J-DSP and Sensor Motes for Education and Research

by

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http://jdsp.asu.edu/JDSP_sensors/index.html

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Overview

J-DSP

- A Web-based DSP Simulation Tool
- Universally accessible DSP functions
- Embeds Interactive Simulations in Web pages
- Seamlessly Integrates Animated Demos

Wireless Sensor Motes

- Seamless Integration with J-DSP enables real-time sensor signal analysis
- Java interface natural for remote sensing
- User-friendly GUI for computation/graphics using the J-DSP-Mote interface
- Hardware: *Mica2* from *Crossbow*

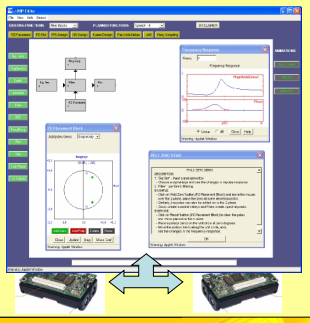
Motivation

- Wireless sensor networks have gained popularity in a number of applications
- Simplify control of *Mica2* platform through the object-oriented, platform independent structure of Java-DSP
- Connectivity with the signal processing environment of Java-DSP allows for real-time sensor data analysis
- Remote sensing possibilities
- Control by Java based handheld devices (i.e. PDAs)

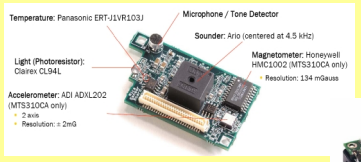
J-DSP: Background

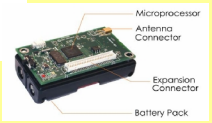
BASIC FUNCTIONALITY IN J-DSP

- Fundamental DSP functions (FFT, IFFT, Windowing, etc.)
- Arithmetic Functionality
- Digital Filtering
- FIR/IIR Filter Design
- Spectral Estimation
- Multi-rate DSP
- Visualization Blocks
- Pole-Zero Demo
- Frequency Response
- **Sensor Networks**



Hardware Platform

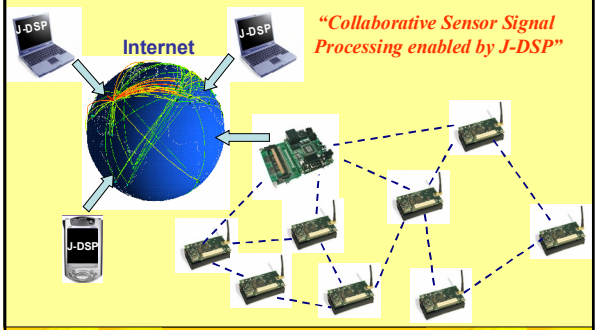




MIB(510) Gateway
: serial port programmer

- **Targeted Applications:** Environmental Monitoring, Security, Source Localization, Tracking, Biological Applications

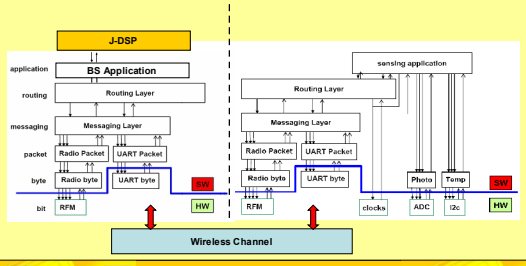
Java-DSP and the Motes



"Collaborative Sensor Signal Processing enabled by J-DSP"

Tiny OS and Java-DSP

- Java-DSP acts as an additional layer at the base station
- Lower layer processing is seamless to the user



Tiny OS & nesC

Tiny OS

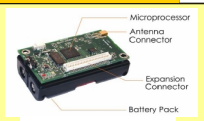
- Simple and powerful OS for low power
- Re-use of component
- "Hurry up and sleep"
- Scheduling based on events and tasks
- FIFO structure

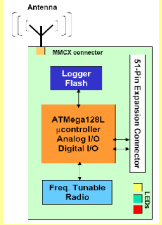
nesC Language

- TinyOS syntax and structure
- Dialect of C language
- A pre-processor
  - Converts wiring of high level modules into efficient code
  - nesC output is a c program file that is compiled and linked using gnu-gcc tools for a specific Mote

The Motes (MICA2 Platform)

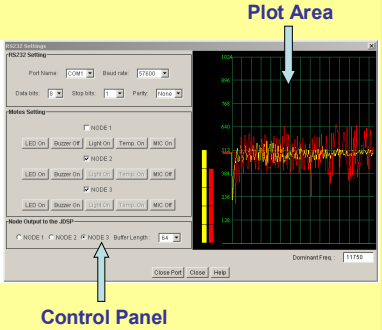
- **Microprocessor:** Atmel ATmega 128L
  - 7.3728 MHz clock
  - 128 kB of Flash for program memory
  - 4 kB of SRAM for data and variables
  - 2 UARTs
  - Serial Pot Interface (SPI) bus
  - Inter IC (I2C) bus
- **Radio:** Chipcon's CC1000
- **External serial flash memory:** 512 kB
- **51-pin expansion connector**
  - Eight 10-bit analog I/O
  - 21 general purpose digital I/O
- **User interface:** 3 LEDs
- **JTAG port**
- **Powered by two AA batteries**
  - 1850 mAh capacity





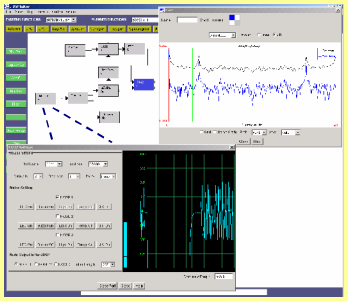
The MOTE Block

- GUI for the motes
- Control panel is used to control the individual motes and the RS232 settings
- MOTE block in J-DSP allows users to control individual motes
- Real-time graph plots data as it comes



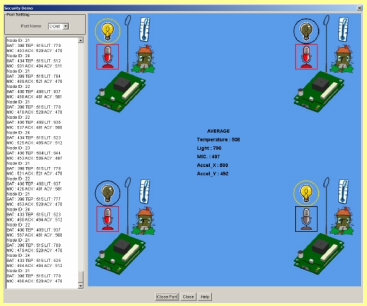
Sensor Network Signal Processing with J-DSP

- A number of advanced signal processing features available in J-DSP
- You can connect the incoming data to existing blocks to create DSP systems
- Example: Fitting incoming data to an auto-regressive model



Remote Sensing with J-DSP

- Preliminary example shows possibilities for sensing and security applications
- Display panel shows which sensors are active
- Active Sensors:
  - Light
  - Sound
  - Temperature
  - Accelerometer



Future Directions

- J-DSP and Motes for Research
  - Source localization using the Motes
  - Target tracking
  - Interfacing with advanced J-DSP features (i.e. HMM)
  - Collaborative remote sensing using J-DSP
  - Implement sensor networks using J-DSP/Motes for smart home and security applications
- J-DSP and Motes for Education
  - Train UG and grad. students the basics of working with wireless Motes using the J-DSP GUI
  - Train engineers and practitioners in real-time analysis of sensor data
  - Use hands-on hardware/ software approach to create a workforce trained in using sensors for security and other applications

Summary

- Simulation modules and blocks in J-DSP have been developed to control the *Crossbow* Motes
- Object-oriented structure of J-DSP allows for easy manipulation of the Motes
- Please visit http://jdsp.asu.edu for more information on J-DSP
- J-DSP also supports: Statistical DSP simulations, Communications, Speech analysis-synthesis, 2D and Image processing, Spectrogram/time-frequency experiments, and Controls simulations

Some figures taken from http://www.xbow.com