

Madhukar Anand

CONTACT INFORMATION

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Department of Computer & Information Science
University of Pennsylvania
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RESEARCH INTERESTS

Real-Time and Embedded Systems, Formal Methods, Hybrid Systems, Sensor Networks.

EDUCATION

University of Pennsylvania, Philadelphia, PA, USA.

Ph.D. Candidate, Computer and Information Science,
(expected graduation date: May 2008)

- Adviser: Prof. Insup Lee.

University of Pennsylvania, Philadelphia, PA, USA.

M.S., Computer and Information Science, May, 2005.

Indian Institute of Technology (IIT), Kharagpur, WB, India.

B.S., M.S.(Int), Mathematics and Computing, May, 2003

RESEARCH EXPERIENCE

- **Compositional analysis framework for real-time embedded systems** Developed a compositional design framework for real-time embedded systems with expressive interfaces that are amenable to efficient resource satisfiability analysis. The framework introduces task and resource models with conditional branches and addresses the problem of compositional analysis by generating abstractions that capture the resource requirements of the underlying components.
- **Analysis framework for network code programs** Network Code is a domain-specific programming language to write predictable, verifiable distributed communication for distributed real-time applications. In this work, a formal modeling framework for network code programs was developed and results on schedulability and average service times with these models were given. Further, composition techniques for different models were developed and their impact on different properties studied.
- **Reliable code generation from hybrid system models** Co-developed techniques for reliable code generation from hybrid systems models for embedded systems. The work focused on providing faithful implementation of the model with respect to its switching semantics. The techniques relied on an instrumentation technique to avoid faulty transitions and identified conditions to detect missed transitions.
- **Isotropism** Co-developed communication theory and analytical model of Isotropic channels, special broadcast communication media in which no party can reliably determine the source of an intercepted message and no party can reliably direct a message towards a particular receiver. Designed protocols for achieving near-perfectly secure confidentiality in Isotropic channels.
- **Quantifying security in sensor networks** Developed metrics for quantifying eavesdropping vulnerability in sensor networks. Different topologies and aggregation functions provide different guarantees about system security, and make different trade-offs in power and accuracy, and the work tries to quantifies these probabilistically.
- **Formal verification of avionics full duplex ethernet (AFDX)** The Avionics Full Duplex Switched Ethernet (AFDX) has been developed to provide reliable data exchange with strong

data transmission time guarantees in internal communication of the aircraft. In this work, a formal model of the AFDX frame management was developed to ascertain the reliability properties of the design. The analysis showed that the frame management of AFDX was vulnerable to faults such as network babbling which could trigger unwarranted system resets. Suggestions to improve the design and fix these vulnerabilities were provided.

BOOK CHAPTERS Madhukar Anand, Jesung Kim, Sebastian Fischmeister, and Insup Lee. “Generating Sound and Resource-Aware Code from Hybrid System Models”. (to appear) *2nd Post proceedings of the Workshop on Advanced Automotive Software and Systems Development, San Diego (ASWSD)*.

CONFERENCE
PUBLICATIONS

1. Madhukar Anand and Insup Lee, “Robust and Sustainable Schedulability Analysis of Embedded Software” (*To Appear*) *Proceedings of the ACM SIGPLAN/SIGBED 2008 Conference on Languages, Compilers, and Tools for Embedded Systems (LCTES 2008)*, Tucson, AZ, Jun 12-13, 2008
2. Madhukar Anand, Arvind Easwaran, Sebastian Fischmeister, and Insup Lee. “Compositional Feasibility Analysis for Conditional Task Models”. (*To appear*) *11th IEEE International Symposium on Object-oriented Real-time Distributed Computing (ISORC)*, 2008.
3. Arvind Easwaran, Madhukar Anand, and Insup Lee. “Compositional Analysis Framework using Explicit Deadline Periodic Resource Models”. *28th IEEE Real-Time Systems Symposium (RTSS)*, 2007, pages 129-138.
4. Luis Almeida, Madhukar Anand, Sebastian Fischmeister and Insup Lee. “A Dynamic Scheduling Approach to Designing Flexible Safety-Critical Systems”. *7th ACM International Conference on Embedded Software (EMSOFT)*, 2007, pages 67-74.
5. Madhukar Anand, Sebastian Fischmeister and Insup Lee. “Composition Techniques for Tree Communication Schedules”. *19th Euromicro Conference on Real-Time Systems (ECRTS)*, 2007, pages 235-246.
6. A Agung Julius, Georgios E. Fainekos, Madhukar Anand, Insup Lee and George J. Pappas. “Robust Test Generation and Coverage for Hybrid Systems”, *10th International Conference on Hybrid Systems: Computation and Control (HSCC)*, 2007, pages 329-342 .
7. Madhukar Anand, Sebastian Fischmeister, and Insup Lee. “An Analysis Framework for Network-Code Programs”. *6th ACM International Conference on Embedded Software (EMSOFT)*, 2006, pages 122-131.
8. Madhukar Anand, Insup Lee, Oleg Sokolsky, and George Pappas. “Unit & Dynamic Typing in Hybrid Systems Modeling with CHARON”. *IEEE International Symposium on Computer-Aided Control Systems Design (CACSD)*, 2006, pages 56-61.
9. Madhukar Anand, Samar Dajani-Brown, Steve Vestal, and Insup Lee. “Formal Modeling and Analysis of AFDX Frame Management Design”. *9th IEEE International Symposium on Object-oriented Real-time Distributed Computing (ISORC)*, 2006, pages 393-399.
10. Madhukar Anand, Sebastian Fischmeister, Jesung Kim, and Insup Lee. “Distributed Code Generation from Hybrid Systems Models for Time-delayed Multirate Systems”. *5th ACM International Conference on Embedded Software (EMSOFT)*, 2005, pages 210-213.
11. Madhukar Anand, Jesung Kim, and Insup Lee. “Code Generation from Hybrid Systems Models for Distributed Embedded Systems”. *8th IEEE International Symposium on Object-oriented Real-time Distributed Computing (ISORC)*, 2005, pages 166-173 (*Invited Paper*).

WORKSHOP
PUBLICATIONS

1. Madhukar Anand, Eric Cronin, Micah Sherr, Matt Blaze, Zachary Ives and Insup Lee. "Sensor Network Security: More Interesting Than You Think". *1st USENIX Workshop on Hot Topics in Security (HotSec)*, 2006.
2. Madhukar Anand, Zachary Ives, and Insup Lee. "Quantifying Eavesdropping Vulnerability in Sensor Networks". *2nd VLDB Workshop on Data Management for Sensor Networks (DMSN)*, 2005, pages 3-9.

JOURNAL ARTICLES

Madhukar Anand, Sebastian Fischmeister, Yerang Hur, Jesung Kim, and Insup Lee. "Generating Reliable Code from Distributed Hybrid System Models". (under submission) *IEEE Transactions on Industrial Informatics*.

OTHER TECHNICAL
WRITINGS

Madhukar Anand, Eric Cronin, Micah Sherr, Matt Blaze, and Sampath Kannan. "Security Protocols with Isotropic Channels". *Cryptology ePrint Archive, Report 2006/396*, 2006

Madhukar Anand, Jesung Kim, and Insup Lee. "Sound Code Generation from Hybrid System Models: Some Theoretical Results". *Tech report, MS-CIS-05-03, University of Pennsylvania*, 2005.

Madhukar Anand, T.Praveen Babu, and S.Sundar. "An Intelligent Decision Making System for Autonomous Vehicle Control". *89th Indian Science Congress*, 2002.

Madhukar Anand, T.Praveen Babu, and Hariharan R. "A Genetic Algorithmic Approach for Finding the Root of an Equation". *89th Indian Science Congress*, 2002.

HONORS AND
AWARDS

RTSS PhD Forum Grant Award, 2007.

USENIX Travel Grant Award, 2006.

Institute Silver Medal awarded for Academic Excellence, IIT, 2003.

Proficiency Prize for Best Project Work in Mathematics and Computing, IIT, 2003.

Graduate Fellowship awarded by the University of Pennsylvania, 2003.

J. C. Ghosh Memorial Award for Highest GPA in Mathematics and Computing, IIT, 2002.

JNCASR Young Summer Research Fellowship, 2000 (Awarded to the top 2% of the candidates, from all over India).

SELECTED TALKS

"Tree Schedules –A Conditional Resource Supply Model for Real-time Embedded Systems", *Fourth Northeastern Verification Seminar (NEVER)*, Philadelphia, 2007

"Compositional Techniques for Real-time Embedded Systems", *General Motors, India*, 2007

"Conditional Models for Compositional Design of Real-time Embedded Systems", Dissertation proposal defense, *University of Pennsylvania*, 2007

"Typing and Hybrid Systems Modeling in CHARON", Given at the *IEEE International Symposium on Computer-Aided Control Systems Design, Munich (CACSD)*, 2006

"Generating Sound and Resource-Aware Code from Hybrid System Models", Given at the *Second Workshop on Advanced Automotive Software and Systems Development, San Diego (ASWSD)*, 2006

"Distributed Code Generation from Hybrid Systems Models for Time-delayed Multirate Systems" Given at the *ACM International Conference for Embedded Software (EMSOFT)*, 2005.

"Formal Modeling and Analysis of the AFDX Frame Management Design" Given at the *Honeywell Technology Center (HTC)*, Aug 2005.

“Code Generation from Hybrid System Models for Distributed Embedded Systems” Given at the *IEEE International Symposium on Object-oriented Real-time Distributed Computing (ISORC)*, 2005.

PROFESSIONAL
EXPERIENCE

University of Pennsylvania, Philadelphia, PA, USA.

PhD Candidate

Sep 2003-

Mentor: Prof. Insup Lee.

Project: Conducted research in real-time embedded systems, sensor networks, and cryptography.

Honeywell Technology Center, Minneapolis, MN, USA.

Summer Intern

Jun-Aug 2005

Mentor: Dr. Steve Vestal.

Project: Formal verification and analysis of avionics full duplex ethernet redundancy management.

Cornell University, Ithaca, NY, USA.

Summer Intern, Adaptive Software Project Group

May- Jul 2001

Mentor: Prof. Stephen Vavasis.

Project: Developed data structures for boundary representation of intersection of geometric models.

Indian Institute of Science, Bangalore, India.

Young Summer Research Fellow

May- Jul 2000

Mentor: Prof. CR Pranesachar.

Project: Worked on various graph theoretic algorithms with a focus on planarity detection and embeddings.

PROFESSIONAL
ACTIVITIES

- External Reviewer for RTAS'04, EMSOFT'04, RTCSA'04, ICESSE'04, RTSS'04, ASPDAC'05, HSCC'05, MEMOCODE'05, RV'06, CASES'06, ATVA'06, RTSS'06, SEUS'07, ICESSE'07, FORMATS'07, ATVA'07, EMSOFT'07, RTSS'07, RTAS'08.
- External Reviewer for the Journal of Logic and Algebraic Programming.
- External Reviewer for the Real-Time Systems: The International Journal of Time-Critical Computing Systems.
- Teaching Assistant, Software Systems(CIS 505), University of Pennsylvania, Spring 2005.
- Teaching Assistant, Mathematical Foundations for Computer Science(CIT 592), University of Pennsylvania, Fall 2004.
- Student Member, ACM.
- Convener, Embedded Systems Group Meeting - Jan-May 2006.

COMPUTING SKILLS *Languages/Tools:* C/C++, Java, Python, Assembly x86, UPPAAL, CHARON, PIC Programming.
Operating Systems: UNIX/Linux, Windows.

COURSE WORK

Software Foundations	Analysis of Algorithms
Theory of Computation	Computer Architecture
Hybrid Systems	Real-time and Embedded Systems
Integration of Embedded-System Components	Machine Virtualization

PERSONAL
INFORMATION

Nationality: Indian.

Visa Status: F-1.

REFERENCES

Available upon request.