Georgios Giannakis

Professor, Dept. of Electrical and Computer Engineering

My general interests span the areas of communications and signal processing, estimation and detection theory, time-series analysis, and system identification. Specific areas of expertise have included (poly)spectral analysis, wavelets, cyclostationary, and non-Gaussian signal processing with applications to array and image processing. Current research topics focus on transmitter and receiver diversity techniques for single- and multi-user fading communication channels, compensation of nonlinear amplifier effects, redundant precoding and space-time coding for block transmissions, multicarrier, and wide-band wireless communication systems.

Selected Publications

"AMOUR: Generalized Multicarrier Transceivers for Blind CDMA regardless of Multipath," G. B. Giannakis, Z. Wang, A. Scaglione, S. Barbarossa, IEEE Trans. on Communications, vol. 48, pp. 2064-2076, December 2000.

"Wireless Multicarrier Communications: Where Fourier Meets Shannon," Z. Wang and G. B. Giannakis, IEEE Signal Proc. Magazine, Vol. 17, No. 3, pp. 29-48, May 2000.

"Redundant Filterbank Precoders and Equalizers, Parts I and II" A. Scaglione, G. B. Giannakis, and S. Barbarossa, IEEE Trans. on Signal Processing, vol. 47, pp. 1988-2022, July 1999. (received IEEE-SP Soc. Best Paper Award, 2000).

"Basis Expansion Models and Diversity Techniques for Blind Equalization of Time-Varying Channels", G. B. Giannakis and C. Tepedelenlioglu, Proceedings of the IEEE, vol. 86, pp. 1969-1986, November 1998.

"Polyspectral analysis of mixed processes and coupled harmonics", G. Zhou and G. B. Giannakis, IEEE Trans. on Information Theory, vol. 42, pp. 943-958, May 1996.

"Principal component filter banks for optimal multiresolution analysis", M. K. Tsatsanis and G. B. Giannakis, IEEE Trans. on Signal Processing, vol. 43, pp. 1766-1777, August 1995 (received IEEE-SP Society's Young Author (Tsatsanis) Paper Award, 1998).

"Identification of Non-Minimum Phase Systems using Higher-Order Statistics", G. B. Giannakis, and J. M. Mendel, IEEE Trans. on Acoust. Speech and Signal Proc., vol. 37, pp. 360-377, March 1989 (received IEEE-SP Soc. Best Paper Award, 1993).

Maria Gini

Professor, Dept. of Computer Science and Engineering

My area of research is artificial intelligence and robotics. I am interested in intelligent agents, in particular self-interested agents that achieve their tasks by engaging in negotiations with other agents, and robotic agents that operate in unstructured and partially known environments.

I am researching the design of software architectures that distribute intelligence among autonomous agents. An example is the University of Minnesota MAGNET (Multi-agent Negotiation Testbed) system, an agent-based system designed to support the negotiation and execution of complex plans among a population of self-interested agents. Applications include e-commerce, logistics, and supply-chain management.

I am also interested in making robots more useful by making them smaller but capable of interacting with other robots. To be useful, robots need to be able to accomplish their tasks despite unexpected changes in the environment or failures of some of their sensors. I am studying ways of distributing intelligence and of accomplishing tasks by cooperation. Specific examples of tasks include exploration, mapping of indoor/outdoor environments, and navigation. The ultimate expectation is that many small robots will be able to operate more robustly and be more cost effective than a few larger and more complex robots

Selected Publications

"Decision Processes in Agent-Based Automated Contracting," IEEE Internet Computing, March 2001 (with J. Collins, C. Bilot and B. Mobasher).

"Enlisting Rangers and Scouts for Reconnaissance and Surveillance," Robotics and Automation Magazine, Vol. 6, No. 3, pp. 14-24, December 2000 (with P. E. Rybski, et.al.).

"Bid Selection Strategies for Multi-Agent Contracting in the Presence of Scheduling Constraints," Agent-Mediated Electronic Commerce II (A. Moukas, C. Sierra and F. Ygge, eds.), Lecture Notes in AI, Vol. 1788, Springer-Verlag, 2000 (with J. Collins, R. Sundareswara and B. Mobasher).

"Repeatability of Real World Training Experiments: A Case Study," Autonomous Robots, Vol. 6, No. 3, pp. 281-292, 1999 (with D. F. Hougen and P. E. Rybski).

"Partitioning-Based Clustering for Web Document Categorization," Decision Support Systems, 1999 (with D. Boley, R. Gross, E.-H. (S) Han, K. Hastings, G. Karypis, V. Kumar, B. Mobasher and J. Moore).

"Parallel Search Algorithms for Robot Motion Planning," Practical Motion Planning in Robotics: Current Approaches and Future Directions (K. Gupta and A. del Pobil, eds.), John Wiley & Sons, 1998 (with D. Challou, C. Olson, D. Boley and V. Kumar).

Mats Heimdahl

Associate Professor, Dept. of Computer Science and Engineering
Director, U of Mn Software Engineering Center

Computers are controlling many aspects of our lives; they control physical systems ranging from microwave ovens and watches to nuclear power plants and aircraft. Computer-related failures can, in many of these applications, have catastrophic effects. My research group, the Critical Systems Research Group (CriSys), is conducting research in software engineering and is developing methods and tools to help us reduce the number of safety-related problems caused by software. Research in this area spans all aspects of system development ranging from concept formation and requirements specification, through design and implementation, to testing and maintenance. In particular, we are currently investigating how to use model-checking techniques to assure that desirable properties are captured in a software requirements model, how to correctly generate production code from software requirements models, and how to effectively generate test suites from formal models.

Selected Publications

"Specifying and Analyzing System Level Inter-Component Interfaces," to appear in the Requirements Engineering Journal (with J. M. Thompson).

"On the Analytical Power Needed When Analyzing State-Based Requirements: An Experience Report," Science of Computer Programming, Vol. 36, Issue 1, January 2000 (with B. J. Czerny).

"Structuring Formal Control Systems Specifications for Reuse: Surviving Hardware Changes," Fifth NASA Langley Formal Methods Workshop, Williamsburg, 2000 (with J. M. Thompson and D. M. Erickson).

"On the Requirements on High Integrity Code Generation," Proceedings of the Fourth IEEE High Assurance in Systems Engineering Workshop, Washington, D.C., November 1999 (with M. Whalen).

"Specification-Based Prototyping for Embedded Systems," Proceedings of the Seventh ACM/SIGSOFT Symposium on the Foundations of Software Engineering, Toulouse, France, September 1999 (with J. M. Thompson and S. P. Miller).

"Specification and Analysis of System Level Inter-Component Communication," IEEE Computer, Vol. 31, No. 4, April 1998 (with J. M. Thompson and B. J. Czerny).

Reduction and Slicing of Hierarchical State Machines," Proceedings of the Fifth ACM SIGSOFT Symposium on the Foundations of Software Engineering, Zurich, Switzerland, September 1997 (with M. Whalen).

"Completeness and Consistency in Hierarchical State-Based Requirements," IEEE Transactions on Software Engineering, Vol. SE-22, No. 6, June 1996, pp. 363-377 (with N. G. Leveson).

Nikolaos Papanikolopoulos

Professor, Dept. of Computer Science and Engineering
Director, Center for Distributed Robotics

My work is focused on robotics, computer vision, and sensors for transportation applications. In robotics, my group studies distributed robotics. We have developed a large system of robots based on the "scouts." Scouts are robots roughly the size of a soda can that have multiple mobility modes (jumping, rolling) and carry a variety of sensors (e.g., camera, microphone, etc.). We are also interested in vision-based robot control and eye-in-hand robotic systems.

I am particularly interested in problems such as vision-based robotic grasping, the active derivation of depth maps from controlled motion of a robotic system, the active calibration of the robot-camera system, the problem of automatically detecting moving objects of interest, and the use of deformable models for tracking and manipulation of rigid and non-rigid objects. Our work also emphasizes experimental verification of the theory that can be done in the Artificial Intelligence, Robotics and Vision Laboratory that has three Datacube systems, two Matrox Genesis boards and the Minnesota Robotic Visual Tracker (a flexible eye-in-hand robotic system).

In computer vision, I am interested in model-based tracking, moving object segmentation, real-time vision, morphing, on-line and off-line handwriting recognition, and object recognition. In transportation, I am interested in the use of computer vision techniques for pedestrian and vehicle detection and tracking, vision-based vehicle following, bicycle counting, monitoring driver fatigue, and monitoring safety in work zones.

Selected Publications

Masoud, O., and Papanikolopoulos, N.P., "A Method for Human Action Recognition", Image and Vision Computing, Volume 21, No. 8, 2003, pp.729-743.

Rybski, P., Stoeter, S., Gini, M., Hougen, D., and Papanikolopoulos, N.P.,"Performance of a Distributed Robotic System Using Shared Communications Channels: A Framework for the Operation and Coordination of MultipleMiniature Robots", IEEE Transactions on Robotics and Automation, Volume18, No. 5, October 2002, pp. 713-727.

Rybski, P., Stoeter, S., Papanikolopoulos, N.P., Burt, I., Dahlin, T.,Gini, M., Hougen, D., Krantz, D., and Nageotte, F., "Sharing Control: A Framework for the Operation and Coordination of Multiple Miniature Robots", IEEE Robotics and Automation Magazine, Volume 9, No. 4, 2002, pp.41-48.

Masoud, O., Papanikolopoulos, N.P., and Kwon, E., "The Use of Computer Vision in Monitoring Weaving Sections", IEEE Trans. on Intelligent Transportation Systems, Volume 2, No.1, March 2001, pp 18-25.

"Rangers and Scouts: A Team of Robots for Reconnaissance and Surveillance," IEEE Robotics and Automation Magazine, Vol. 7, No. 4, December 2000, pp. 14-24 (with P. Rybski, D. Krantz, S. Stoeter, M. Gini, R. Voyles, D. Hougen, B. Yesin, B. Nelson and M. Erickson).

Stergios Roumeliotis

Assistant Professor, Dept. of Computer Science and Engineering

My research is concentrated on sensing and estimation techniques - analysis, modeling and fusion - for autonomous vehicle navigation. Specific examples of these platforms are wheeled Mars rovers, tracked vehicles, unmanned helicopters and spacecrafts, and their domain of application spans from indoors to outdoors and from autonomous landing to planetary exploration. These estimation algorithms are necessary to support intelligent operation such as perception and representation of the environment, planning under uncertainty, autonomous robot navigation and control.

It is within the focus of my research to develop efficient probabilistic algorithms for real-time state estimation from noisy and uncertain sensor information. Over the past few years I have been working on extensions of the state estimation problem to the case of heterogeneous groups of mobile robots operating under communication and processing limitations. The same theoretical framework is also appropriate for dealing with similar issues pertinent to distributed teams of autonomous vehicles and reconfigurable arrays of networked sensors or intelligent embedded systems.

Selected Publications

"Distributed Multi-Robot Localization," in *IEEE Transactions on Robotics and Automation*, vol. 18, no. 5, pp. 781-795, Oct. 2002 (with G. A. Bekey).

"Multi-Sensor, High Speed Autonomous Stair Climbing," *In Proc. 2002 IEEE/RSJ International Conference on Intelligent Robots and Systems*, Sept. 30 - Oct. 4, EPFL, Switzerland, pp. 733-742 (with D. M. Helmick, M. C. McHenry and L. Matthies).

"Stochastic Cloning: A generalized framework for processing relative state measurements," *In Proc. 2002 IEEE International Conference on Robotics and Automation*, Washington D.C., May 11-15, pp. 1788- 1795 (with J. W. Burdick).

"Augmenting Inertial Navigation with Image-Based Motion Estimation," *In Proc. 2002 IEEE International Conference on Robotics and Automation*, Washington D.C., May 11- 15, pp. 4326-4333 (with A. E. Johnson and J. F. Montgomery).

"Weighted Range Sensor Matching Algorithms for Mobile Robot Displacement Estimation," *In Proc. 2002 IEEE International Conference on Robotics and Automation*, Washington D.C., May 11-15, pp. 1667-1674 (with S. T. Pfister, K. L. Kreichbaum and J. W. Burdick).

"Bayesian estimation and Kalman filtering: A unified framework for Mobile Robot Localization," *In Proc. 2000 IEEE International Conference on Robotics and Automation*, San Francisco, CA, April 22-28, pp. 2985- 2992(with G. A. Bekey).