as project principal or main researcher.

Keynote Presentation 3：Recent Advancement for High-Fidelity Simulation of Free Surface Flow

Violent free surface flow is a common occurrence in many situations in natural or industrial process. The violent mixture of gas and water creates numerous bubbles and droplets in different scales, which plays an important role in mass/energy exchange and energy dissipation of a two-phase flow system. Although experimental measurement was able to provide statistical/averaged information of the violent two-phase-mixing process, many characteristic properties, e. g., bubble/droplet distribution, time evolution of the void fraction cannot be given through the experiment. Recently, with the rapid development of the high-performance computing (HPC), the two-phase flow behavior in model scale can be reproduced completely with the HPC hardware in current level. In this study, the two-phase Navier-Stokes equations are solved based on Cartesian grid solver with a mass-momentum consistent scheme. For better resolution of the free surface and multi-scale flow structures, a block-structured adaptive mesh refinement strategy is adopted. For tracking the violent free surface, a mass-conservative interface capturing method CLSVOF (coupled level-set and volume of fluid) is implemented. Two sets of surface tension models, the sharp surface force model and the continuum surface force model are implemented and compared. A series of typical free surface problems are simulated and given for validation.

Dr. Weiwen Zhao

Dr. Weiwen Zhao received his Ph.D. degree in 2019 at Shanghai Jiao Tong University and is currently an assistant professor of Computational Marine Hydrodynamics Laboratory (CMHL) at SJTU. His research interest includes hybrid RANS/LES methods, Detached-Eddy Simulation, dynamic overset grid methods, vortex identification and post-processing, etc.

Keynote Presentation 4: Vortex Identification and Visualization for Complex Ship and Ocean Engineering Flows

Several existing vortex identification methods, including the Eulerian Q criterion, Lambda2 criterion, NewOmega and Liutex method are reviewed. The advantages and disadvantages of these methods are presented. The Liutex method, which is claimed to be the third generation vortex identification method, solves six core issues for vortex definition: (1) the absolute strength, (2) the relative strength, (3) the rotation axis, (4) the vortex core center, (5) the vortex core size, and (6) the vortex boundary. We extended the Liutex method from structured grid to unstructured grid and applied it to typical ship and ocean engineering flow problems. The extracted vortex structures, as well as the air-water interface for ship and ocean engineering flows are further visualized by ray-tracing rendering software to get near photo-realistic images.

Mr. Xiaosong Zhang

Ph.D. candidate Xiaosong Zhang, works as a member of Computational Marine Hydrodynamic Lab (CMHL) in Shanghai Jiaotong University since 2017, under the supervise of Professor Decheng Wan. Xiaosong Zhang mainly works on the ship energy saving techniques, such as energy saving device, unconventional propulsor and air lubrication drag reduction. Currently, he is working on the numerical simulation of bubble drag reduction (BDR) and air-layer drag reduction on a flat plate turbulent boundary layer.

Keynote Presentation 5: Numerical Simulation of Typical Ship Energy Saving Techniques

In recent years, the International Maritime Organization (IMO) has speeded up the implementation of green shipbuilding and the limitation of greenhouse gas emissions from newly built ships. EEDI (Energy Efficiency Design Index) representing the energy efficiency of the ship is set up to establish a minimum energy efficiency standard for ships, which greatly promotes the research and application of ship energy saving techniques. The presentation introduces our numerical method and simulation application for typical ship energy saving techniques. First, the propel boss cap fins (PBCF), which is a widely used traditional energy saving device on the propeller, is simulated to investigate its effect on the hub vortex. Both model-scale simulation and full-scale simulation are performed. Second, the bubble drag reduction on a flat plate turbulent boundary layer is simulated by the Euler-Lagrange method. Fluid is solved on the grid based on Euler framework while kinematic equation is solved to track large amount of microbubbles (over 105). Bubble breakup and coalescence are developed as individual modules in the code, which can be used to predict the bubble size distribution in the turbulent boundary layer. Finally, the air-layer drag reduction is introduced, which is the latest and most promising air lubrication technique for large transport ships. Numerical simulation is based on the Volume of Fluid (VOF) model and turbulent flow is modeled by Large Eddy Simulation (LES). Flow characteristics of air layer are analyzed in detail.

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