Java-DSP: Recent Developments and Extensions

Karthikeyan Natesan Ramamurthy,
Jayaraman J. Thiagarajan and Andreas Spanias

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http://jdsp.asu.edu
Agenda

- i-JDSP: Interactive iPhone/iPad based tool based on Java-DSP.
- Java-DSP Quiz Version: Interface to enhance student learning.
- Interfacing Java-DSP to MATLAB and LabVIEW.
- User-defined Java Code.
- Java-DSP and Sensor Motes.
i-JDSP : Interactive Signal Processing Tool
for iPhone/iPad
i-JDSP

• An interactive iPhone/iPad based signal processing tool based on Java-DSP.

• Implemented in Objective-C and C as a native Cocoa Touch application that can be run on any iOS device.

• Offers basic signal processing simulation functions on the new compact and convenient iPhone/iPad graphical user interface (GUI).

• Provides a very compelling multi-touch programming experience.
Using the Tool

• All simulations can be visually established by forming interactive block diagrams through multi-touch and drag-and-drop.

• List of existing function blocks:
  a. signal generator
  b. Filter
  c. Filter coefficient
  d. Frequency response
  e. FFT
  f. Plot
  g. Frequency response demo
Key Features

• Graphical programming experience.
• Easy to use (multi-touch and drag-and-drop).
• Portability and accessibility through online app store.
• Small footprint/efficiency.
• Scalability.

• Future Work
  i. Adding more function blocks.
  ii. Extension to other mobile platforms.
  iii. Release to online app store.
Java-DSP Quiz Version for Enhanced Student Learning
Motivation

- J-DSP Simulations
- DSP Lecture Notes
- DSP Lecture Videos
- Online DSP Labs
- DSP Quizzes
- Other Web Links

Study of DSP Concepts
Proposed Interface

- Integration of several discrete learning components to Java-DSP.
- Access to three simulations in a single Java-DSP window.
- Allows implementation of large simulations that cannot be accommodated in a single window.
Web-Based Quiz

- Connecting link between DSP questions, J-DSP simulations and other learning components.

Chapter 4  Question 7

Question:
The worst ripple characteristic when truncating the FS is produced by:

Answer (Select Only One Answer):

a) ○ L-point rectangular window
b) ○ L-point triangular window

Correct Answer:
Answer: a, L-point rectangular window

Comments: The rectangular window is associated with the sharpest transition in the time domain which causes the ripples in the frequency domain.

Evaluate  Return to Index  Switch to JDSP Editor  Proceed

JDSP Demo  Brief Explanation  DSP Lecture Video
Links to Relevant Material

• Links to all relevant materials and demos are activated after the student attempts a question.

• Includes animated Java-DSP demos, lecture notes, lecture videos.
Interfacing Java-DSP to MATLAB and LabVIEW
Overview

- Enables students and instructors to exchange data and perform simulations on both the platforms.
- Allows to translate the block diagram from Java-DSP into MATLAB code.
- Enables users to repeat, verify and expand simulations in the MATLAB environment.
- Conversely, MATLAB programs can mapped to flowchart like diagrams and run in Java-DSP.
MATLAB Interface

Script Export

Copy and paste this code:

```
% in a manner consistent with the program
% working on software updates that will allow

clear all; close all;

% Signal Generator (a,1)
t=[0:1:255]; y=3.0 * sin(pi*t*0.2);
VAR1=[zeros(1,0)];

% Signal Generator (d,4)
t=[0:1:255]; y=2.0 * sin(pi*t*0.4);
VAR2=[zeros(1,0)];

%Mixer (+/-,2)
if (length(VAR1)>length(VAR2))
    VAR2=[VAR2 zeros(1,(length(VAR1)-length(VAR2)))];
else
    VAR1=[VAR1 zeros(1,(length(VAR2)-length(VAR1)))];
end

VAR3=VAR1+VAR2;

% FFT (c,3)
VAR4=fft(VAR3,256);
% Plot (e,5)
figure(5);
eps = 1e-7;
```

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MATLAB Interface

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Mathscript Code from Java-DSP

• Uses the script generation capabilities of J-DSP to generate Mathscript code.

• Most J-DSP simulations can be translated to Mathscript code.

• “Export Script” from file menu and select “Mathscript(TM) Code”.

• Copy paste code into m-file.

• Signed Applet – will eliminate copy-paste process.
Simulation Example

• Uses the script generation capabilities of J-DSP to generate Mathscript code.
• The design is extended in LabVIEW with native blocks.
Including Custom Java Code
User-defined Block

- The user-defined block allows custom java code to be interfaced with other J-DSP blocks.
**Example**

```java
public class MyFunction1 {
    public void myCode(double[] x1, double[] x2, double[] y1, double[] y2 {
        /*
         * BLOCK */
        (0)<...(4)               /* BASIC BLOCK MODEL */
        (1)<...(5)
        */
        // x1 - input at pin 0, exponential signal
        // check the top portion of the plot on the Left side
        // y1 - output at pin 4, absolute value of input signal
        // check the top portion of the plot on Right side
        for(int i=0; i<256; i++)
        {
            y1[i] = Math.abs(x1[i]);
        }
        // x2 - input at pin 1, triangular signal
        // check the bottom portion of the plot on the Left side
        // y2 - output at pin 5, input-Para1 (Para1 - 1)
        // check the bottom portion of the plot on Right side
        for(int i=0; i<256; i++)
        {
            y2[i] = x2[i] - para1;
        }
    }
}
```

Sample Java Code for the User Defined Block
Example
Java-DSP and Sensor Motes
Overview

- A Web-based DSP Simulation Tool
- Universally accessible DSP functions
- Embeds Interactive Simulations in Web pages
- Seamlessly Integrates Animated Demos
- Integration 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
Java-DSP and the Motes

Collaborative Sensor Signal Processing enabled by J-DSP
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
Remote Sensing Example

• Preliminary example shows possibilities for sensing and security applications.

• Display panel shows which sensors are active
  
  a. Active Sensors:
  
  b. Light
  
  c. Sound
  
  d. Temperature
  
  e. Accelerometer
Java-DSP Earth Systems Edition
Earth Systems Signals

• “Real-Time” monitoring
  • Global temperature, Concentration of greenhouse gases, River flow, atmospheric pressure, earth orientation.

• “Deep-Time” proxy data
  • Proxy data that are representative of past Earth system behaviour.
  • Ice sheet isotopes (air temperatures), tree ring thicknesses (hydrology), magnetic intensity of ancient sediment (geomagnetic field).

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Expected Astronomical Frequencies

Earth’s orbital parameters

E - periods 400,000 and 100,000 years, T - period 41,000 years,
P - periods of 23,000 and 19,000 years.

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ETP Model Analysis

- **Standardized ETP Signal**
  - Amplitude vs. Time (Kyr)

- **Spectrogram**
  - Frequency (cycles/Kyr) vs. Time (Kyr)
  - Bands: P Band, T Band, E Band

- **Multiple Prolate Taper Spectrum**

- **Taner Filter**

- **Filtered Signal P-Band**

- **Significance Level**
  - Amplitude vs. Frequency (cycles/Kyr)
  - Labels in kyr:
    - 100, 29, 23, 19, 16, 14

- **Signals**
  - http://jdsp.asu.edu

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ARIZONA STATE UNIVERSITY

Ira A. Fulton Schools of Engineering
Functions Available and Planned

- Data preparation
- Basic Utilities
- Data/Workspace Handling
- Spectral/Coherency TF Analysis
- Filtering/Smoothing
- Modeling/Prediction

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How is \( pCO_2 \) correlated with global climate change?

Mauna Loa atmospheric \( pCO_2 \) (ppm) mid-monthly values, with the seasonal cycle removed by subtracting “a 4-harmonic fit with a linear gain factor.”

http://scrippsc02.ucsd.edu/

Monthly global temperature record averaged over 5°x5° areal grids, from more than 3000 stations temperature time series, preprocessed to remove the seasonal cycle and biases from stations at different elevations and different averaging formulae.

http://www.cru.uea.ac.uk/cru/data/temperature
The “interannual” variations in global temperature and their relationship to those in pCO$_2$ provide additional important information, and are best assessed statistically, through signal processing and time series analysis.

The interannual variations of global temperature v. pCO$_2$ at Mauna Loa shown below (seasonal cycles and long-term trends removed) appear to share cyclic variations -- are these cycles significant and are they correlated?
Global Warming in 20th Century

Global IT-\text{CO}_2 \text{ Coherency}

Global IT-\text{CO}_2 \text{ Cross Phase}

Global IT Spectrum

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