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Editorial

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Advances in low-cost and low-power wireless communication, microsensor, and microprocessor hardware, as well as progress in ad hoc networking routing and protocols, distributed signal and array processing, pervasive computing, and embedded systems have all made sensor networking a topic of active interest. In recent years, the Internet has been able to provide a large number of users with the ability to move diverse forms of information readily and thus revolutionized business, industry, defense, science, education, research, and human interactions. Sensor networking may, in the long run, be equally significant by providing measurement of the physical phenomena around us, leading to their understanding and ultimately the utilization of this information for a wide range of applications. Potential applications of sensor networking include environmental monitoring, health care monitoring, battlefield surveillance and reconnaissance, modern highway, modern manufacturing, condition-based maintenance of complex systems, and so forth.

In order to understand and build sensor networks, diverse technology and technical disciplines are involved. However, in this special issue we deal only with various signal processing aspects of sensor networking. Of the seven papers, four of them deal with source localization, two of them with tracking, and one with sensor network decomposition and organization. *Energy-Based Collaborative Source Localization Using Acoustic Microsensor Array*, by D. Li and Y. H. Hu, uses acoustic energy measurements to perform source localization. This approach assumes the acoustic source energy decays inversely with the square of the distance. By comparing acoustic sensor energy measurements around the source, the source location can be estimated as the intersection of multiple hyperspheres. *The Fusion of Distributed Microphone Arrays for Sound Localization*, by P. Aarabi, also deals with acoustic source localization. The author proposes to use the spatial observability function (SOF), which gives an indication of how well a microphone array perceives events at different spatial position. Each microphone array also has a spatial likelihood function (SLF) which reports the likelihood of a source at each spatial location. SOF and SLF approaches are used together for sound localization. In *A Self-Localization Method for Wireless Sensor Networks*, by R. L. Moses, D. Krishnamurthy, and R. Patterson, the authors consider the problem of locating and orienting a network of unattended sensors by using a number of known source signals for calibration purposes. The maximum-likelihood (ML) estimation and Cramér-Rao Bound (CRB) techniques are used. *Acoustic Source Localization and Beamforming: Theory and Practice*, by J. C. Chen, K. Yao, and R. E. Hudson, again uses the ML method for direct localization of wideband acoustical source in the near field and uses the cross bearing of the direction-of-arrivals (DOA) for localization in the far field. For multiple sources, an alternating projection procedure is used. CRB analysis provides various insights for the localization problem. *Dynamic Agent Classification and Tracking Using an Ad Hoc Mobile Acoustic Sensor Network*, by D. Friedlander, C. Griffin, N. Jacobson, S. Phoha, and R. R. Brooks, presents methods for dynamic distributed signal processing using an ad hoc mobile network of sensors to detect, identify, and track targets. Forming dynamic clusters around events of interest allows for processing multiple events in parallel over different geographic areas along the trajectory of the targets. In *Collaborative In-Network Processing for Target Tracking*, J. Liu, J. Reich, and F. Zhao consider collaborative signal

processing using acoustic-amplitude sensors for target distance estimation and DOA sensors for bearing estimation. The information-driven sensor querying framework selectively activates sensors based on their utility and cost. Issues of distributed processing for tracking and energy efficiency of the network are addressed. *Preprocessing in a Tiered Sensor Network for Habitat Monitoring*, by H. Wang, D. Estrin, and L. Girod, considers some common principles for task-decomposition and collaboration for tiered sensor networks. The system has a few powerful macronodes in the first tier and many less-powerful nodes in the second tier. Each macronode combines data collected by many micronodes for target classification and localization. Application is made to habitat monitoring and classification and localization of birds. All seven of these papers use simulations and measured data to verify the proposed methods. In the coming years, it is expected that sensor networking will become ever more important both in research and industry and that hardware and software availability will enable significant data collection and field experimentation.

Kung Yao received the B.S.E. (Highest Honors), M.A., and Ph.D. degrees in electrical engineering all from Princeton University, Princeton, NJ. He was a NAS-NRC Postdoctoral Research Fellow at the University of California, Berkeley. Presently, he is a Professor in the Electrical Engineering Department at UCLA. In 1969, he was a Visiting Assistant Professor at the Massachusetts Institute of Technology. In 1985–1988, he served as an Assistant Dean of the School of Engineering and Applied Science at UCLA. His research and professional interests include sensor array system, digital communication theory and system, smart antenna and wireless radio system, chaos communications and system theory, digital and array and signal and array processing, systolic and VLSI algorithms, architectures and systems, radar system, and simulation. He has published over 250 journal and conference papers. Dr. Yao received the IEEE Signal Processing Society's 1993 Senior Award in VLSI Signal Processing. He was the coeditor of a two-volume series of an IEEE Reprint Book on *High Performance VLSI Signal Processing*, IEEE Press, 1997. In 1991–1993, he was the Associate Editor of VLSI Signal Processing of the IEEE Trans. on Circuits and Systems. Since 1999, he is an Associate Editor of the IEEE Communications Letters. He is a member of the Editorial Board of the Journal of VLSI Signal Processing and Integration: the VLSI Journal. He was also a Guest Editor of a Special Issue on *Applications of Chaos in Modern Communication Systems* of the IEEE Trans. on Circuits and Systems—Part I in 2001. He is a Fellow of IEEE.

Deborah Estrin is a Professor of computer science at UCLA and Director of the Center for Embedded Networked Sensing (CENS), a newly awarded National Science Foundation Science and Technology Center. She received her Ph.D. degree in computer science from the MIT (1985) and was on the faculty of Computer Science at USC from 1986 through mid-2000, where she received the National Science Foundation, Presidential Young Investigator Award for her research in network interconnection and security (1987). During the subsequent 10 years her research focused on the design of network and routing protocols for very large, global networks. Estrin has been instrumental in defining the national research agenda for wireless sensor networks, first chairing a 1998 DARPA ISAT study and then a 2001 NRC study; the latter culminated in an NRC publication—*Embedded Everywhere: A Research Agenda for Networked System of Embedded Computers*. Estrin's research group develops algorithms and systems to support rapidly-deployable and robustly operating networks of many thousands of physically embedded devices. She is particularly interested in applications to environmental monitoring. Estrin has served on numerous program committees and editorial boards, including SIGCOMM, Mobicom, SOSP, and ACM/IEEE Transactions on Networks. She is a Fellow of the ACM and the AAAS.

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