

GEORGIOS E. FAINEKOS

School of Computing, Informatics and Decision Systems Engineering, Arizona State University.

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RESEARCH INTERESTS

Cyber-Physical Systems : *Hybrid and Dynamical Systems, Real Time and Embedded Systems*, Control & Automation, Formal Methods : *Synthesis, Verification, Testing and Logic*, (Motion) Planning in Robotics, Mechatronics, Unmanned Aerial Vehicles (UAV), Inverse design engineering

EDUCATION

- **University of Pennsylvania** (2004 – 2008), Philadelphia, PA, USA
Doctor of Philosophy in Computer and Information Science
Advisor: Prof. G. Pappas (UPenn) GRASP Lab
- **University of Pennsylvania** (2002 – 2004), Philadelphia, PA, USA
Master of Science in Engineering in Computer and Information Science
Advisor: Prof. G. Pappas (UPenn) GRASP Lab
- **National Technical University of Athens** (1996 – 2001), Athens, Greece
Diploma (Master of Science in Engineering) in Mechanical Engineering; Major in **Design & Control**
Advisor: Prof. K. Giannakoglou (NTUA) Lab of Thermal Turbomachines

ACADEMIC EMPLOYMENT

- **Assistant Professor**, Aug. 2009 – up to now
Arizona State University, Tempe, USA
Appointment: School of Computing, Informatics and Decision Systems Engineering.

RESEARCH EXPERIENCE

- **Postdoctoral Researcher**, NEC Laboratories America, Oct. 2008 – Aug. 2009, USA
 - *Tessa: Techniques for Embedded System and Software Assurance*
Research on verification and testing of embedded systems software. Developed a framework for the robustness analysis of Simulink simulations and models using self-validated arithmetics (interval and affine arithmetic). The goal of the project was to study the robustness and correctness of Simulink simulations under system uncertainties, numerical errors and floating point rounding errors. The outcome of the project was the Matlab toolbox RobSim which can analyze continuous-time, discrete-time and mixed-signal systems.
- **Research Assistant**, GRASP Lab, University of Pennsylvania, 2002 – 2008, USA
 - *Formal Methods for Testing Hybrid and Dynamical Systems*
Developed a theory for the robustness of temporal logic specifications over discrete and continuous time signals in metric spaces. Built a software toolbox for analyzing the robustness of temporal logic specifications over discrete time signals. Developed a framework for reasoning in continuous time using discrete time methods. Applied the theory to the analysis of continuous – discrete time systems with metric state spaces. Built a software toolbox for testing hybrid systems.

- *Controller Design Using Temporal Logic Specifications*
Developed a framework for deriving controller specifications from temporal logic formulas. Built a toolbox that synthesizes hybrid systems from temporal logic specifications.
 - *From Structured English to Path Planning for Mobile Robots*
Developed a framework for deriving hybrid controllers for path planning for mobile robots from structured English. The framework uses as intermediate formalism linear temporal logic and applies to motion planning of both dynamic and kinematic models of robots.
 - *Modelling and Development of Unmanned Aerial Vehicles (UAV)*
Developed aerodynamic and structural models of the Penn UAV platform. Designed and built parts of the Penn UAV platform.
- **Research Assistant**, Lab of Thermal Turbomachines, NTUA, Jan. – Nov. 2001, Greece
 - *Inverse design of airfoils using Ant Colony Optimization algorithms*
Extended the discrete ant colony optimization algorithm to handle continuous optimization problems. Built a software toolbox for the application of the method to the problem of inverse design of airfoils.

PROFESSIONAL EXPERIENCE

- **Postdoctoral Researcher**, NEC Laboratories America, Oct. 2008 – Aug. 2009, USA
Principal researcher for the project Tessa (Techniques for Embedded System and Software Assurance): see Research Experience section.
- **Mechanical Engineer**, Jet Engineering ltd, Nov. 2001 – Jul. 2002, Greece
Part of an engineering team working on the design, verification, validation and manufacturing of tank trailers and tank containers for hazardous materials. Successfully designed (using SolidWorks) three out of the four tank models of the company's current production line. Design for adherence to international standards: ADR, PrEN-13094, PrEN-14025, DIN-4100 and EN-288. Trained in verification using finite element methods and in experimental validation (data acquisition from the prototype tank vehicles).
- **Intern**, Microfluidics Laboratory, Purdue University, Aug. – Dec. 2000, USA
Part of a group of students working on the design of a manifold supporting a model (microchip) of the choroidal vasculature. Responsibilities: Design of the model in Pro Engineer; Web page development.
- **Intern**, Engines Maintenance Unit, Hellenic Aerospace Industry ltd, Mar. – Jul. 2000, Greece
Development of an automated Local Heat Treatment (LHT) unit for military engine parts. Trained on LHT processes for aerospace materials. Successfully designed and implemented in Visual Basic a software package for the control of LHT processes. Tuning of the PID controllers. Selected components and designed procedures in accordance with military specifications. Final report (in Greek) co-supervised by Dr. Freskos (HAI) and Dr. Giannakoglou (NTUA): *Local Heat Treatment Processes: Development of computer software for Control and Data Acquisition*.
- **Intern**, Current Technology ltd, 1996 – 99, Greece
Participated in various posts in summer internships in CT ltd which is specialised in the design and production of industrial automations and CNC machines. Sample projects: plasma cutting and milling CNC machines, foam cutting machines, jet-engine testing facilities.

TEACHING EXPERIENCE

- **Instructor**, Arizona State University, USA
 - CSE 355 (Fall 2009): *Introduction to Theoretical Computer Science*
- **Teaching Assistant**, University of Pennsylvania, USA

- CSE 110 (Spring 2004): *Introduction to Programming (in C)*, Responsibilities: recitations (3 hour lectures per week), office hours, homeworks and exams, grading
- CSE 390/MEAM 420 (Fall 2003): *Robotics*, Responsibilities: office hours, homeworks and exams, preparation of labs (using Lego Mindstorms), grading

PUBLICATIONS

Thesis

1. **Georgios E. Fainekos**, Robustness of Temporal Logic Specifications, PhD Thesis, Department of Computer and Information Science, University of Pennsylvania, August 2008
2. **Georgios E. Fainekos**, Ant Colony Optimization: Applications to discrete and continuous problems, Diploma Thesis, Department of Mechanical Engineering, National Technical University of Athens, September 2001 (in Greek)

Editorials

- **G. E. Fainekos**, E. Goubault, F. Ivancic and S. Sankaranarayanan, Guest editors for the special issue in the ACM Transactions on Embedded Computing Systems on the Numerical Software Verification of Cyber-Physical Software Systems (*Under preparation*)

Refereed Journal Publications

1. H. Kress-Gazit, **G. E. Fainekos** and G. J. Pappas, Temporal Logic-based Reactive Mission and Motion Planning. *IEEE Transactions on Robotics*, 2009. (In press)
2. **G. E. Fainekos** and G. J. Pappas, Robustness of temporal logic specifications for continuous-time signals. *Theoretical Computer Science*, Elsevier, V 410, N 42, pp 4262-4291, 2009.
3. **G. E. Fainekos**, A. Girard, H. Kress-Gazit and G. J. Pappas, Temporal Logic Motion Planning for Dynamic Mobile Robots. *Automatica*, Elsevier, V 45, N 2, pp 343-352, 2009.
4. H. Kress-Gazit, **G. E. Fainekos** and G. J. Pappas, Translating Structured English to Robot Controllers. *Advanced Robotics*, VSP\Brill Academic Publishers, V 22, N 12, pp 1343-1359, 2008. (**Invited paper**)
5. **G. E. Fainekos** and K. C. Giannakoglou, Inverse Design of Airfoils Based on a Novel Formulation of the Ant Colony Optimization Method. *Inverse Problems in Engineering*, Taylor & Francis, V 11, N 1, pp 21-38, 2003.

Refereed Conference Papers

1. **G. E. Fainekos**, S. Sankaranarayanan, F. Ivancic, A. Gupta, Robustness of Model-based Simulations. *IEEE Real-Time Systems Symposium*, Washington DC, Dec. 2009 (To Appear)
2. **G. E. Fainekos** and G. J. Pappas, MTL Robust Testing and Verification for LPV Systems. In the *Proceedings of the 2009 American Control Conference*, pp 3748 - 3753, St. Louis, Missouri, June 2009
3. D. Del Vecchio, E. A. Lee, J.-F. Raskin, G. J. Pappas, **G. E. Fainekos**, D. Caveney and L. Caminiti, Partial Order Techniques for the Analysis and Synthesis of Hybrid and Embedded Systems. In the *Proceedings of the 46th IEEE Conference on Decision and Control*, New Orleans, Louisiana, December 2007
4. **G. E. Fainekos** and G. J. Pappas, Robust Sampling for MITL Specifications. *In the 5th Inter. Conference on Formal Modelling and Analysis of Timed Systems*, Lecture Notes in Computer Science, Vol. 4763, pp 147-162, Springer 2007

5. H. Kress-Gazit, **G. E. Fainekos** and G. J. Pappas, From Structured English to Robot Motion. In the *Proceedings of the 2007 IEEE/RSJ International Conference on Intelligent Robots and Systems*, San Diego, California, October 2007
6. H. Kress-Gazit, **G. E. Fainekos** and G. J. Pappas, Where's Waldo? Sensor-Based Temporal Logic Motion Planning. In the *Proceedings of the 2007 International Conference on Robotics and Automation*, Rome, Italy, April 2007 (**Finalist for best student paper**)
7. **G. E. Fainekos**, A. Girard and G. J. Pappas, Hierarchical Synthesis of Hybrid Controllers from Temporal Logic Specifications. *Hybrid Systems: Computation and Control*, Lecture Notes in Computer Science, Vol. 4416, pp 203-216, Springer 2007 (**25% Acceptance Rate**)
8. A. A. Julius, **G. E. Fainekos**, M. Anand, I. Lee and G. J. Pappas, Robust test generation and coverage for hybrid systems. *Hybrid Systems: Computation and Control*, Lecture Notes in Computer Science, Vol. 4416, pp 329-342, Springer 2007 (**25% Acceptance Rate**)
9. **G. E. Fainekos**, A. Girard and G. J. Pappas, Temporal Logic Verification Using Simulation. In the *4th Inter. Conference on Formal Modelling and Analysis of Timed Systems*, Lecture Notes in Computer Science, Vol. 4202, pp 171-186, Springer 2006
10. **G. E. Fainekos** and G. J. Pappas, Robustness of Temporal Logic Specifications. In the *Workshop on Formal Approaches to Testing and Runtime Verification*, Lecture Notes in Computer Science, Vol. 4262, pp 178-192, Springer 2006
11. **G. E. Fainekos**, S. G. Loizou, G. J. Pappas, Translating temporal logic to controller specifications. In the *Proceedings of the 45th IEEE Conference on Decision and Control*, San Diego, California, December 2006
12. **G. E. Fainekos**, H. Kress-Gazit and G. J. Pappas, Hybrid Controllers for Path Planning: A Temporal Logic Approach. In the *Proceedings of the 44th IEEE Conference on Decision and Control*, Seville, Spain, December 2005
13. **G. E. Fainekos**, H. Kress-Gazit and G. J. Pappas, Temporal Logic Motion Planning for Mobile Robots. In the *Proceedings of the International Conference on Robotics and Automation*, Barcelona, Spain, April 2005
14. S. Bayraktar, **G. E. Fainekos** and G. J. Pappas, Experimental Cooperative Control of Fixed-Wing Unmanned Aerial Vehicles. In the *Proceedings of the 43rd IEEE Conference on Decision and Control*, The Bahamas, December 2004

Patents

1. Robust Testing for Discrete-Time and Continuous-Time System Models (*Provisional to be filled soon*)

Technical Reports

1. **G. E. Fainekos**, A. Girard, H. Kress-Gazit and G. J. Pappas, Temporal Logic Motion Planning for Dynamic Mobile Robots, *Technical Report MS-CIS-07-02*, Department of CIS, University of Pennsylvania, January 2007
2. **G. E. Fainekos**, A. Girard and G. J. Pappas, Hierarchical synthesis of hybrid controllers from temporal logic specifications, *Technical Report MS-CIS-07-01*, Department of CIS, University of Pennsylvania, January 2007
3. **G. E. Fainekos** and G. J. Pappas, Robustness of Temporal Logic Specifications for Finite State Sequences in Metric Spaces. *Technical Report MS-CIS-06-05*, Department of CIS, University of Pennsylvania, May 2006
4. **Georgios E. Fainekos**, An Introduction to Multi-Valued Model Checking. *Technical Report MS-CIS-05-16*, Department of CIS, University of Pennsylvania, September 2005

5. S. Bayraktar, **G. E. Fainekos** and G. J. Pappas, Hybrid Modeling and Experimental Cooperative Control of Multiple Unmanned Aerial Vehicles. *Technical Report MS-CIS-04-32*, Department of CIS, University of Pennsylvania, December 2004

PRESENTATIONS

Invited Talks, Tutorials & Defenses

1. *Robustness of Temporal Logic Specifications*, PhD thesis defense, University of Pennsylvania, USA, June 2008
2. *Testing and Verification of Cyber-Physical Systems*, Department of Computer Science, Columbia University, USA, May 2008
3. *Testing and Verification of Cyber-Physical Systems*, Department of Computer Science and Engineering, Arizona State University, USA, April 2008
4. *Testing and Verification of Cyber-Physical Systems*, NEC Laboratories, USA, March 2008
5. *Cyber-Physical Systems: Theory and Applications*, Department of Electrical and Computer Engineering, Stevens Institute of Technology, USA, February 2008
6. *Temporal Logics over Lattices and Applications*, Tutorial session on partial order techniques for the analysis and synthesis of hybrid and embedded systems, IEEE Conference on Decision and Control, New Orleans, USA, December 2007
7. *Robustness of Temporal Logic Specifications (and an application to verification using simulation)*, Verimag, Grenoble, France, September 2006
8. *Multi-Valued Model Checking*, In-depth examination, University of Pennsylvania, USA, June 2005
9. *Ant Colony Optimization: Applications to discrete and continuous problems*, Thesis defense, National Technical University of Athens, Greece, September 2001

Conference & Workshop Presentations

1. *MTL Robust Testing and Verification for LPV Systems*, American Control Conference, St. Louis, Missouri, June 2009
2. *Robust Sampling for MITL Specifications*, Formal Modelling and Analysis of Timed Systems, Salzburg, Austria, October 2007
3. *Hierarchical Synthesis of Hybrid Controllers from Temporal Logic Specifications*, Hybrid Systems: Computation and Control, Pisa, Italy, April 2007
4. *Robust test generation and coverage for hybrid systems*, Hybrid Systems: Computation and Control, Pisa, Italy, April 2007
5. *Temporal Logic Verification Using Simulation*, Formal Modelling and Analysis of Timed Systems, Paris, France, October 2006
6. *Robustness of Temporal Logic Specifications*, Workshop on Formal Approaches to Testing and Runtime Verification, Seattle, Washington, August 2006
7. *Translating temporal logic to controller specifications*, IEEE Conference on Decision and Control, San Diego, California, December 2006
8. *Temporal Logic Motion Planning for Mobile Robots*, International Conference on Robotics and Automation, Barcelona, Spain, April 2005

9. *Temporal Logic Motion Planning for Mobile Robots*, Northeast Nonlinear and Hybrid Control Workshop, Troy, New York, April 2005
10. *Experimental Cooperative Control of Fixed-Wing Unmanned Aerial Vehicles*, IEEE Conference on Decision and Control, The Bahamas, December 2004

Posters

1. *Temporal Logic Motion Planning for Mobile Robots*, Hybrid Systems : Computation and Control, Santa Barbara, California, March 2006
2. *Temporal Logic Motion Planning for Mobile Robots*, Graduate Research Symposium, University of Pennsylvania, March 2005 (**Best poster award**)

RELEASED SOFTWARE

- TALiRO computes the robustness estimate of a Metric Temporal Logic formula with respect to a bounded duration discrete time signal : <http://www.seas.upenn.edu/~fainekos/robustness.html>

AWARDS

- 2008 Frank Anger Memorial ACM SIGBED/SIGSOFT Student Award
- Finalist, Best Student Paper (2007 International Conference on Robotics and Automation)
- Best Poster Award (2005 Graduate Research Symposium at the University of Pennsylvania)
- 2002 – 08: Graduate Research Fellowship (University of Pennsylvania)
- Award for academic excellence in engineering sciences for the academic year 2000-2001 (Awarded by the Technical Chamber of Greece; Given to the top 5 students of every year in each department)

COMMUNITY SERVICE AND PROFESSIONAL ACTIVITIES

- Organizer:
 - with E. Goubault and S. Putot; Numerical Software Verification (NSV) III; Under review for affiliation with the Federated Logic Conference (FLOC) 2010.
 - with E. Goubault and S. Sankaranarayanan; Numerical Software Verification (NSV) II: Verification of Cyber-Physical Software Systems; Affiliated with the Cyber-Physical Systems (CPS) Week 2009.
- Program Committee member:
 - Interaction and Concurrency Experiences (ICE): 2009
 - Quantitative Formal Methods (QFM): 2009
- Reviewer for Journals:

IEEE Transactions on Automatic Control, IEEE Transactions on Automation Science and Engineering, IEEE Transactions on Robotics, Formal Methods in System Design, IEEE Control Systems Magazine, IEEE Robotics and Automation Magazine, *and* IEEE Systems, Man and Cybernetics.
- Reviewer for Conferences:

Hybrid Systems: Computation and Control (HSCC), IFAC Conference on Analysis and Design of Hybrid Systems (ADHS), ACM Conference on Embedded Systems Software (EMSOFT), IEEE Real-Time Systems Symposium (RTSS), Computer Aided Verification (CAV), Reachability Problems (RP), IEEE

Conference on Decision and Control (CDC), American Control Conference (ACC), IEEE European Control Conference (ECC), Mediterranean Control Conference (MED), IEEE Multi-conference on Systems and Control (MSC) IEEE International Conference on Robotics and Automation (ICRA), *and* IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).

- Graduate Student Representative for the academic year 2007-08 at the University of Pennsylvania (Attending faculty meetings; Member of the committee for the appointment of the new department Chairperson)

PROFESSIONAL MEMBERSHIPS

- Member of the Association for Computing Machinery (ACM) since 2008:
Special Interest Group on Embedded Systems (SIGBED) 2007-08, Student Member 2006-08
- Member of the American Society Of Mechanical Engineers (ASME) since 2008:
Student Member 2006-08
- Member of the Institute of Electrical and Electronics Engineers (IEEE) since 2008:
Robotics and Automation Society (RAS), Control Systems Society (CSS), Student Member 2004-08
- Member of the Technical Chamber of Greece since 2002 (as Mechanical Engineer)

OTHER ACADEMIC ACTIVITIES

- **Ecole Centrale Paris**, Board of European Students of Technology (BEST) Spring course 2002: “Launching of Ariane V”, Paris, France; Classes on the propulsion system of Ariane V and visits to ESA, Snecma
- **Chalmers University of Technology**, BEST Summer course 2001: “Usability Engineering”, Gothenburg, Sweden; Classes on usability engineering and visits to SKF
- **University of Patras**, 1995 – 96, Greece
Department of Mathematics; Classes on Mathematics and Computer Science

COMPUTER KNOWLEDGE & FOREIGN LANGUAGES

- **Programming:** C, C++, Fortran, Visual Basic, OCaml
- **CAD/FEA:** SolidWorks, CosmosWorks, AutoCAD, Mechanical Desktop, Pro Engineer
- **Model Checking Tools:** SPIN, SMV
- **Modelling and Prototyping:** MATLAB, Simulink, Mathematica, ...
- **Greek:** Native, **English:** Fluent (Cambridge Certificate of Proficiency in English), **German, Spanish:** beginner, **Japanese:** Currently studying

EXTRA-CURRICULAR ACTIVITIES

- Open Sea Sailing (former member of the Hellenic Offshore Racing Club, Greece)
- Horse Riding (former member of the Horse Riding Club of Mesogeion, Greece)
- Basketball (During High-School: member of Kronos Basketball Team, Greece)
- Playing the saxophone (former member of Agios Dimitrios Municipality Band, Greece)