Autonomous Wireless Sensors

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Abstract

Sensor nodes comprising a power source and means for communication significantly reduce the barrier to sensor deployment and enable a vast array of new applications. Power represents the most significant constraint in many applications. We discuss available power sources and the power dissipation of circuits and optical and RF communication. A solar powered node with passive optical communication has a volume of just 16mm³ and measures ambient light and acceleration. A larger unit fabricated from off-the-shelf parts and RF communication implements a self-configuring network for communicating sensor results.

1. Introduction

MEMS and related sensor technologies have significantly expanded the range of inexpensive and easy to use sensors. But while the cost of sensors has come down, deployment is still a major barrier in many applications. In many uses, such as building automation or automotive sensing, the cost for power delivery, data cabling, and the necessary control structures exceeds that of the sensors by orders-of-magnitude.

A solution that adds computation, communication, and a power source to the sensor has the potential to overcome this problem. In this article we explore existing and emerging solutions for autonomous sensors, including networks of such sensors. We explore the limits on packaging density for an autonomous sensor with integrated power source, computation, and communication.

Scaling trends in microelectronics are driving the reduction in cost, size, and power dissipation of computation, communication, and sensing. Extrapolating these trends we envision sensors to become increasingly ubiquitous. Self
powered and arranged in self-organizing networks they will vastly increase our ability to gather information about our environment. Possible outcomes include sensor networks reporting real time to freeway traffic conditions or guide us to a vacant parking place. At the office, a sensor network adjusts the climate to our individual preferences all while conserving energy in our absence. Sensors help us find a free conference room, lost glasses, and sound appropriate alarms if our briefcase leaves without us.

2. Smart Sensors

Temperature, magnetic field, and light / imaging sensors have long exploited the benefits of integrated circuit technology. Advantages include efficient high volume means of production, small size, low power dissipation, and the ability to easily include additional functions such as signal conditioning, temperature compensation, or self-calibration. The electrical interface and IC compatible packaging simplify system integration and reduce size, cost and power dissipation.

![Integrated 3-axis acceleration sensor with on-chip signal conditioning and A/D conversion.](image)

*Fig. 1. Integrated 3-axis acceleration sensor with on-chip signal conditioning and A/D conversion.*