Matthias Althoff

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born 06.03.1981 in Freising, Germany.

Curriculum Vitae

EDUCATION AND RESEARCH

Assistant Professor, **Technische Universität München** **(since 10/2013)**
Department of Computer Science, München, Germany
Professorship for *Cyber-Physical Systems*

Assistant Professor, **Technische Universität Ilmenau** **(06/2012 - 09/2013)**
Department of Computer Science and Automation, Ilmenau, Germany
Head of research group *Automation Engineering*

Lecturer, **Technische Universität Ilmenau** **(04/2012 - 06/2012)**
Department of Computer Science and Automation, Ilmenau, Germany

Postdoctoral Researcher, **Carnegie Mellon University** **(03/2010 - 03/2012)**
Joint appointment with the Department of Electrical and Computer Engineering and the Robotics Institute, Pittsburgh, USA
(joint appointment with the Robotics Institute since 03/2011)

Advisors: Prof. Bruce H. Krogh (IEEE Fellow)
John M. Dolan (Principal Systems Scientist)

PhD Student, **Technische Universität München** **(01/2006 - 02/2010)**
Department of Electrical Engineering, Munich, Germany

Advisor: Univ. Prof. Dr.-Ing./Univ. Tokio Martin Buss

Thesis: Reachability Analysis and its Application to the Safety Assessment of Autonomous Cars

Research Scholar, **Virginia Tech** **(04/2005 - 12/2005)**
Department of Aerospace and Ocean Engineering, Blacksburg, Virginia, USA

Advisor: Prof. Mayuresh Patil

Thesis: Nonlinear Dynamics and Control of Integrally Actuated Helicopter Blades

Diploma Student, **Technische Universität München** **(10/2001 - 12/2005)**
Department of Mechanical Engineering, Munich, Germany
Course of Studies: Mechatronics and Information Technology

RESEARCH INTERESTS

Cyber-physical systems, hybrid systems, embedded systems, formal verification, reachability analysis, probabilistic safety assessment, model-based design principles, architectures for cyber-physical systems, nonlinear control, field robotics, automation engineering, human-robot interaction, control of power systems, analog/mixed-signal circuits.

AWARDS AND HONORS

IEEE/ACM William J. McCalla ICCAD Best Paper Award **(11/2011)**
International Conference on Computer-Aided Design

PhD graduation with distinction (summa cum laude) **(07/2010)**

Best Poster Award **(06/2009)**
IEEE Intelligent Vehicles Symposium

TEACHING

Technische Universität München
Department of Informatics, München, Germany

10/2014 - now	Artificial Intelligence
04/2015 - now	Pearls of Informatics
04/2014 - now	Cyber-Physical Systems
04/2015 - now	Seminar: Cyber-Physical Systems
04/2015 - now	Practical Course: Control of Modular Robots

Technische Universität Ilmenau
Department of Computer Science and Automation, Ilmenau, Germany

10/2012 - 08/2013	Discrete Event Systems
04/2012 - 08/2013	Automation Engineering 1
10/2012 - 02/2013	Automation Engineering 2

PROJECTS

Research Grants

01/2015 - 12/2018	EU project *Unifying Control and Verification of Cyber-Physical Systems (UnCoVerCPS)*; Role: Coordinator; Total funding 4.9 mEUR, own funding 508 kEUR.
01/2015 - 12/2017	DFG project *Analysis and Synthesis of Robustly Controlled Smart-Grid-Systems (ROCS-Grid)*; Role: PI; own funding 207 kEUR.
04/2014 - 03/2017	DFG project *Formal Verification of Collision Avoidance Systems for Road Vehicles*; Role: PI; own funding 235 kEUR.

Supervision

11/2013 - 10/2017	EU project *Sustainable Manufacturing Through Advanced Robotics Training in Europe (SMART-E)*; Role: PI.
07/2014 - 06/2017	DFG doctorate program *Program and Model Analysis (PUMA)*; Role: PhD supervisor.

Participation

03/2010 - 03/2012	NSF project *Computational Modeling and Analysis for Complex Systems (CMACS)*; Role: postdoctoral researcher.
09/2010 - 12/2010	Center for Circuits and Systems Solutions project *Investigation of Formal Verification Methods for Self-Healing Analog/RF Systems*; Role: postdoctoral researcher.
09/2010 - 03/2012	NSF project *An Architecture Approach to Heterogeneous Verification of Cyber-Physical Systems*; Role: postdoctoral researcher.
03/2006 - 02/2010	DFG project *Cognitive Automobiles (SFB TR 28 Kognitive Automobile)*; Role: PhD student.

SUPERVISION

Postdoctoral researcher

11/2014 - now	Dongkun Han (funding from state of Bavaria)

PhD students

02/2014 - now	Sebastian Söntges (DFG Collision Avoidance)
07/2014 - now	Andrea Giusti (EU SMART-E)
07/2014 - now	Esra Icer (EU SMART-E)
07/2014 - now	Aaron Pereira (EU SMART-E)
07/2014 - now	Albert Rizaldi (DFG PUMA)
11/2014 - now	Hendrik Röhm (external PhD student at Bosch)
01/2015 - now	Ahmed El-Guindy (DFG ROCS-Grid)
04/2015 - now	Bastian Schürmann (EU UnCoVerCPS)
06/2015 - now	Silvia Magdici (DFG PUMA)

SERVICE

- Organizer of the workshop *Applied Verification for Continuous and Hybrid Systems* with Goran Frehse (since 2014).
- Program committee member:

  - Hybrid Systems: Computation and Control, associated with Cyber-Physical Systems Week (2014,2015).
  - IEEE Workshop on Modeling and Simulation of Cyber-Physical Energy Systems (2015,2016).
  - Future Active Safety Technology towards Zero traffic accidents (2015).
  - 1st International Workshop on Symbolic and Numerical Methods for Reachability Analysis (2015).
- Associate Editor: IEEE/RSJ International Conference on Intelligent Robots and Systems (2015).
- Reviewer of the following Journals: IEEE Transactions on Intelligent Transportation Systems, IEEE Transactions on Automatic Control, Automatica, Asian Journal of Control, Nonlinear Analysis: Hybrid Systems, Autonomous Robots, The International Journal of Robotics Research, IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, Engineering Applications of Artificial Intelligence, Advances in Operations Research, IEEE Transactions on Vehicular Technology, Mathematics in Computer Science, Microelectronics Journal, Formal Methods in System Design
- Reviewer of the following Conferences: Hybrid Systems: Computation and Control, IEEE Conference on Decision and Control, IEEE Intelligent Vehicles Symposium, American Control Conference, European Control Conference, IEEE Conference on Intelligent Transportation Systems, IEEE International Conference on Robotics and Automation, IEEE/RSJ International Conference on Intelligent Robots and Systems, Mediterranean Conference on Control and Automation, IEEE International Conference on Automation Science and Engineering, Computer Aided Verification

PUBLICATIONS

Peer-Reviewed Journals

[1] M. Althoff. Formal and compositional analysis of power systems using reachable sets. *IEEE Transactions on Power Systems*, 29(5):2270–2280, 2014.

[2] M. Althoff and J. M. Dolan. Online verification of automated road vehicles using reachability analysis. *IEEE Transactions on Robotics*, 30(4):903–918, 2014.

[3] M. Althoff and B. H. Krogh. Reachability analysis of nonlinear differential-algebraic systems. *IEEE Transactions on Automatic Control*, 59(2):371–383, 2014.

[4] M. Althoff, A. Rajhans, B. H. Krogh, S. Yaldiz, X. Li, and L. Pileggi. Formal verification of phase-locked loops using reachability analysis and continuization. *Communications of the ACM*, 56(10):97–104, 2013.

[5] M. Althoff, M. J. Patil, and J. P. Traugott. Nonlinear modeling and control design of active helicopter blades. *Journal of the American Helicopter Society*, 57(1):1–11, 2012.

[6] M. Althoff and A. Mergel. Comparison of Markov chain abstraction and Monte Carlo simulation for the safety assessment of autonomous cars. *IEEE Transactions on Intelligent Transportation Systems*, 12(4):1237–1247, 2011.

[7] M. J. Patil and M. Althoff. Energy-consistent, Galerkin approach for the nonlinear dynamics of beams using intrinsic equations. *Journal of Vibration and Control*, 17(11):1748–1758, 2011.

[8] M. Althoff, O. Stursberg, and M. Buss. Computing reachable sets of hybrid systems using a combination of zonotopes and polytopes. *Nonlinear Analysis: Hybrid Systems*, 4(2):233–249, 2010.

[9] M. Althoff, O. Stursberg, and M. Buss. Model-based probabilistic collision detection in autonomous driving. *IEEE Transactions on Intelligent Transportation Systems*, 10(2):299 – 310, 2009.

[10] M. Althoff, O. Stursberg, and M. Buss. Sicherheitsbewertung von Fahrstrategien kognitiver Automobile. *at - Automatisierungstechnik*, 56:653–661, 2008.

Book Chapter

[11] M. Althoff, B. H. Krogh, and O. Stursberg. *Modeling, Design, and Simulation of Systems with Uncertainties*, chapter Analyzing Reachability of Linear Dynamic Systems with Parametric Uncertainties, pages 69–94. Springer, 2011.

Peer-Reviewed Conference Articles

[12] D. Althoff, M. Althoff, and S. Scherer. Online safety verification of trajectories for unmanned flight with offline computed robust invariant sets. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 3470–3477, 2015.

[13] M. Althoff. An introduction to CORA 2015. In *Proc. of the Workshop on Applied Verification for Continuous and Hybrid Systems*, 2015.

[14] A. Giusti and M. Althoff. Automatic centralized controller design for modular and reconfigurable robot manipulators. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 3268–3275, 2015.

[15] D. Han and M. Althoff. Control synthesis for non-polynomial systems: A domain of attraction perspective. In *Proc. of the 54th IEEE Conference on Decision and Control*, 2015.

[16] H.-S. L. Lee, M. Althoff, S. Hoelldampf, M. Olbrich, and E. Barke. Automated generation of hybrid system models for reachability analysis of nonlinear analog circuits. In *Proc. of the 20th Asia and South Pacific Design Automation Conference*, pages 725–730, 2015.

[17] G. Mesesan, E. Icer, and M. Althoff. Hierarchical genetic path planner for highly redundant manipulators. In *Proc. of the Workshop on Task Planning for Intelligent Robots in Service and Manufacturing*, 2015.

[18] A. Pereira and M. Althoff. Safety control of robots under computed torque control using reachable sets. In *Proc. of the IEEE International Conference on Robotics and Automation*, pages 331 – 338, 2015.

[19] A. Rizaldi and M. Althoff. Formalising traffic rules for accountability of autonomous vehicles. In *Proc. of the 18th IEEE International Conference on Intelligent Transportation Systems*, 2015.

[20] A. Rizaldi, S. Söntges, and M. Althoff. On time-memory trade-off for collision detection. In *Proc. of the IEEE Intelligent Vehicles Symposium*, 2015.

[21] S. Söntges and M. Althoff. Determining the nonexistence of evasive trajectories for collision avoidance systems. In *Proc. of the 18th IEEE International Conference on Intelligent Transportation Systems*, 2015.

[22] D. Heß, M. Althoff, and T. Sattel. Formal verification of maneuver automata for parameterized motion primitives. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 1474–1481, 2014.

[23] M. Althoff. Reachability analysis of nonlinear systems using conservative polynomialization and non-convex sets. In *Hybrid Systems: Computation and Control*, pages 173–182, 2013.

[24] M. Althoff, D. Heß, and F. Gambert. Road occupancy prediction of traffic participants. In *Proc. of the 16th International IEEE Conference on Intelligent Transportation Systems*, pages 99–105, 2013.

[25] D. Heß, M. Althoff, and T. Sattel. Comparison of trajectory tracking controllers for emergency situations. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 163–170, 2013.

[26] D. Heß, M. Althoff, and T. Sattel. Should collision avoidance systems use yaw stabilization? In *Proc. of the 16th International IEEE Conference on Intelligent Transportation Systems*, pages 2058–2062, 2013.

[27] M. Althoff, M. Cvetković, and M. Ilić. Transient stability analysis by reachable set computation. In *Proc. of the IEEE PES Conference on Innovative Smart Grid Technologies Europe*, 2012.

[28] M. Althoff and J. M. Dolan. Reachability computation of low-order models for the safety verification of high-order road vehicle models. In *Proc. of the American Control Conference*, pages 3559–3566, 2012.

[29] M. Althoff and B. H. Krogh. Avoiding geometric intersection operations in reachability analysis of hybrid systems. In *Hybrid Systems: Computation and Control*, pages 45–54, 2012.

[30] M. Althoff and J. M. Dolan. Set-based computation of vehicle behaviors for the online verification of autonomous vehicles. In *Proc. of the 14th IEEE Conference on Intelligent Transportation Systems*, pages 1162–1167, 2011.

[31] M. Althoff and B. H. Krogh. Zonotope bundles for the efficient computation of reachable sets. In *Proc. of the 50th IEEE Conference on Decision and Control*, pages 6814–6821, 2011.

[32] M. Althoff, C. Le Guernic, and B. H. Krogh. Reachable set computation for uncertain time-varying linear systems. In *Hybrid Systems: Computation and Control*, pages 93–102, 2011.

[33] M. Althoff, A. Rajhans, B. H. Krogh, S. Yaldiz, X. Li, and L. Pileggi. Formal verification of phase-locked loops using reachability analysis and continuization. In *Proc. of the Int. Conference on Computer Aided Design*, pages 659–666, 2011.

[34] D. Althoff, M. Althoff, D. Wollherr, and M. Buss. Probabilistic collision state checker for crowded environments. In *Proc. of the IEEE International Conference on Robotics and Automation*, pages 1492–1498, 2010.

[35] M. Althoff, D. Althoff, D. Wollherr, and M. Buss. Safety verification of autonomous vehicles for coordinated evasive maneuvers. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1078–1083, 2010.

[36] M. Althoff, O. Stursberg, and M. Buss. Safety assessment for stochastic linear systems using enclosing hulls of probability density functions. In *Proc. of the European Control Conference*, pages 625–630, 2009.

[37] M. Althoff, O. Stursberg, and M. Buss. Safety assessment of driving behavior in multi-lane traffic for autonomous vehicles. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 893–900, 2009.

[38] S. Kraus, M. Althoff, B. Heißing, and M. Buss. Cognition and emotion in autonomous cars. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 635–640, 2009.

[39] M. Althoff, O. Stursberg, and M. Buss. Online-Analyse von Fahrstrategien kognitiver autonomer Fahrzeuge. In *Proc. of Automatisierungssysteme, Assistenzsysteme und eingebettete Systeme für Transportmittel (AAET)*, pages 314–330, 2008.

[40] M. Althoff, O. Stursberg, and M. Buss. Reachability analysis of nonlinear systems with uncertain parameters using conservative linearization. In *Proc. of the 47th IEEE Conference on Decision and Control*, pages 4042–4048, 2008.

[41] M. Althoff, O. Stursberg, and M. Buss. Stochastic reachable sets of interacting traffic participants. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1086–1092, 2008.

[42] M. Althoff, O. Stursberg, and M. Buss. Verification of uncertain embedded systems by computing reachable sets based on zonotopes. In *Proc. of the 17th IFAC World Congress*, pages 5125–5130, 2008.

[43] M. Goebl, M. Althoff, M. Buss, G. Färber, F. Hecker, B. Heißing, S. Kraus, R. Nagel, F. Puente León, F. Rattei, M. Russ, M. Schweitzer, M. Thuy, C. Wang, and H.-J. Wünsche. Design and capabilities of the Munich cognitive automobile. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1101–1107, 2008.

[44] F. Rohrmüller, M. Althoff, D. Wollherr, and M. Buss. Probabilistic mapping of dynamic obstacles using Markov chains for replanning in dynamic environments. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 2504–2510, 2008.

[45] M. Althoff, O. Stursberg, and M. Buss. Online verification of cognitive car decisions. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 728–733, 2007.

[46] M. Althoff, O. Stursberg, and M. Buss. Reachability analysis of linear systems with uncertain parameters and inputs. In *Proc. of the 46th IEEE Conference on Decision and Control*, pages 726–732, 2007.

[47] M. Althoff, O. Stursberg, and M. Buss. Safety assessment of autonomous cars using verification techniques. In *Proc. of the American Control Conference*, pages 4154–4159, 2007.

[48] M. Althoff, M. J. Patil, and J. P. Traugott. Nonlinear modeling and control design of active helicopter blades. In *Proc. of the 47th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference*, 2006. AIAA Paper 2006-2040.

[49] M. J. Patil and M. Althoff. Energy-consistent, Galerkin approach for the nonlinear dynamics of beams using mixed, intrinsic equations. In *Proc. of the 47th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference*, 2006. AIAA Paper 2006-1737.

Other Conference Articles

[50] M. Althoff, O. Stursberg, and M. Buss. Erreichbarkeitsanalyse von Verkehrsteilnehmern zur Verbesserung von Fahrerassistenzsystemen. In *Proc. of 3. Tagung Aktive Sicherheit durch Fahrerassistenz*, 2008.

[51] M. Thuy, M. Goebl, F. Rattei, M. Althoff, F. Obermeier, S. Hawe, R. Nagel, S. Kraus, C. Wang, F. Hecker, M. Russ, M. Schweitzer, F. Puente León, G. Färber, M. Buss, K. Diepold, J. Eberspächer, B. Heißing, and H.-J. Wünsche. Kognitive Automobile: Neue Konzepte und Ideen des Sonderforschungsbereiches/TR-28. In *Proc. of 3. Tagung Aktive Sicherheit durch Fahrerassistenz*, 2008.

Theses

[52] M. Althoff. *Reachability Analysis and its Application to the Safety Assessment of Autonomous Cars*. Dissertation, Technische Universität München, 2010. http://nbn-resolving.de/urn/resolver.pl?urn:nbn:de:bvb:91-diss-20100715-963752-1-4.

[53] M. Althoff. *Nonlinear Dynamics and Control of Integrally Actuated Helicopter Blades*. Diploma thesis, Technische Universität München, 2005.