

## **DSP Applications**

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#### **Goals for Describing These Applications:**

- Describe uses of filters. System surrounding filter often more interesting than the filters themselves, but filters integral.
- Highlight signal-processing techniques.
- Highlight important filter characteristics.

#### **Various Applications:**

- Phased Array Signal Processing (FFT)
  - Electronically steer-able antenna or detector
  - Radio telescopes, radar, sonar (submarines)
  - Signals from array are combined; resultant contains energy from selected (physical) direction.
  - Constructive & destructive interference is created via phase adjustments in the frequency domain, after FFT.
- Audio Forensics (FFT)
  - Determine presence of single or multiple 60Hz (59.99Hz) signatures on an audiotape, to determine if multiple recordings were made on one tape. Is the tape original or a copy?
  - Average signal energy with multiple FFTs.
  - See spectrogram.
- Equalizer (Filter)
  - Series of BPFs. Overlap of passbands important in design.
  - Variable gain for each filter, set by user.
- Time-Of-Flight Measurement (Correlation Detection, Dispersion Issues)
  - Measure time of propagation to find dimensions of materials, or material property.
  - Detect echo of tone burst via correlation.
  - For delay measurement and correlation, dispersion important.
  - [Wanted subsample accuracy, studied methods with Monte Carlo analysis, to estimate accuracy and benchmark processing time].
  - If tone burst is periodic then correlation is periodic. Some systems use varying chirp frequency for single correlation peak.
- CDMA for Cell Phones (Correlation Detection of Bit Stream)
  - Cell phones broadcast in same RF band, without crosstalk. Unlike TV channels or radio stations.
  - Each bit of message modulated with long pseudo-random code. Receivers correlate random code, finding match or opposite match. This translates into occurrence of 1 or 0 in message.
  - Crosscorrelation of PN codes is low.
- JPEG Image Compression (Discrete Cosine Transform)
  - Transform, quantize, encode, transmit.
  - Encoding reduces amount of data by replacing commonly occurring signal values with shorter symbols. This reduces data rate on average.
- MPEG Audio Compression (BPF)
  - Bank of parallel BPFs, quantize output, encode.
  - Quantization level is dynamically adjusted to allocate better resolution (more bits, more accurate transmission, more bandwidth) to frequency bands with more signal energy. Bands with low energy are nearly eliminated.
  - Quantization also takes varying sensitivity of human perception.
- Speed Error (Filters)
  - Measure error in period of a signal (2.3 samples). Used dual-slope FM detection.