A Wireless Embedded System for Real-Time Environmental and Structural Monitoring
Motivation

- Automatic real time monitoring is gaining critical importance in a broad range of domains

- Necessity of several kinds of monitoring:
  - Structural (acceleration, strain, tilt, vibration, displacement)
  - Environmental (temperature, humidity, pollution)
  - Disaster (flood, earthquake, hurricane, wildfire)
Requirements

- Low cost, to allow deployment almost anywhere
- Efficient and flexible communication
- Easy installation and maintenance
  - Even in remote locations and hostile environments
Our Device is Not a Mote

- It is an autonomous embedded system with
  - onboard power source
  - long-range communication capability
  - considerable computing power
  - data storage
  - embedded sensors
  - embedded signal conditioner that can support a wide range of additional sensors

- Our system supplies multi-purpose software that enables the plug-and-play addition of other sensors.
  - The simplicity of this software leads to more dependable operation than that of motes with complex operating systems.

- Encapsulation of the system in a rugged waterproof and dustproof case further increases dependability.
Specific Contributions

Design, implementation and testing of the Smart Brick, a general purpose wireless device for structural monitoring

1. Significant reduction of installation and maintenance costs
2. Minimization of power consumption, achieving several years of unattended operation using standard batteries
3. Implementation of a completely wireless device, eliminating all power and communication cables
Overall Design
IP 68 Waterproof Box
Embedded Sensors

- Sensors mounted on main board:
  - Digital sensors
    - Floater presence
    - Flood
    - Tampering
  - Analog sensors
    - Temperature
    - Battery level
    - Water level
The Prototype

- External Memory
- 3-Axis Accelerometer
- DB-9 Serial Port
- Sensor Board 1 Socket
- ICD2 Interface
- Vibration Sensor
- Magnetic Switches
- GSM Module
- Micro Controller
- Interface
Deployment

- The first prototype has been deployed at Bagnell Dam in Osage Beach, MO
Summary of Features

- Wireless connectivity
  - 4 band class 10 GPRS cell phone
  - Embedded TCP/IP stack (internet)
  - Autom. data upload through FTP
  - SMS and email alarm messages
  - Remote sw upgrade and config.

- Power supply
  - Self-contained alkaline batteries
  - Up to 5 years operations w/ hourly data log and weekly FTP upload
  - Self-resetting overload protection
  - High efficiency thermal insulation
(cont.)

- **Embedded sensors**
  - 0.1°C accuracy temperature sensor
  - 0.2° accuracy 2-axis tilt sensor
  - embedded 3-axis accelerometers
  - passive vibration wake-up sensor
  - anti-tampering reed switches
  - floater switch for flood alarm
  - capacitive water level sensor
- **Other sensor inputs/outputs**
  - 2 strain gauge or load cell inputs
  - 2 resist. displacement gauge input
  - 2 multi-purpose voltage inputs
  - RS232 interface for digital sensors
  - 2 voltage and 1 relay outputs