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Preface

Special issue on the advances in mesh reduction methods—In honor of Professor Subrata Mukherjee on the occasion of his 65th birthday

We are pleased to present two special issues of *Engineering Analysis with Boundary Elements* in honor of Professor Subrata Mukherjee from Cornell University on the occasion of his 65th birthday. As a scholar, Professor Mukherjee has made numerous seminal contributions in the field of computational mechanics, specifically in several novel mesh-reduction methods. As an educator, he has made immense efforts in mentoring a younger generation of researchers in computational mechanics. All of us have learnt a great deal in research by working with him.

Professor Mukherjee joined the faculty of Cornell University in 1974. He has been a visiting faculty member in several universities around the world including the University of Waterloo in Canada, the Technische Hochschule in Darmstadt, Germany, the University of Arizona in Tucson, and the École Polytechnique, in Palaiseau, France. He is a fellow of the American Society of Mechanical Engineers (ASME) and of the American Academy of Mechanics (AAM). He has authored or co-authored three books, several invited review articles, and over one hundred and sixty articles in archival journals. He has supervised more than twenty Cornell PhDs. Some of his former students are professors in the USA and around the world, and some have joined the industry.

Professor Mukherjee's research contributions in mesh-reduction methods are broad and we envision that they will have a long-lasting impact. His early pioneering work include the development of the boundary integral equation (BIE) and boundary element method (BEM) for inelastic materials and fracture mechanics problems in the late 1970s. This research lead to his first well known book on *Boundary Element Methods in Creep and Fracture* published by Applied Science Publishers in 1982, one of the very few BEM books available in the early research on the BEM. In the early 1980s, he expanded his work to solving various time-dependent plate and shell, large-deformation, and eddy current problems using the BEM. In the mid and late of 1980s, he and his collaborators extended the BEM to modeling sheet metal forming, solidification, and design sensitivity problems, all of which are still challenging problems for the numerical methods even as of today. In the early 1990s, there were many challenges associated with the solution of hypersingular BIEs. Professor Mukherjee and his students contributed several important solutions to the problems.

Throughout Professor Mukherjee's professional career, a pursuit of perfection can be noticed. He is the primary developer of a variant of the BEM, termed the boundary contour method (BCM), which further reduces the dimensionality of a problem. The method was initially developed for linear elasticity, with successful applications to stress analysis, design sensitivity analysis, and shape design optimization. It has also been extended to other linear problems such as potential theory, Stokes flow, and fracture analysis of bimaterial interface cracks. Other research groups have further developed the BCM to create the Galerkin BCM and the dual BCM (for fracture analysis of homogeneous materials), or to cover other types of application such as bending of elastic thin plates, piezoelectric materials, magneto-electro-elastic media, and others. Later, Professor Mukherjee further advanced the idea of dimension reduction and, together with his group, proposed the boundary node method (BNM) which is a meshfree method that further simplifies the implementations and applications of the BIEs. The book *Boundary Methods—Elements, Contours, and Nodes*, authored by Professor Mukherjee and Dr. Yu Mukherjee and published by CRC Press in 2005, is a good resource for students, researchers, and engineers to learn from a single book all the three mesh-reduction methods: BEM, BCM, and BNM.

With his sharp vision and mind, Professor Mukherjee is always at the frontier of the field of computational mechanics. As one of the pioneers who applied the BEM to modeling and design of microelectromechanical systems (MEMS), he has made significant contributions to further advance the BEM and associated optimization techniques suitable for the design of MEMS. This effort has resulted in efficient and intelligent design methodologies, which greatly shorten the design cycle of MEMS devices. Applications of numerical techniques and design methodologies include, but are not limited to, the design of variable comb drive actuators, the modeling of thin beams/plates in MEMS devices, and the study of the viscous damping of microresonators. Recently, Professor Mukherjee has ventured into nano-scale investigations. He has proposed and developed a hierarchical modeling approach combining continuum approaches with molecular dynamics simulation which has been applied to the fundamental study of the dynamic behavior of carbon nanotubes. His work has paved the road for many other followers in the field of micro-/nano-systems.

Borrowing inspiration from Professor Mukherjee's work, this is the first of the two special issues. There are 11 papers in this issue, with topics covering new developments in the meshfree methods, fast multipole method, boundary face method, BEM for dynamic and acoustic problems, and the BEM in image-based bio-medical applications. The first paper by Sladek and Sladek is on a meshfree method based on local integral equations using moving least square approximations and analytical integrations to achieve improved accuracy and efficiency. The second paper by Liu presents a novel boundary meshfree method proposing to directly apply area- or volume-distributed sources to solving

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boundary-value problems, which is similar to the method of fundamental solutions but with no fictitious boundaries and no singularity difficulties. The third paper by Luiz, Miers, and Telles is on the application of the orthogonal moving least square method to handle domain integrals in the BIE for potential problems with heterogeneous media. The fourth paper by Zhu, Huang, et al., presents a fast multipole BEM for solving 2D problems of magneto-electro-elastic materials, which have a wide range of applications in smart structures and MEMS. The fifth paper by Qin, Zhang, et al., is on a direct element implementation of the boundary face method, proposed by Zhang earlier, that uses the CAD surfaces of a 3D model directly in the discretization of the boundary in solving the BIEs, which shows significant advantages in comparison with the traditional BEM where the surfaces are subdivided into elements. The next five papers are on the BEM for elastodynamic and acoustic problems. The paper by Messner and Schanz presents a symmetric time-domain boundary element formulation for 3D elastodynamic problems accelerated by the adaptive cross approximation. The paper by Yan, Zhang, and Ye is on a BEM accelerated by the precorrected-FFT algorithm for solving 3D frequency-domain elastodynamic problems. The paper by Guduru, Phan, and Tippur presents a study on the transient analysis of the dynamic stress intensity factors and dynamic *T*-stress for particulate composite materials using the symmetric Galerkin BEM and with experimental validations. The paper by Jiang, Wu, and Cheng is on a novel single-domain acoustic BEM for packed silencers with multiple bulk-reacting sound absorbing materials. The paper by Salvadori and Temponi presents some results of the analytical integrations in the BIEs for the 3D hyperbolic scalar equation. The last paper by Chen, Zhang, and Wu presents an interesting application of a multi-domain BEM in modeling human brain electrical fields using the scanned images directly, which shows the potential of the BEM in this emerging and important bio-medical application.

We thank all the authors of the above-mentioned papers for their contributions to this special issue in honor of Professor Subrata Mukherjee. Finally, we wish that the two special issues will help further advance all the mesh-reduction related methods in the field of computational science and engineering.

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