

## Intelligent Sensor Validation and Fusion with distributed “MEMS Dust” Sensors

(Abstract)

**Shijun Qiu**\*

Dept of Mechanical and Electrical Engineering  
Xiamen University, China  
[sjiu@newton.berkeley.edu](mailto:sjiu@newton.berkeley.edu)

**Alice M. Agogino, Jessica Granderson**

Department of Mechanical Engineering  
University of California, Berkeley  
[aagogino@euler.berkeley.edu](mailto:aagogino@euler.berkeley.edu)

**Key Words :** sensor networks, sensor fusion, sensor validation, micro-electromechanical systems, MEMS

MEMS sensors make a rich design space of networked sensors viable. They can be deeply embedded in the physical world and spread throughout our environment like “smart dust”. Sensors now interact with various fields and forces to detect light, heat, position, movement, chemical presence, and so on. In each of these areas, the technology is crossing a critical threshold that makes networked sensors an exciting regime to apply systematic design methods. Today, networked sensors can be constructed using commercial components on the scale of a square inch in size and a fraction of a watt in power.

Such networks require a large number of sensors for control at different levels. However, in reality, sensor information is always corrupted to some degree by noise and sensor degradation, which vary with operating conditions, environmental conditions, and other factors. To overcome these shortcomings, sensor validation is needed to assess the integrity of the sensor information and adjust or correct as appropriate. Sensor redundancy is essential to achieve high sensor data fidelity. Two types of redundancy are appropriate for a sensor system, functional redundancy and physical redundancy. In the presence of redundant information sensor data must be fused, accommodating the findings from the validation process. With “MEMS dust” sensors this information needs to be contextualized in terms of uncertainties concerning location and other local factors.

In this paper, several methods to accomplish the validation and fusion are developed and implemented for use in distributed arrays of “smart dust” MEMS sensors. Key issues include management of uncertainty at various levels, aggregation of heterogeneous information, temporal changes and decision making strategies.

---

\* Visiting scholar in Mechanical Engineering Dept. at UC Berkeley

## References

1. Alag, S, K. Goebel, and A.M. Agogino, "A Framework for Intelligent Sensor Validation, Sensor Fusion and Supervisory Control of Automated Vehicles in IVHS," *Intelligent Transportation: Serving the User through Deployment, Proceedings of the 1995 Annual Meeting of ITS AMERICA*, (CASET Associates, LTD, 1020
2. Alag, S, A.M. Agogino, and M.. Morjaria, " A Methodology for Intelligent Sensor Measurement Validation, Fusion, and Sensor Fault Detection for Equipment Monitoring and Diagnostics ," to appear in *AIEDAM (Artificial Intelligence for Engineering Design, Analysis and Manufacturing)*, Special Issue on AI in Equipment Service, Vol. 15, No. 4, April 2001, pp. 307-319.
3. Doherty, L., "Algorithms for Position and Data Recovery in Wireless Sensor Networks", UC Berkeley EECS Masters Report, May 2000.
4. Doherty, L., L. El Ghaoui, K. S. J. Pister, "Convex Position Estimation in Wireless Sensor Networks", Infocom 2001, Anchorage, AK, April 2001.
5. Hill, Jason, Robert Szewczyk, Alec Woo, Seth Hollar, David Culler, Kristofer Pister. System architecture directions for network sensors. ASPLOS 2000.
6. Hill, Jason, Philip Bounadonna, David Culler. Active Message Communication for Tiny Network Sensors. Submitted to Infocom 2001
7. Hill, Jason. A Software Architecture Supporting Networked Sensors. Masters thesis, December 2000.
8. Goebel, Kai and A.M. Agogino, "Sensor Validation and Fusion for Automated Vehicle Control Using Fuzzy Techniques," *ASME Trans, Journal of Dynamic Systems, Measurement and Control*, Vol. 123, pp. 145-146, March 2001.
9. Perrig, Adrian, Robert Szewczyk, Victor Wen, David Culler, J.D. Tygar. SPINS: Security Protocols for Sensor Networks. Mobicom 2001.
10. Qiu, Shijun, Agogino, A. M., "A Fusion of Bayesian and Fuzzy Analysis for Print Faults Diagnosis" Proceedings of The International Society for Computers and Their Application-ISCA 16<sup>th</sup> International Conference, Seattle, Washington, pp 229-232, Mar.2001.
11. Wang, Jiangxin, Susan Y, Chao and Alice M. Agogino, "Validation and Fusion for Longitudinal Positioning Sensors in Aves", Proceedings of The American Control Conference ACC Session TM08-2, June, 1999.
12. Woo, Alec, David Culler. A Transmission Control Scheme for Media Access in Sensor Networks. Mobicom 2001.