Yang Wang

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Research Interests

- Energy (generation, storage, and utilization) system modelling and optimization
- Scientific computation, multi-physics modelling and optimisation
- Computational Fluid Dynamics in multi-disciplinary applications
- Data-driven modelling and machine learning

Skills

- Numerical methods for Partial Differential Equations: algorithms, discretisation schemes and linear solvers
- Multi-scale and multi-physics modelling, numerical optimisation: stochastic and deterministic methods
- Finite Volume Method and Spectral Element Method (Finite Element Method + Spectral Method)
- Fortran, MATLAB/SIMULINK and C++ programming
- Tools/software: Aspen Plus, SolidWorks, ProE, GMSH, ICEM, ParaView, OpenFOAM, Fluent,
- Automatic Differentiation (AD) tool TAPENADE
- Linux operation systems, Shell script, Vim, Meld, Make, Git, Doxygen, Gprof, and HYPRE open source libraries
- MS Office tools (e.g. Word, Excel and PowerPoint), Texmaker (editor for Latex), etc.

Education

- 2012. 9 - 2017. 1 PhD in Mechanical Engineering, Queen Mary, University of London, United Kingdom
- 2009. 9 - 2012. 6 MSc in Power Engineering and Thermophysics, Xi'an Jiaotong University, China
- 2005. 9 - 2009. 7 BEng in Energy and Power Engineering, Xi'an Jiaotong University, China

Research Experience

- 2017. 11 - present Parenting and working from home during relocation, Cambridge, USA
  - ➢ Studying data types/structures and algorithms in C++
  - ➢ Researching on multi-physics modelling and computation strategies
  - ➢ Machine Learning by Stanford University on Coursera
  - ➢ Writing and publishing journal papers; doing peer reviews for journals
- 2017. 3 - 2017. 10 Research fellow on projects funded by Engineering and Physical Science Research Council (EPSRC), School of Engineering, University of Warwick, Coventry, United Kingdom
  - ➢ *Next Generation Grid Scale Thermal Energy Storage Technologies*:
    - ∗ Developed a MATLAB/SIMULINK toolbox with the team for designing, controlling and optimising grid-scale thermal energy storage system
    - ∗ Evaluated system performance by assembling and analysing the time-dependent and multi-scale simulation data set in many case studies of energy systems
    - ∗ Improved the system cycle efficiency by 10% by optimizing the storage materials in the heat storage
  - ➢ *Ultra-Supercritical (USC) steam power generation technology with Circulating Fluidized Bed (CFB): Combustion, Materials and Modelling*:
    - ∗ Created a light-weight super-fluid property data package (MATLAB and Fortran), which is an extendible, high speed, and platform-neutral tool for academic and industrial partners in the project
    - ∗ Developed a data transfer protocol for the heat exchange coupling between the CFB boiler and the the water-wall, to computational-effectively increase fidelity of the system-level modelling

    - Built a realistic numerical prototype via collecting and analysing data from industrial partners and collaborating with the Tsinghua University for model comparison and validation

- 2012. 9 - 2017. 1 PhD candidate, working on the project *About Flow* funded by the European commission
  - ➢ Led the development team of in-house CFD codes (in Fortran) for incompressible flow with discrete adjoint sensitivity/gradient solvers using Automatic Differentiation
    - Developed solvers on cell-centered/face-based and node-centered/edge-based data structure
    - Preprocessed mesh data: sorting, listing, searching and tagging elements and calculating geometric information
    - Restructured high-order schemes via node data interpolations
    - Proposed the pseudo-inverse approach for Pressure Schur Complement (non-linear flow system algorithms) to solve incompressible Navier-Stokes Equation
    - Applied matrix preconditioning techniques for solving discretised linear sub systems with data compressed in Compressed Raw Storage (CRS)
    - Applied data post-processing and visualization in Matlab and implemented interfaces (in Fortran) to .vtk output files compatible with ParaView
    - Proposed the pseudo-inverse approach for Pressure Schur Complement (non-linear flow system algorithms) to solve incompressible Navier-Stokes Equation
    - Applied matrix preconditioning techniques for solving discretised linear sub systems
    - Improved the solution accuracy with residuals reduced by 1 order of magnitude
    - Reduced CPU time by 60% in a run of both flow and gradient computation (on PCs and the HPC cluster)
    - Increased the solver robustness for convergence in wider control parameter space and skewer mesh cases
    - Expanded the solver compatibility to other data post-processing tools for better analysing and visualising data
  - ➢ CAD-based shape optimization of the S-bend air duct in Volkswagen Golf vehicle for reducing pressure drop
    - Processed the 3D mesh perturbation using in-house CAD tool (NURBS-based parametrisation with continuity constraints) for gradient calculation of surface nodes w.r.t. control points
    - Developed CAD-based shape optimization driver (in Fortran and Shell script)
    - Optimised the shape of S-bend air duct and achieved pressure loss reduction by 20%
  - ➢ Node-based shape optimisation of the filaments in membrane channels for reducing pressure drop and increasing mass transfer rate
    - Developed and implemented numerical models for Pressure Retarded Osmosis (PRO) and Reverse Osmosis (RO) membrane process (in OpenFOAM and Fortran codes)
    - Computed mass transport across the membrane in dual-channel flow using OpenFOAM preprocessing tools
    - Firstly analysed filament surface sensitivities obtained from discrete adjoint computation
    - Designed/Optimised the spacer shape (in Fortran and Shell script) and achieved pressure loss reduction by 25% with negligible mass transfer loss
    - Developed a membrane model library (in MATLAB) for simulating the flow and mass transfer of water and salts in desalination membrane processes
- 2009. 9 - 2012. 7 Postgraduate researcher at School of Energy and Power Engineering, Xi'an Jiaotong University, China
  - ➢ Spectral element method for acoustic propagation problem in non-uniform flows
    - Studied Spectral Element Method, the combination of Finite Element and Spectral discretisation methods methods for high-accuracy, multi-scale flow and acoustic coupling computation
    - Firstly derived the mathematical description of acoustic propagation in non-uniform flow
    - Implemented governing equation and high accuracy on the absorbing boundary conditions (in C++)
- 2008. 9 - 2009. 6 Undergraduate research project: the design of high flow rate vortex/generative blower
  - ➢ Impeller design based on empirical correlations in literature and 3D model via software ProE

Selected Publications

1. **Yang Wang** and J.-D. Müller. Re-visit SIMPLE-like algorithms via Pressure Schur Complement for stabilisation of discrete adjoint solver with industrial incompressible flow application. In preparation
2. **Yang Wang**, W. He, and J.-D. Müller. Sensitivity analysis and gradient-based optimisation of feed spacer shape in reverse osmosis membrane processes using discrete adjoint approach. *Desalination*, 449:26 – 40, 2019
3. **Yang Wang**, W. He, and J. Wang. Pumped seawater combined with Compressed Air Energy Storage: an integrated co-storing/producing energy/water system. *Applied Energy*. Under revision
4. W. He, J. Wang, **Yang Wang**, Y. Ding, H. Chen, Y. Wu, and S. Garvey. Study of cycle-to-cycle dynamic characteristics of adiabatic compressed air energy storage using packed bed thermal energy storage. *Energy*, 141:2120 – 2134, 2017
5. **Yang Wang**, W. He, and H. Zhu. Computational fluid dynamics (CFD) based modelling of osmotic energy generation using pressure retarded osmosis (PRO). *Desalination*, 389:98–107, 2016
6. X. Zhang, **Yang Wang**, M. Gugala, and J.-D. Müller. Geometric continuity constraints for adjacent nurbs patches in shape optimisation. *ECCOMAS-2016*, 2016
7. W. He, **Yang Wang**, V. Elyasigomari, and M. H. Shaheed. Evaluation of the detrimental effects in osmotic power assisted reverse osmosis (RO) desalination. *Renewable Energy*, 93:608–619, 2016
8. Y. Geng, G. Qin, **Yang Wang**, and W. He. The research of space-time coupled spectral element method for acoustic wave equations. *Chinese Journal of Acoustics*, 35(01):31–49, 2016
9. S. Akbarzadeh, **Yang Wang**, and J.-D. Müller. Fixed point discrete adjoint of SIMPLE-like solvers. In *22nd AIAA Computational Fluid Dynamics Conference*, page 2750, 2015
10. **Yang Wang**, S. Akbarzadeh, and J.-D. Müller. Stabilisation of discrete adjoint solvers for incompressible flow. In *22nd AIAA Computational Fluid Dynamics Conference*, page 2749, 2015
11. W. He, **Yang Wang**, and M. H. Shaheed. Maximum power point tracking (MPPT) of a scale-up pressure retarded osmosis (PRO) osmotic power plant. *Applied Energy*, 158:584–596, 2015
12. W. He, **Yang Wang**, and M. H. Shaheed. Stand-alone seawater RO (reverse osmosis) desalination powered by PV (photovoltaic) and PRO (pressure retarded osmosis). *Energy*, 86:423–435, 2015

Awards and grants

- 2015 Postgraduate Research Fund (Queen Mary University of London)
- 2014 Postgraduate student grant (School of Engineering and Material Science, QMUL)
- 2012 Best Postgraduates (Top 10%)
- 2010 Outstanding Postgraduate Student Award (Top 15%)
- 2009 Postgraduate Innovation Fund Scholarship (1st Class, 2/46)
- 2009 Best Graduates (Top 10%)
- 2008 *Fusheng* Industrial Scholarship (1st Class, Top 15%)

Teaching and supervising experiences

- 2012 - 2015 Teaching and demonstrating in undergraduate courses:
  - ➢ Heat Transfer and Fluid Mechanics: coursework tutorial
  - ➢ Mechanics of Fluids: lab demonstration and reports marking
  - ➢ Computer Aided Engineering in Fluids and Solids: OpenFOAM tutorial
- 2012 - 2015 Leader of the segregated flow solver development team:
  - ➢ Mentoring junior researchers with code review and implementation
- 2009 - 2012 Instructor in Department of Fluid Machinery