

An Experimental Measurement of Power Consumption in Facility Sensor Networks

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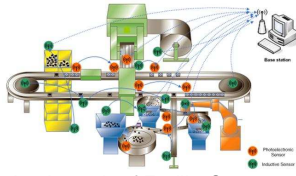
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Motivation

The research in the area facility sensor network (FSN) is motivated to achieve following objectives:

- **Application** of wireless sensor network (WSN) to automate industrial facilities.
- **Develop energy minimization** algorithm to maximize sensor operational lifetime.
- **Optimal deployment**, to minimize the capital cost.
- **Maximize** throughput, data reliability, and **minimize** latencies.



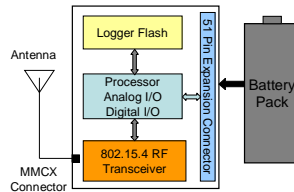
A schematic of Facility Sensor Network (FSN)

Wireless Sensor

- **MICAz mote** from Crossbow is selected for deployment and sensing in FSN.
 - MICAz has a **MPR2400CA** processor @ **2.4 GHz** with 128kbps of program memory. It is **IEEE 802.15.4** compliant.
 - Operating range is **2400 MHz to 2485 MHz**.
 - Radio frequency (RF) power ranges from **-24dBm to 0 dBm**.
 - Outdoor range of **75 m to 100 m** and indoor range of **<30m**.
- **Sensors Module**, includes temperature, humidity, light, sound, accelerometer, and magnetometer.



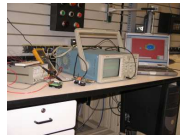
A 2.4 GHz MICAz mote from Crossbow.



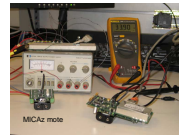
A schematic representation of MICAz mote.

Experimental Results

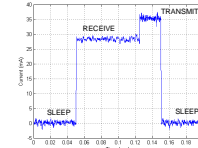
- **Current Measurement**
 - A 2.4 GHz MICAz mote is **programmed** in TinyOS environment to be active for 0.2 seconds.
 - Mote undergoes cycle of **SLEEP, WAKE-UP, LISTEN, RECEIVE, TRANSMIT, and SLEEP** in 0.2 seconds.
 - **Microscopic current consumption** waveform the during cycle is measured using digital oscilloscope.



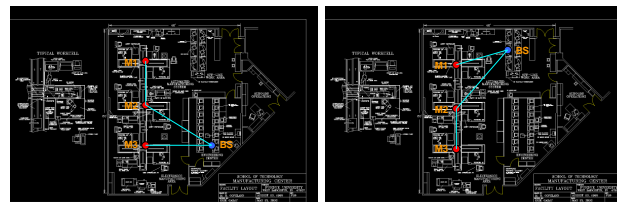
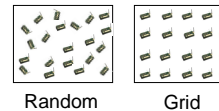
Experimental setup for measure current consumption of MICAz mote.



Microscopic current load profile during SLEEP, RECEIVE and TRANSMIT modes of operation.



- **Deployment Scenarios**
 - **Power consumption** of mote is highly dependent on the deployment scenarios:
 - Random deployment and
 - Grid deployment.
 - In our deployment, the position **Base station** is varied.



A real time two different deployment scenario of sensors along the assembly line. (Left) Base station (BS) close of mote (M3) and (Right) Base station (BS) close to mote (M1). Layout of KNOY 258

Clustering Routing Approach

In some applications, motes form **clusters (C1, C2, C3, and C4)** and communicate to **cluster head**.

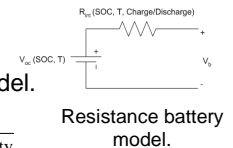


A schematic representation of different cluster routing network.

Proposed State Space Modeling

- We propose a **novel state space mathematical modeling** of power flow in WSN.
- Experimental analysis shows that **lifetime** of WSN depends on **battery's state of charges (SOC)**.

- **Batteries** are often crudely represented by a simple equivalent electric resistance model.



$$SOC(t) = \frac{E_f(t)}{E_{max}} = \frac{\text{Instantaneous battery energy}}{\text{Maximum rated energy capacity}}$$

Accomplishments and Future Research

- **An extensive experimental study** on power consumption was performed under different:
 - Deployment scenarios,
 - Radio transmission modes, and
 - Operating range.
- **Battery model** based on state space is developed.
- Progressive research on **novel state space modeling** of power flow in WSN.

Acknowledgements

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