**RAKESH RANJAN**

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**Education**

**University of Oklahoma, Norman, OK**

Senior Research Associate, School of Aerospace and Mechanical Engineering, Jan 2017-present

Projects: Development of hypersonic compressible flow solver with WENO and AUSM schemes for studying non equilibrium aero-thermodynamics effects, development of a stabilized finite element based compressible flow solver.

Supervisor: Dr. P. Vedula

**Los Alamos National Laboratory (LANL), Los Alamos, NM**

Research Associate, Nuclear Engineering and Non-proliferation Division, Systems Analysis and

Design, Sept 2013-Sept 2015.

Projects: Development of LANL VOF based free surface flow code, Nuclear Fuel Casting simulations, simulating compressible flow solver in an axi-symmetric geometry.

Supervisor: Dr. N. Carlson, Dr. P. Sadasivan

**University of Texas, San Antonio, San Antonio, TX**

PostDoctoral Fellow, Dept. of Mechanical Engineering, SiViRT Center, Aug 2010-Aug 2013.

Research: hp/spectral SUPG-PSPG formulations for solving incompressible computational fluid dynamics

problems, parallel preconditioning, hybrid mixture theory

Projects: spectral/hp methods, Inexact Newton Krylov method, high performance computing, mixture theory.

Supervisor: Dr. Y. Feng

**Texas A&M University, College Station, TX**

Ph.D. in Mechanical Engineering, May 2010

Dissertation: hp/spectral methods for structural mechanics and fluid dynamics problems.

Merit based: Teaching and Research assistantships throughout Ph.D. program.

Major Advisor: Dr. J.N. Reddy

**Pennsylvania State University, University Park, PA**

M.S., Mechanical Engineering, December 2001

Major Advisor: Dr. J. Mahaffy

**Indian Institute of Technology, IIT-Kharagpur, India**

B.Tech. (Honors), Engineering, July 1999

**Skills**

Openmpi, Mvapich, MPI, OpenMP, and CUDA C based parallel programming, C++ programming (MSVC 6.0, 2008), Fortran, Cubit (Mesh generation), Hypre (solving linear systems), DDD, Totalview, Comsol Multiphysics, MATLAB, AutoCAD 2000, Visual LISP Programming, VLISP, Solidworks, Tecplot, Java, HTML, JBuilder3, LaTeX, Linux, Fluent, Ansys, Comsol,. Python, STAAD, AutoCAD, Solidworks, Flow3d, Pardiso (direct linear solver).

**Resident Status** Permanent Resident, since March, 2013, Applied for Citizenship, April 2018.

**Work Experience**

***University of Oklahoma****, Senior Research Associate, Jan 2017-present.*

Primary developer of hypersonic compressible flow solver considering aero-thermo non equilibrium effects for hypervelocity flows. Considering vibration modes of energy of different constituent species in the atmosphere at re-entry conditions. Discretization with strong stability preserving (SSP) time stepping RK-3 in conjunction with high order WENO-5 and advection upwind splitting methods (AUSM) for flux splitting. Solved and benchmarked the compressible flow solver with the Sod-shock tube problem in each of the three orthogonal directions. Solved the flow past a blunt body at Mach number 8.0 and benchmarked with the two dimensional code ANDEE2D for testing the vibrational energy distributions and obtaining bow shock (shock standoff distance). Solved turbulence (Taylor Green vortex) on a periodic box at Re-400 and Re-1600 and M-0.845 and 2.0. Code development in Fortran with MPI.

***Astronautics Technology Center*** *Senior Computational Modeler Sept 2015-Dec 2016.*

Solution of coupled differential equations in heat transfer and fluid flow with high order b-spline

(hpk) finite element code. Incorporated entropy minimization with specific terms evaluations in a space-time code for multi-layered magneto-caloric material (involving thermodynamics) with applications in magnetic refrigeration. Non Uniform Rational B-spline (NURBS) based code for solving two phase heat transfer and fluid flow equations in a space time collocation finite element framework.

Utilized the NURBS based hpk code to obtain optimized designs based on a NAND (nested

analysis and design optimization) procedure. Solved Euler-Bernoulli beam theory and Timoshenko beam theory (with Von Karman geometric nonlinearity) with Non uniform rational b-splines (NURBS) with mixed formulations. Finite element analysis, creating finite element models from 3-D drawings, performing thermal, and structural analysis of structures. Experience with Ansys Icepack for thermal cooling.

Solved three-dimensional flow past a fully immersed cylinder at Reynolds number 200 and verified the same shedding frequency as the two dimensional projection of the problem. Solved flow past a partially immersed cylinder with an immersion length of 0:50. Introduced a new formulation for solving SUPG and GLS formulations and named the formulation Augmented SUPG and Augmented GLS formulations for solving incompressible flow. Determined demagnetization factors for different geometries with the Electromagnetic module in COMSOL. The problem becomes a magntostatics problem.

***Los Alamos National Laboratory*** *Research Associate Sept 2013-Sept 2015*

*Nuclear Engineering and Non-Proliferation Division*

Key Contributions: 1) Incorporating surface tension effects in Los Alamos code Truchas with

a) convolution of conservative level set-volume of fluid (CLS-VOF) b) Rudman Kernels convolution with finite element gradients, c) Formulation and implementation of convolution free least squared L2 distance L2 smearing algorithm for estimating surface tension effects in a continuum surface force (CSF) formulation. 2) Modeling casting solidification and validation of nuclear fuel rods with the free surface code Flow3d with Volume of Fluid (VOF) method. 3) Solving compressible flow in an axi-symmetric geometry (with shocks) with Fluent.

***University of Texas****, PostDoctoral Fellow, Aug 2010-Aug 2013*

*Department of Mechanical Engineering, University of Texas, San Antonio*

Key Contributions: 1) Obtained values of the drag and lift for both impermeable and permeable square and circular obstacles in a Newtonian flow field with porous media flow equations described with the Brinkman-Forchheimer equations. 2) Developed a new computational fluid mechanics (CFD) methodology for solving backward facing step at Re-300, 600 and 800, flow past a cylinder at Re-20 and 40, driven cavity problem at Reynolds numbers of 1000 and 3200, and Koznavy flow at Re-40 with hp/spectral SUPG/PSPG stabilized methods 3) Extended the usage of hp/spectral methods for solving CFD problems in contraction regions. Solved the forward facing step at Re=100 and 450 to demonstrate the effectiveness of the above method for solving CFD problems 4) Implemented scalable LU preconditioning for solving extensive CFD problems and tested the algorithm on processor counts upto 600. 5) Solved the skewed driven cavity problem at skew angles of 30 and 45 degrees with hp/supg-pspg spectral Inexact Newton Krylov method at Reynolds numbers of 100 and 1000, backward facing step at Re-300 to obtained benchmark results. 6) Solved the flow past a square obstruction in a Newtonian flow field at Re-100 and 200 with both moving wall and stationary wall boundary conditions. 7) Solved shear flow past a flap at Re-20 and 55 to obtain benchmark results. 8) Solved both steady and unsteady driven cavity problems at Re-100 and 400 with aspect ratio of 1 and 2, transient backward facing step at Re-300 and 600 with spectral/hp methods. 9) Solved transient flow past a cylinder at Re-100 and ellipse

with axis ratio 0:70 and obtained Von-Karman vortex shedding.

***Texas A&M University****, Research Assistant, Ph.D. August 2006-Dec 2009*

*Advanced Computational Mechanics Laboratory, Department of Mechanical Engineering*

Key contributions: 1) Introduced spectral/hp methods for solving non-linear problems as those that arise in the solution of beam problems i.e. Euler-Bernoulli beam theory with mixed formulations, and Timoshenko beam theories with both mixed and displacement based formulations, modeling isotropic and orthotropic plates for modeling first order shear deformation theories with displacement based formulations. Use of reduced integration was found to be unnecessary in the aforementioned work and results obtained from the hp-spectral methods were found to achieve spectral accuracy to the analytical series solutions to the simplified linear solutions available (as subcomponents of the non-linear problems solved). 2) Introduced hp-spectral applications for solving problems in computational fluid dynamics with least squares formulations, namely the driven cavity in two dimensions 3) Solved the generalized Navier-Stokes equations for a porous filled cavity, and buoyancy driven flow-convective heat transfer analysis with Lagrange based finite element method. 4) Devised efficient solution techniques for solving CFD problems with the domain decomposition methods for solving huge linear systems of equations with MPI and OpenMP based parallelism. 5) Developed the usage of multigrid as a preconditioner for solving CFD problems. Applied the multigrid method for least squares problems in specific for solving the driven cavity on highly skewed meshes and backward facing step problem at Re-800.

***Applied Geoscience and Engineering****, Staff Engineer Sept 2001-May 2006*

Designed foundations and retaining walls in general. Determined the bearing capacity of foundations, pavement design, slope stability analysis, pile deflection determination using LPILE, bridge foundation recommendations. Designed retaining walls of all different types (cast in place cantilever, T-wall, anchored walls, soldier-pile lagging systems, modular wall, and MSE wall). Design reported to Pennsylvania Department of Transportation (PENNDOT). Extensive experience with LPILE modeling, caisson foundations, H- piles encased in Caissons, pavement design, bearing capacity of foundations, slope stability, etc. Automated engineering drawings of subsurface investigation profiles and tracings with AutoCAD using AutoLISP.

**Authored over 22 peer reviewed journal papers, 17 conference publications.**

**Google Scholar (full publication list):**

[**https://scholar.google.com/citations?hl=en&user=I5NTFusAAAAJ&view\_op=list\_works&sortby=pubdate**](https://scholar.google.com/citations?hl=en&user=I5NTFusAAAAJ&view_op=list_works&sortby=pubdate)