

## Reza Madankan

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Data Scientist,  
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### EDUCATION

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- Ph.D. of Mechanical Engineering Sept. 2014
- State University of New York at Buffalo, Buffalo, NY, USA
  - Dissertation Topic: *Model-Data Fusion and Adaptive Sensing of Large Scale Systems: Application to Atmospheric Release Incidents*
- M.S., Mechanical Engineering February 2011
- State University of New York at Buffalo, Buffalo, NY, USA
  - Thesis Topic: *Polynomial Chaos Based Method for State and Parameter Estimation*
- BS, Mechanical Engineering February 2007
- Sharif University of Technology, Tehran, Iran

### RESEARCH INTERESTS

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Uncertainty Quantification, Machine Learning, Hypothesis Testing, Bayesian Inference, Data Assimilation, Computational Biology, Digital Agriculture, Information Theory, Inverse Problems, Estimation Theory, Stochastic Processes, Experimental Design, Optimal Control, Medical Imaging.

### PROFESSIONAL EXPERIENCE

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- Data Scientist July 2019 - Present
  - Amazon
- Research Data Scientist May 2016 – May 2019
  - Monsanto Company
- Postdoctoral Fellow Sept. 2014 – May 2016
  - Department of Imaging Physics, MD Anderson Cancer Center
- Research Assistant Aug. 2008 – Sept. 2014
  - Department of Mechanical and Aerospace Engineering, University at Buffalo
- Fuel Oil Systems Engineer Mar. 2007 – July 2008
  - Mapna Turbine Manufacturing Co., Karaj, Iran
- Design Engineer June 2006 – Mar. 2007
  - Siman Sazan Co., Tehran, Iran

### TEACHING EXPERIENCE

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- Teaching Assistant
- Applied Mathematics, Mechanical & Aerospace Eng. Dept., Fall 2011

- Teaching Assistant: Machine Design, Mechanical & Aerospace Eng. Dept., Spring 2009.
- Teaching Assistant: Heat Transfer Laboratory, Mechanical & Aerospace Eng. Dept., Fall 2008.

## HONORS & AWARDS

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- SIAM Conference on Uncertainty Quantification (UQ14), Student Travel Award, 2014
- International Society of Bayesian Analysis (ISBA), Student Travel Award, 2013
- Student Ambassador Award, University at Buffalo School of Eng. & Applied Sciences, Spring 2013
- International Workshop on Source Term Estimation Methods for Estimating the Atmospheric Radiation Release from the Fukushima Daiichi Nuclear Power Plant, Student Travel Award, 2011

## RESEARCH EXPERIENCE

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- Postdoctoral Fellow, MD Anderson Cancer Center, Houston, TX, USA

*Accelerated Model-based Signal Reconstruction for Magnetic Resonance Imaging in Presence of Uncertainties:*

- Developed a new approach to expedite the signal reconstruction in Magnetic Resonance Imaging (MRI) procedure.
- Developed approach significantly reduces the operational time for MRI procedure, while simultaneously improving the accuracy of the process.

- Research Assistant, State University of New York at Buffalo, Buffalo, NY, USA

*Data Assimilation in Absence of Sensor Error Characteristics:*

- Developed a novel probabilistic method for parameter estimation and accurate forecasting of large-scale systems in absence of sensor error characteristics. The key idea of this approach is to minimize the expected value of error between model forecast and measurement data while preserving higher order central moments of error distribution.
- Independence of proposed technique from sensor error characteristics makes this method a very powerful tool for data assimilation in occasions in which accurate knowledge of noise statistics is not available.

*Optimal Information Collection for Source Parameter Estimation of Atmospheric Release Phenomenon:*

- Developed an information theoretic framework for optimal sensor strategy for the accurate tracking to toxic plumes. This effort combines high performance computing, stochastic analysis,

information and control theory resulting in real time tracking of plume motion that accounts for varying wind conditions and a range of model variables.

*Uncertainty Quantification and Source Parameter Estimation for Toxic Plume Forecasting:*

- Developed computationally efficient statistical tools to generate probabilistic hazard maps for toxic plume forecasting. The developed methodology makes use of recently developed the Conjugated Unscented Transformation (CUT) in conjunction with the generalized polynomial chaos approach to combine model forecast with satellite observation data to provide posterior density function of source parameters.
- In particular, developed approach has been validated by considering the real-world test cases such as the volcanic ash transport due to Eyjafjallajökull volcano eruption in Iceland in April 2010 and the Deepwater Horizon Oil spill in Gulf of Mexico.

*Uncertainty Propagation through Nonlinear Dynamical Systems:*

- Developed a generalized Polynomial Chaos (gPC) based framework for model-data fusion to estimate model state and parameter simultaneously along with the confidence bounds (described by joint density function) associated with their estimates.
- In addition to this, I also worked on the multi-resolution approximation of probability density functions while solving the Liouville Equation.

*Parameter Identification of Dispersion Phenomena:*

- Developed a multi resolution approach to model the spatio-temporal dispersion of geospatial data such as dispersion of chemical/biological agents subsequent to natural or man-made disasters. The proposed methodology was also used for estimation of spatio-temporally varying diffusion coefficient in dispersion phenomena.

## INVITED TALKS

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1. “Model-Data Fusion and Adaptive Sensing of Large-Scale Systems”, MD Anderson Cancer Center, June 30, 2014.
2. “Model-Data Fusion and Adaptive Sensing of Large-Scale Systems: Applications to Atmospheric Release Incidents”, Massachusetts Institute of Technology, Department of Earth, Atmospheric, and Planetary Science, August 6, 2014.

## PUBLICATIONS

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### JOURNAL PAPERS

[J1] R. Madankan, S. Pouget, P. Singla, M. Bursik, J. Dehn, M. Jones, A. Patra, M. Pavolonis, E. B. Pitman, T. Singh, P. Webley, “Computation of Probabilistic Hazard Maps and Source Parameter

Estimation for Volcanic Ash Transport and Diffusion”, *Journal of Computational Physics* 271 (2014): 39-59, <http://dx.doi.org/10.1016/j.jcp.2013.11.032>

[J2] Reza Madankan, Puneet Singla, Tarunraj Singh, Peter Scott, “Polynomial Chaos based Bayesian Approach for State and Parameter Estimation”, *AIAA Journal of Guidance Control and Dynamics* (2013): Vol.36: 1058-1074, doi: 10.2514/1.58377

[J3] Fahrenholtz, S. J., Madankan, R., Hazle, J. D., Stafford, R. J., Fuentes, D., “SU-C-BRA-03: Prediction of Laser Induced Thermal Therapy: Results of Model Training and Cross Validation”, *Medical Physics*, 42(6), 3196-3196, <http://dx.doi.org/10.1118/1.4923813>

[J4] Fahrenholtz, S. J., Madankan, R., Hazle, J. D., Stafford, R. J., Fuentes, D., “Global optimization provides flexible model calibration and validation of laser ablation model”, *International Journal of Hyperthermia*.

[J5] E.R. Stefanescu, A. Patra, M. Bursik, R. Madankan, S. Pouget, M. Jones, P. Singla, T. Singh, B. Pitman, D. Morton, M. Pavolonis, P. Webley, J. Dehn, “Temporal, probabilistic mapping of ash clouds using wind field stochastic variability and uncertain eruption source parameters: Example of the 14 April 2010 Eyjafjallajökull eruption”, *Journal of Advances in Modeling Earth Systems* 6.4 (2014): 1173-1184, <http://dx.doi.org/10.1002/2014MS000332>

[J6] R. Madankan, W. Stefan, S.J. Fahrenholtz, C. MacLellan, J. Hazle, R.J. Stafford, J.S. Weinberg, G. Rao, D. Fuentes, “Accelerated Model-based Signal Reconstruction for Magnetic Resonance Imaging in Presence of Uncertainties”, *Physics in Medicine and Biology*.

[J7] S. Fahrenholtz, R. Madankan, Sh. Danish, J. Hazle, R.J. Stafford, D. Fuentes, “Theoretical model for laser ablation outcome predictions in brain: calibration and validation on clinical MR thermometry images”, *International Journal of Hyperthermia*

#### BOOK CHAPTERS

[1] P. W. Webley, A. Patra, M. Bursik, E. B. Pitman, J. Dehn, T. Singh, P. Singla, M. D. Jones, R. Madankan, E. R. Stefanescu, and S. Pouget, “Building an uncertainty modeling framework for real-time VATD”, *Characterizing Uncertainties in Natural Hazard Modeling*, AGU Geophysical Monograph Series, ISBN: 978-1-119-02786-7

#### CONFERENCE PAPERS & PROCEEDINGS

[C1] Drew Mitchell, **Reza Madankan**, Samuel Fahrenholtz, Christopher MacLellan, Wolfgang Stefan, Jason Stafford, John Hazle and David Fuentes, “Quantitative Subsampling Guidance for Model-Based MR Thermal Image Reconstruction via Mutual Information”, 2016 Interventional MRI Symposium, Baltimore, MD, October 7 - 8, 2016.

[C2] R. Madankan, P. Singla, T. Singh, “A Robust Data Assimilation Approach in the Absence of Sensor Statistical Properties”, 2015 American Control Conference, July 1-3, 2015.

[C3] R. Madankan, P. Singla, T. Singh, “Parameter Estimation of Atmospheric Release Incidents Using Maximal Information Collection”, The Dynamic Data-driven Environmental Systems Science Conference, Massachusetts Institute of Technology, Nov. 5-7, 2014.

[C4] E. Stefanescu , A. Patra, M. Bursik, M. Jones, R. Madankan, E. B. Pitman, , S. Pouget, T. Singh, P. Singla, P. Webley, D. Morton, “Fast Construction of Surrogates for UQ Central to DDDAS – Application to Volcanic Ash Transport”, 2014 International Conference on Computational Science.

[C5] Reza Madankan, M. Amin Karami, Puneet Singla, “Uncertainty Analysis of Energy Harvesting Systems”, ASME 2014 International Design Engineering Technical Conferences (IDETC).

[C6] Reza Madankan, Puneet Singla, Tarunraj Singh, “Optimal Information Collection for Source Parameter Estimation of Atmospheric Release Phenomenon”, 2014 American Control Conference.

[C7] A. Patra, M. Bursik, J. Dehn, M. Jones, R. Madankan, M. Pavolonis, E. B. Pitman, T. Singh, P. Singla, E. Stefanescu, S. Pouget, P. Webley, “Challenges in Developing DDDAS Based Methodology for Volcanic Ash Hazard Analysis – Effect of Numerical Weather Prediction Variability and Parameter Estimation”, Procedia Computer Science Volume 18, 2013, Pages 1871-1880, <http://dx.doi.org/10.1016/j.procs.2013.05.356>

[C8] Reza Madankan, Puneet Singla, Tarunraj Singh, “Application of Conjugate Unscented Transform in Source Parameters Estimation”, 2013 American Control Conference, June 17-19, Washington, DC.

[C9] R. Madankan, P. Singla, A. Patra, M. Bursik, J. Dehn, M. Jones, M. Pavolonis, B. Pitman, T. Singh, P. Webley, “Polynomial Chaos Quadrature-based minimum variance approach for source parameters estimation”, Procedia Computer Science, Volume 9, 2012, Pages 1129-1138, <http://dx.doi.org/10.1016/j.procs.2012.04.122>

[C10] Reza Madankan, Puneet Singla, Tarunraj Singh, Peter Scott, “Polynomial Chaos Based Method for State and Parameter Estimation”, 2012 American Control Conference, June 27-29, Montreal, Canada.

[C11] Reza Madankan, Puneet Singla, Tarunraj Singh, Peter Scott, “A Multi-resolution Approach for Modeling of Diffusion Phenomenon”, 12th International Conference on Information Fusion, Seattle, 6-9 July 2009, Washington, USA.

[C12] Michael Mercurio, Reza Madankan, Puneet Singla, Manoranjan Majji, “Approximation of Probability Density Functions Propagated Through the Perturbed Two-Body Problem”, AAS/AIAA Astrodynamics Specialist Conference, 11 – 15 August 2013, Hilton Head Island, South Carolina, USA.

#### CONFERENCE ABSTRACTS

[A1] **R. Madankan**, P. La Rosa, A. Cartier, N. Singla, “A New Hierarchical – Statistical Ranking Algorithm to Measure Similarities of Heterogeneous Ranking Systems”, 29<sup>th</sup> Conference on Applied Statistics in Agriculture, April 23 -25, 2017, Manhattan, Kansas.

- [A2] **R. Madankan**, C. J. MacLellan, S. J. Fahrenholtz, J. Hazle, R. J. Stafford, D. Fuentes, “Effect of Different Tissue Segmentation schemes on Precise Treatment Planning of Laser Induced Thermal Therapy: A Retrospective Study”, 2016 International Congress for Hyperthermic Oncology, April 11-15, 2016, New Orleans, Louisiana, accepted.
- [A3] R. Madankan, W. Stefan, C. J. MacLellan, S. J. Fahrenholtz, D. Mitchell, R.J. Stafford, J. Hazle, D. Fuentes, “Information Theoretic Approach for Accelerated Magnetic Resonance Thermometry in the Presence of Uncertainties”, 2016 SIAM Conference on Imaging Science, May 23-26, 2016, Albuquerque, New Mexico, submitted.
- [A4] S. Loupot, W. Stefan, R. Madankan, K. Mathieu, D. Fuentes, J. Hazle, “Sparse Source Reconstruction for Nanomagnetic Relaxometry”, 2016 SIAM Conference on Imaging Science, May 23-26, 2016, Albuquerque, New Mexico, submitted.
- [A5] D. Mitchell, R. Madankan, S. Fahrenholtz, C. MacLellan, W. Stefan, R.J. Stafford, J. Hazle, D. Fuentes, “Stability of Information Theoretic  $k$  – space Trajectories for Model – Based MR Thermal Image Reconstruction”, 2016 SIAM Conference on Imaging Science, May 23-26, 2016, Albuquerque, New Mexico, submitted.
- [A6] R. Madankan, W. Stefan, C. MacLellan, S. Fahrenholtz, D. Mitchell, R.J. Stafford, J. Hazle, D. Fuentes, “Accelerated MR Thermometry in Presence of Uncertainties”, 24<sup>th</sup> ISMRM annual meeting, May 7-13, 2016, Singapore, accepted.
- [A7] D. Mitchell, R. Madankan, W. Stefan, C. MacLellan, S. Fahrenholtz, R.J. Stafford, J. Hazle, D. Fuentes, “Stability of information theoretic  $k$ -space trajectories for model-based MR thermal image reconstruction”, 24<sup>th</sup> ISMRM annual meeting, May 7-13, 2016, Singapore, submitted.
- [A8] S. Loupot, W. Stefan, R. Madankan, K. Mathieu, D. Fuentes, J. Hazle, “L1-based Magnetic Source Reconstruction”, International Workshop on Magnetic Particle Imaging, March 16-18, 2016, Lubeck, Germany, submitted.
- [A9] R. Madankan, D. Fuentes, “Accelerated Model-based Signal Reconstruction for Magnetic Resonance Thermometry Data in Presence of Uncertainties”, 13<sup>th</sup> United States National Congress on Computational Mechanics conference, July 26-30, 2015, San Diego, California.
- [A10] S. Fahrenholtz, R. Stafford, R. Madankan, J. Hazle, D. Fuentes, “Prediction of Laser Induced Thermal Therapy: Results of Model Training and Cross Validation”, 57<sup>th</sup> AAPM annual meeting.
- [A11] R. Madankan, S. Fahrenholtz, J. Hazle, R. J. Stafford, A. Shetty, D. Fuentes, “Accurate Modeling of Laser Induced Thermal Therapy in Presence of Heterogeneous Tissue”, 32<sup>st</sup> Annual Meeting of the Society for Thermal Medicine, Orlando, Florida.
- [A12] P. Webley, A.K. Patra, M.I. Bursik, E.B. Pitman, J. Dehn., T. Singh, P. Singla, E.R. Stefanescu, R. Madankan, S. Pouget, M. Jones, D. Morton and C.G. Hughes, “Probabilistic volcanic ash cloud simulations: Characterizing the uncertainty and moving into the operational environment”, AGU 2014 Fall Meeting, San Francisco, CA, USA.

- [A13] C.G. Hughes, E.R. Stefanescu, A.K. Patra, M.I. Bursik, R. Madankan, S. Pouget, M. Jones, P. Singla, R. Singh, E.B. Pitman, D. Morton and P. Webley, “UQ -- Fast Surrogates Key to New Methodologies in an Operational and Research Volcanic Hazard Forecasting System”, AGU 2014 Fall Meeting, San Francisco, CA, USA.
- [A14] R. Madankan, N. Adurthi, P. Singla, “Optimal Information Collection for Source Parameter Estimation”, 2014 SIAM Conference on Uncertainty Quantification.
- [A15] P. W. Webley, A. Patra, M. Bursik, E. B. Pitman, T. Singh, J. Dehn, P. Singla, E.R. Stefanescu, R. Madankan, S. Pouget, M. D. Jones, D. J. Morton, M. Pavolonis, “Characterizing uncertainty in the motion, future location and ash concentrations of volcanic plumes and ash clouds”, AGU 2013 Fall meeting, San Francisco, CA, USA.
- [A16] A. Patra, E. B. Pitman, M. Bursik, P. Webley, J. Dehn, T. Singh, R. Stefanescu, S. Pouget, D. Morton, M. Pavolonis, M. Jones, R. Madankan, “A Framework for Uncertainty Quantification for Volcanic Ash Dispersion Phenomena”, AGU 2013 Fall meeting, San Francisco, CA, USA.
- [A17] R. Stefanescu, A. Patra, M. Bursik, E. B. Pitman, T. Singh, P. Singla, R. Madankan, S. Pouget, D. Morton, P. Webley, J. Dehn, M. Pavolonis, and M. Jones, “Wind-field stochastic variability integrated in an ash transport and dispersal model”, EGU General Assembly 2013.
- [A18] S. Pouget, M. Bursik, P. Webley, J. Dehn, M. Pavolonis, T. Singh, P. Singla, A. Patra, B. Pitman, R. Stefanescu, R. Madankan, D. Morton, and M. Jones, “Estimation of Eruption Source Parameters from Plume Growth Rate”, EGU General Assembly 2013.
- [A19] R. Madankan, P. Singla, T. Singh, A. Patra, M. Bursik, E. B. Pitman, M. Jones, P. Webley, J. Dehn, M. Pavolonis, “Polynomial Chaos based Minimum Variance Approach for Characterization of Source Parameters”, International Workshop on Source Term Estimation Methods for Estimating the Atmospheric Radiation Release from the Fukushima Daiichi Nuclear Power Plant, February 22-23, 2012, National Center for Atmospheric Research (NCAR), Boulder, Colorado.

## PATENTS

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1. Reza Madankan, David Fuentes, Wolfgang Stefan, R. Jason Stafford, “Accelerated Model-based Signal Reconstruction for Magnetic Resonance Imaging in Presence of Uncertainties”, MD Anderson Cancer Center, Office of Technology Commercialization (OTC), Reference # MDA15-026, Oct. 2014, pending.

## MANUSCRIPT REVIEW

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1. Journal of Applied Clinical Medical Physics
2. Journal of Applied Stochastic Models in Business and Industry
3. ASME Journal of Dynamic Systems, Measurement and Control

4. Bulletin of Volcanology
5. The Journal of the Astronautical Sciences
6. Chinese Journal of Aeronautics
7. Unmanned Systems
8. Mathematical Problems in Engineering
9. Engineering Optimization
10. American Control Conference 2013
11. American Control Conference 2016
12. American Control Conference 2020
13. ASME 2014 Design & Engineering Technical Conference
14. COMPUTATION TOOLS 2015 conference

## PROFESSIONAL AFFILIATIONS

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- Sigma Xi, The Scientific Research Society
- American Society of Mechanical Engineers (ASME)
- Institute of Electrical and Electronics Engineers (IEEE)
- International Society for Magnetic Resonance in Medicine (ISMRM)
- The Society for Thermal Medicine (STM)

## ACADEMIC SERVICES

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- Technical committee member, COMPUTATION TOOLS 2015: The Sixth International Conference on Computational Logics, Algebras, Programming, Tools, and Benchmarking, March 22 - 27, 2015 - Nice, France.
- Co-chair, "Dynamic Data-driven Application Systems" session, 2015 American Conference, Chicago, IL.
- Organizing committee member, IEEE CASE 2016 Full-day Workshop on "Uncertainty Quantification: Methods and Application to Dynamical Systems", Aug. 21, 2016, Fort Worth, Texas, <http://uncertaintyquantification.website/>
- Organizing committee member, DSCC 2016 Workshop on "Uncertainty Quantification: Methods and Application to Dynamical Systems", Oct. 13, 2016, Minneapolis, Minnesota.

## COMPUTER SKILLS

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Rstudio, Python (SciKit-learn, NLTK, Keras, Numpy, Pandas, Matplotlib, etc.), Matlab, Spark, Parallel Computing, GPU programming, PETSc, some use of shell scripts