

# Matthew Charles Ruschmann

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## Professional Summary

- Senior engineer with 11 years of R&D experience on projects for DARPA, NASA, and AFRL
- Experienced developer of high-fidelity space vehicle physics simulations and flight software algorithms
- Expert knowledge of automatic control, FDIR (fault detection, isolation, and recovery), and Markov processes
- Experienced with linear and non-linear optimization including convex optimization and simulated annealing
- Practitioner of CMMI Level 3 certified Agile process management for 6 years, scrum master for 3 years

## Education

- 2009      **Ph.D., Electrical Engineering;** Binghamton University (Binghamton, NY)  
Dissertation: *Optimal Dataset Reliability and Robust Asset Allocation in Air Operations*
- 2006      **M.S., Electrical Engineering;** Binghamton University (Binghamton, NY)  
Thesis: *Receding Horizon Control of Air Operations Resource Allocation*
- 2004      **B.S., Electrical Engineering;** Clarkson University (Potsdam, NY)  
Minor: *Mathematics*

## Skills & Experience Summary

**Algorithms**      Extended Kalman Filter, Convex Optimization, Dynamic Programming, Perturbation Analysis, Receding Horizon Control, Unscented Transformation, Linear Covariance Analysis, Pulse Compression Probing, PID Controller, Phase Plane Controller

**Software engineering**      Enterprise Architect UML, Test-driven Development, Model-driven Development, CMMI Level 3, Atlassian JIRA Agile, Atlassian Bamboo, Jenkins Continuous Integration, Git, Subversion, Puppet, SaltStack

**Languages**      C/C++, Python, MATLAB, Simulink, MATLAB Coder, Stateflow, Java, Lua

**NASA tools**      42 simulation, Trick simulation, Core Flight System (cFS), JSC's Engineering Orbital Dynamics (JEOD), Orbit Determination Toolbox (ODTBX), Multimission

OS Three-Axis Stabilized Spacecraft (MTASS) system  
Windows, Linux, FreeBSD, RTEMS

## Professional Experience

**Emergent Space Technologies, Inc.**

**May 2011-Current**

Led agile development of Distributed In-flight Control (DISCo) for two UAV sensorcraft and a rover primary

- Integrated sensor and data processing algorithms into DISCo real-time software for a DARPA SBIR
- Led engineering and software development team of five engineers using Agile SCRUM methodology

Supported Firefly Space Systems with integration and validation of launch vehicle GN&C algorithms

- Designed and developed interfaces in the simulated environment that mimic the runtime environment
- Verified the frequency domain analysis of gimballed steering controls
- Developed a Simulink block for verifying flight software controller in their analysis tool
- Created a configuration managed and easy to install virtual machine with development environment for GN&C software developers

Principal investigator (PI) for R&D of Separable Architecture for Fault Isolation and Recovery (SAFIR) from concept to a high fidelity product demonstration.

- Acquired Phase 1 SBIR and Phase 2 SBIR funding from NASA for the SAFIR model based fault detection algorithms and service oriented fault management architecture
- Designed, developed, and analyzed fault detection and isolation methods for clusters of spacecraft using likelihood ratio and majority voting
- Enhanced Emergent's clustered spacecraft dynamics simulation with modeled spacecraft faults
- Developed fault management services using algorithm models and C source code generation
- Implemented sound software engineering practices such as agile process management, use case analysis, model based design using UML, automated testing, and automated static code analysis
- Demonstrated that SAFIR is TRL5 for FDIR of guidance, navigation, and control in a cluster of four spacecraft

Team lead development of orbit maintenance and maneuver planning algorithms as well as flight code for relative guidance of clustered spacecraft in support of DARPA's F6 program.

- Designed novel orbit maintenance methods for clusters of spacecraft
- Developed the Cluster Orbit Maintenance Evaluation Tool (COMET) in MATLAB to conduct trade studies analyze guidance, navigation and control algorithms

- Designed and executed trade studies to analyze performance of station keeping methods and maneuver planning algorithms for spacecraft clusters
- Designed an unscented transformation to analyze orbit covariance to compute collision probability
- Implemented a linear optimization method for solving relative spacecraft maneuvers

### **Binghamton University / Research Foundation of SUNY**

**May 2009–April 2011**

Postdoc position developing robust sensor placement algorithms and FDIR algorithms.

- Derived robust sensor placement for phase measurement units (PMU) in power networks that maximized fault-tolerance of state observability
- Developed a pulse-compression probing method for health monitoring of nonlinear systems such as the NASA generic transport model (GTM) UAV
- Implemented an extended Kalman Filter for estimating parameters of aircraft actuator faults
- Derived reachable sets and analyzed fault coverage for the NASA GTM and power distribution networks

### **Research Foundation of SUNY**

**May 2006 – May 2009**

Research assistant developing fault-tolerant policies for discrete event systems such as Markov processes.

- Implemented receding horizon for an uncertain bilinear system with control constraints that modeled resource allocation for improved win probability of an air operation
- Designed state estimators and detectors for Markov models with uncertain observations
- Simulated hybrid models in MATLAB and Simulink using Stateflow and SimEvents
- Optimized dataset renewal policies for fault tolerant database servers by deriving sensitivity gradients using perturbation analysis

## **Noteable Awards**

2012	Emergent Special & Talented Achievement Recognition (STAR) Award
2009	Excellence in Research Award; Awarded by the electrical engineering department to a single post-graduate for dedication and excellence in their research
1999	The Clarkson School; Program for high school seniors to start college a year early

## **Affiliations**

- Eta Kappa Nu (HKN) inducted 12/2002, Gamma Gamma chapter
- Member of Institute of Electrical and Electronics Engineers (IEEE)
- Member of American Institute of Aeronautics and Astronautics (AIAA)
- Registered small unmanned aircraft system (sUAS) operator

## Publication list

Ruschmann, M., Duffy, B., de la Torre, R., and Hur-Diaz, S. "Efficient Station Keeping for Cluster Flight." *24th International Symposium on Space Flight Dynamics*. Laurel, MD, May 2014.

Schmidt, J., Phillips, M., and Ruschmann, M. "Satellite Cluster Flight Design Considerations," *24th International Symposium on Space Flight Dynamics*. Laurel, MD, May 2014.

Duffy, B., Brown, A., Ruschmann, M., and Ward, L. "Scatter Strategies for Cluster Flight." *24th International Symposium on Space Flight Dynamics*. Laurel, MD, May 2014.

Brown, A., Ruschmann, M., Duffy, B., Ward, L., Hur-Diaz, S., Ferguson, E., and Stewart, S. "Simulated Annealing Maneuver Planner For Cluster Flight." *Proceedings 24th International Symposium on Space Flight Dynamics*. Laurel, MD, May 2014.

Hur-Diaz, S., Ruschmann, M., Heyne, M., and Phillips, M. "Computing Collision Probability Using Linear Covariance and Unscented Transforms." *AIAA Guidance, Navigation, and Control and Co-located Conferences and AIAA Infotech@Aerospace 2013*. Boston, MA, 19-22 Aug 2013.

Huang, J., Wu, N.E., Ruschmann, M.C. "Data-Availability-Constrained Placement of PMUs and Communication Links in a Power System." *IEEE Systems Journal*, vol. 8, no. 2, 2013.

Ruschmann, M., Wu, N.E., and Huang, J. "Redundancy Architecture Design of PMU Networks for Availability of Synchrophasors." *2012 IEEE PES Innovative Smart Grid Technologies*. Washington, D.C., Jan 2012.

Wu, N.E. and Ruschmann, M. "Toward a Highly Available Modern Grid." *Power Electronics and Power Systems*, vol. 3, 2011.

Wu, N.E. and Ruschmann, M.C. "Fault-Tolerant Control of a Hidden Markov Process with Application to Resource Allocation in an Air Operation." *Journal of Systems Engineering and Electronics*, vol. 22, no. 1, 2011.

Ruschmann, M., Wu N.E. "Pulse-Compression Probing for Nonlinear Systems with Additional Hard Nonlinearity at the Input." *Proceedings of the 2011 American Control Conference*. San Francisco, CA, 2011.

Wu, N.E., Ruschmann, M.C., and Huang K. "Probing the NASA Generic Transport Aircraft in Real-Time for Health Monitoring." *IEEE Transactions on Control System Technology*, vol. 19, no. 5, 2010.

Ruschmann, M., Wu N.E., and Shin, J.Y. "Actuator Fault Diagnosis Using Two-Stage Extended Kalman Filters." *Proceedings of the 2010 Guidance, Navigation, and Control Conference*. Toronto, ON CA, 2010.

Ruschmann, M., Huang, J., and Wu, N.E. "Pulse-Compression Probing of Small Signal Characteristics for Nonlinear Systems in Dynamic Operating Conditions." *Proceedings of the 49th IEEE Conference on Decision and Control*. Atlanta, GA, 2010.

Ruschmann, M. and Wu, N.E. "Online Estimation of Linear State-Space Parameters of the Generic Transport Model for a Set of Structural Damage Scenarios." *Proceedings of the 49th IEEE Conference on Decision and Control*. Atlanta, GA, 2010.

Wu, N.E., Ruschmann, M.C., and Linderman, M. "Fault-Tolerant Control of a Distributed

Database System." *Journal of Control Science and Engineering*, vol. 2008, no. 1, 2008.

Wu, N.E. Wu, Guo, Y., Huang, K., Ruschmann, M., and Fowler, M. "Fault-Tolerant Tasking and Guidance of an Airborne Location Sensor Network." *International Journal of Control Automation and Systems*, vol. 6, no. 3, p. 351, 2008.

Ruschmann, M. and Wu, N.E. "Perturbation Analysis for Optimal Update Intervals of Data Sets." *Proceedings of the 2008 American Control Conference*. pp. 4318–4323. Seattle, WA, 2008.

Ruschmann, M. and Wu, N.E. "Optimal control of a database with reduced & full state models." *Proceedings of the 46th IEEE Conference on Decision and Control*, pp. 2663–2668. New Orleans, LA, 2007.

Wu, N.E. and Ruschmann, M. "Loop Closure for Enhanced Win Percentage in an Air Operation." *Proceedings of the 2007 American Control Conference*, pp. 1097–1102. New York, NY, 2007.