JDSP in Education

NSF Phase 3 J-DSP Workshop, UCy

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Agenda

• JDSP-based OFDM for Wireless Communications
• iJDSP – Audio processing
• AJDSP – Sensor Interfaces
• Localization using Android devices

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Orthogonal Frequency Division Multiplexing (OFDM)

- Used mainly in cases of multipath propagation
  - Frequency selectivity
  - Signal spreading
  - Solutions can include lower data rates, equalization, and methods such as CDMA

- OFDM uses the cyclic property of the FFT

- Intuition: OFDM divides a wide-band frequency selective channel into several narrow band frequency flat channels

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Multipath environment – No OFDM

- Transmit a series of pulses
With OFDM

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Educational value

• Demonstrates:
  – Properties of the DFT matrix
  – Cyclic nature of the FFT
  – Random signals (noise)

• Simulations in JDSP can show
  – Effect of channel length
  – Effect of noise

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Block Diagram Based Learning in iJDSP

- Requirements
  - Provision of speech/audio signals
  - Microphone Recording and Playback facility
  - Frame-by-Frame Processing Capability
  - Effective visualization tools

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Blocks for Audio Signal Processing

- Long Signal Generator
- Sound recorder (device microphone)
- Spectrogram
- Linear Predictive Coding (LPC)
- Quantization
- Line Spectral Pairs
- MPEG I Layer 3 Psychoacoustic Model
- Loudness Control

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Educational Value

On an iOS device:

• Visualization of audio in time-frequency domains
• Distinction between loudness and intensity
• Speech models
• Effects of quantization
• MP3 algorithm

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AJDSP

- Android-based DSP simulation program

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AJDSP – Sensor Interfaces

SHIMMER

- GSR
- ECG
- Accelerometer
- Camera
- Microphone

AJDSP

- Statistics
- Graphs
- Audio Feedback

MOBILE DEVICE

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Sensors for Biomedical Applications

• **Camera**
  – Heart Rate estimation by extracting PPG data.

• **Accelerometer**
  – Step counter and estimation of walking, standing and running duration.

• **ECG**
  – Estimating heart rate and extracting features such as R-R interval, HRV, pulse transit time etc.

• **GSR**
  – Extract features such as mean and standard deviation of skin conductance level (SCL) and number of startle responses.

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Educational Value

• Wireless sensor data acquisition
• Accelerometers and context aware applications
• Non-invasive health monitoring
• ECG signal characteristics
• Parameter estimation, and filtering

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Localization

• Audio-based localization
  – Pairwise distance estimation
  – Localization by triangulation

• Communications between devices
  – Wi-Fi on tablets/phones
  – Server-client model
  – Server-server model
Distance Estimation


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Educational Value

• Demonstration of localization

• Effect of different transmit signal waveforms and frequencies

• Effect of different environmental conditions

• Android-based system with a simple GUI

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THANK YOU

Questions?

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