PostDoc Position at University of Houston
On Project to Develop Self-Healing Wireless Smart Sensor Networks

Project Description

Many applications that will enable human presence in the space require *wireless communications*, in particular smart sensor applications. Wireless smart sensor network brings many challenges to be addressed. Fault tolerance is of significant interest to the research community especially in mission critical applications. From users' perspective, the quality of information collected from smart sensor networks is affected by many factors: i) timeliness, ii) coverage, iii) integrity, and iv) reliability. In smart sensor networks, failures and anomalies can occur at both node level and system level which will lead to loss of data. For instance, sensing components on nodes may fail or misbehave due to software and hardware reasons. Communication links between different smart sensor network elements can be unavailable. Contention in medium access may cause excess delay or routing failure. Due to the extent of interactions among smart sensor nodes, faults at individual components may not be contained and can potentially propagate to other parts of the network. Therefore, *self-healing* smart sensor networks should be an integrate part of ISHM-capable applications. Self-healing system is a system that has the ability to detect, correlate and analyze the root cause of faults. In essence, the emphasis of the proposed research is not just to provide connectivity but more importantly, quality of data acquisition as a result of intricate interactions of many players in the system.

The long term goal of this research team is to develop novel fault-tolerant algorithms, modeling techniques to mitigate the effect of faults, and measurement procedures to evaluate smart sensor network in ISHM-capable complex system. The main research goal of this proposal is to model the response time of faulty wireless smart sensor network, and to develop and implement fault tolerant algorithms for wireless smart sensor networks. These algorithms will be implemented and validated in the Testbed of Smart Sensors (ToSS), being developed at the Engineering Technology Department, to gather preliminary results that will support full proposals to be submitted to federal agencies.

To address the issues and challenges on self-healing smart sensor networks, we have identified the following objectives for the long-term project:

1. Develop **fault-tolerant protocols** that are resilient to temporary or permanent failures in the network;
2. Develop theoretical **models** characterizing trade-offs between resource utilization, performance and robustness of the resulting system.
3. Develop hybrid (centralized and distributed) algorithms and systems for **fault detection and analysis** incorporating data mining technique;
4. Develop **measurement methodology** and **test procedures** to evaluate and validate compatibility, robustness and performance of wired/wireless heterogeneous smart sensor network solutions;

Facilities

The Electromagnetic Systems Branch (EV4) at NASA Johnson Space Center (JSC) is building a ground-based integrated testbed to evaluate wireless and RFID technologies and is acquiring hardware to implement and test the related communication standards and protocols that currently dominate the commercial sector.

Facilities at UH include testbed of smart sensor (TOSS) laboratory, Intelligent Sensor GRid and Informatics (ISGRIN), and optical networking research lab (ONRL). The research activities involved in these labs include implementation of testbed of smart sensors that can be utilized to test and validate the IEEE 1451 compliant sensor systems and health monitoring system using wireless sensors.

Desired Academic Background

A Ph.D. in an engineering or computer science fields with expertise in wireless networking, wireless ad hoc networks, and/or wireless sensor networks. The fellow will be expected to lead the research effort towards one or more research goals of the project as listed above. The fellow is expected to write conference paper and journal articles about the research results, and will get heavily involved in the effort of identifying funding opportunity and writing up proposals to federal and other funding agencies. The Post-doc fellow would also be the main liaison between the investigators at the University of Houston and JSC's Lunar Architecture Team (LAT). The Post-doc fellow will also guide and supervise the research efforts of the graduate and undergraduate students. Opportunities to teach one course per semester are available.

Please send your resume along with a cover letter stating your interest and motivations to the following point of contact.

Point of Contact

Driss Benhaddou, Assistant Professor
Department of Engineering Technology
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Dr. Benhaddou, Ph.D. (2002, Interdisciplinary in *Telecommunications and Engineering*) degree from the school of computing and engineering at The University of Missouri Kansas City. Ph.D. (1995, in Optoelectronics) degree from the University of Montpellier-France. Dr. Benhaddou's areas of expertise include optical networking, switching system design, routing protocols in optical networks, performance analysis, and optical instrumentation and defect characterization in opto-electronic material. He is an expert in the area of multi-protocol internetworking (SONET, ATM, IP, optical) and also has a solid background in software development with applications in routing/signaling protocols and network simulation. During his tenure at Sprint, Dr. Benhaddou implemented an extensive broadband test-bed for vendor equipment certification and research/development activities. This experience gave him detailed practical knowledge about the deployment, operation, and interoperability of differing network technologies. He has authored and co-authored over 30 publications. Since he joined the University of Houston he initiated and contributed to several research projects that are funded by UH, Sprint, AT&T, NSF, and NASA.

Other Co-PIs on the project:

Xiaojing Yuan, Assistant Professor
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Dr. Xiaojing Yuan has years' experiences in embedding intelligence into sensors and actuators to deal with uncertainties. She authored and co-authored more than 30 technical papers; has one patent; and has been very active in professional organization. Since she joined the University of Houston, she has initiated several projects funded by EIH, UH new faculty grant, GEAR, FDIP, Abramson Family Center for Future of Health, Texas Workforce Commission, Texas Heart Institute, and NASA. Her paper on real world case study for biased feature selection got best application paper award in 2006 annual international conference of data mining.

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Dr. Deniz Gurkan, Assistant Professor in the Department of Engineering Technology, has received her PhD degree in Electrical Engineering from the University of Southern California. She has been an active researcher in the fiber optics field with emphasis on the network routing functions, novel optical fiber sensor development, and sensor networking.

She has implemented novel optical subsystems for fiber optic networks that increased the network transparency to different protocols and data formats. She also has been a contributing PI in active grants from outside agencies: NSF grant on remote optical circuits laboratories and AT&T (former SBC) Foundation. She is the PI for NASA-SSC grant on the development of an intelligent sensor network testbed for ISHM. She has over 30 publications in her field of research.

Patrick Fink, Deputy Chief
Electromagnetic Systems Branch in the Avionic Systems
NASA Johnsson Space Center
patrick.w.fink@nasa.gov
Dr. Patrick Fink is the Deputy Chief for the Electromagnetic Systems Branch in the Avionic Systems Division at NASA Johnson Space Center. The Branch is responsible for design, development, test, and analysis of electromagnetic systems for the Programs and advanced technology efforts. Dr. Fink is currently leading a sub-team for lunar habitat communications under the Lunar Architecture Team 2 (LAT2) Communication and Navigation Focus Element. He is leading another team to prototype and test an adaptive, passive, wireless sensor system for JSC's Chamber A (Vacuum and Thermal-Cycle). Dr. Fink is a Co-PI for the NESC Passive, Wireless Sensor Project, in which he serves as the Antenna Sub-Team lead and the RFID liaison. Dr. Fink is also the NASA lead for the Consultative Committee on Space Data Systems (CCSDS) Wireless Group. He has authored numerous papers on computational electromagnetics and holds multiple U.S. patents.

Richard J. Barton, Ph.D.
Senior Staff Scientist, ERC Inc.
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Dr. Richard J. Barton received a B.A. degree in actuarial science and finance in 1976, an M.S. in Mathematics in 1984, and a Ph.D. in Electrical Engineering in 1989, all from the University of Illinois in Urbana-Champaign. From 1989 to 1997, he worked for ORINCON Corporation in San Diego, CA, specializing in signal processing research and development. In 1994, he also established his own research and development company, Neoteric Technologies. From 1997 to 2006, he was in academia, first in the Electrical and Computer Engineering Department at Iowa State University in Ames, IA and then in the Electrical and Computer Engineering Department at University of Houston in Houston, TX. In 2006, he moved to NASA JSC, where he is currently employed by Engineering Research and Consulting (ERC), Inc. Dr. Barton's research interests span many different aspects of statistical signal processing. Past research contributions have been in the areas of robust signal detection and estimation, signal detection in the presence of long-term dependent noise, applications of higher-order statistics to modulation design on communication channels, biological sequence analysis, and applications of wavelet transforms and higher-order statistics to pattern recognition and signal classification. His current research interests include the impact of signal dimension and channel uncertainty on wireless communication channel capacity, the development of stochastic approaches to computational electromagnetics for channel modeling, applications of statistical signal processing to location estimation in wireless environments, and the use of cooperative communication techniques for increasing the energy efficiency and the information capacity in wireless sensor networks. In March of 2000, Dr. Barton received an NSF Faculty Early Career Development Grant.