1. Introduction to Adaptive Filters
   1. Adaptive filtering
      1. Definition
      2. Basic functional blocks
   2. Adaptive transversal filters
      1. 2 basic functional blocks
      2. Signal flow
      3. M-tap adaptive transversal filter
         1. Vectors
            1. Weights
            2. Input / output
   3. Performance surfaces
      1. Mean square error
      2. Minimization of MSE
         1. Quadratic function / hyperboloid
         2. Optimum weight vector
         3. Minimum MSE
   4. Adaptive algorithms
      1. Definition
      2. LMS
         1. Weight update equation
         2. Step size choice & convergence rate
         3. MATLAB function
         4. Computation complexity
      3. NLMS
         1. Weight update equation
         2. Step size choice & convergence rate
         3. MATLAB function
         4. Computation complexity
      4. AP
         1. Increase convergence rate
         2. Weight update equation
         3. MATLAB function
         4. Computation complexity
      5. RLS
         1. Minimization of the sum of weighted least-square errors
         2. Weight update equation
         3. Relationship between NLMS / AP / RLS
         4. MATLAB function
         5. Computation complexity
   5. Spectral dynamic range and misadjustment
   6. Applications
      1. Adaptive interference cancellation
   7. Transform domain and subband adaptive filters
      1. Transform domain adaptive filters
         1. Frequency domain adaptive filter
            1. Definition
            2. Block diagram
            3. Process (back and forth between time and frequency domain)
            4. Weight update equation (block complex LMS algorithm)
            5. Unconstrained frequency domain adaptive filter
            6. MATLAB function
         2. Self-orthogonalizing adaptive filter
            1. Definition
            2. Comparison with RLS
            3. Block diagram
            4. Process
            5. Weight update equation
         3. Subband adaptive filter
            1. Block diagram
            2. Synthesis filter bank
            3. Delayless subband adaptive filter
            4. Similarities and differences between SAF and self-orthogonalizing adaptive filter
2. Subband Decomposition and Multirate Systems
   1. Multirate systems
      1. Definition
      2. Decimator by a factor D
         1. IO relation
         2. D-fold decimator in z domain
         3. MATLAB implementation
      3. Interpolator by a factor I
         1. IO relation
         2. I-fold interpolator in z domain
         3. MATLAB implementation
      4. Linearity & shift-variance of decimators and interpolators
         1. Memoryless operation – commutable
         2. Filtering order – not commutable
   2. Filter banks
      1. Introduction
         1. Analysis filter bank vs. synthesis filter bank
            1. Definition
            2. Jobs
            3. MATLAB implementation
         2. Special filter banks
            1. Uniform filter bank

Definition

Property

* + - * 1. Critically decimated filter bank

Definition

Property

* + - * 1. Aliasing-free filter bank
        2. Quadrature-mirror filter (QMF) bank
    1. Input-output relation of the N channel QMF bank
    2. Perfect reconstruction filter banks
       1. Transfer function design
       2. IO relation
       3. Distortion transfer function
          1. Perfect reconstruction
    3. Polyphase representation
       1. Analysis filter bank
          1. Polyphase form

Type-I polyphase component matrix + delay chain

* + - * 1. Type-I polyphase representation
      1. Synthesis filter bank
         1. Polyphase form

Type-II polyphase component matrix + delay chain

* + - * 1. Type-II polyphase representation
      1. Polyphase realization
         1. Analysis filter
         2. Synthesis filter
         3. N-channel QMF bank

Serial-parallel / parallel-serial

Perfect reconstruction filter bank

* + - * 1. MATLAB implementation
  1. Paraunitary filter banks
     1. Paraconjugate of the polyphase component matrix
     2. Impulse response of synthesis / analysis filter
     3. Overall delay in a QMF bank
  2. Block transforms
     1. Introduction
        1. Regard as
        2. Impulse response of bandpass filters
        3. Difference between block transform & filter bank
        4. Relationship between block transform & filter bank in adaptive filtering
     2. Filter bank as a block transform
        1. Filter bank as a block transform with memory block diagram
           1. Analysis / synthesis filter bank matrices
           2. Input vector
           3. Delay chain
           4. Overlap in input & output vector
        2. MTALAB implementation
  3. Cosine-modulated filter bank
     1. Introduction
        1. Definition
        2. Analysis / synthesis filter bank
        3. Reconstruction
           1. Approximately perfect
           2. Perfect
        4. 2 main classes
        5. Phase property of the whole system
        6. Impulse responses of analysis / synthesis filters
        7. Summary of practical virtues of cosine-modulated filter bank
     2. Design example
        1. Design a 16-channel cosine-modulated filter bank
  4. DFT filter bank
     1. Introduction
        1. Definition
        2. DFT filter bank via complex modulation
        3. Impulse response of prototype / modulated filter
     2. Design example
        1. Design a 8-channel DFT filter bank
  5. A note of cosine modulation

1. Subband Adaptive Filters
   1. Subband adaptive filtering
      1. Introduction
         1. Conventional SAF block diagram
         2. Conventional SAF brief process
      2. Computational reduction
         1. Advantage of SAF
         2. Computational saving
            1. Critically sampled SAF – D=N – greatest computation saving
            2. Oversampled SAF – D<N – minimize aliasing distortion
      3. Spectral dynamic range
         1. Why SAF can raise convergence rate
   2. Subband adaptive filter structures
      1. Classify criterion
      2. Open-loop structures
         1. Definition
         2. Limitation
      3. Closed-loop structures
         1. Similarity / difference with open-loop
         2. Pros-and-cons
   3. Aliasing, band-edge effects and solutions
      1. Introduction
         1. Aliasing
            1. Cause
            2. How to reduce

Oversampling condition (将在第五章中阐述)

Critically-sampled condition (后三种解决方法将在4.3.2-4.3.4中分别阐述)

* + - 1. Band-edge effects
         1. Definition and cause
         2. How to observe
    1. Aliasing and band-edge effects
       1. Spectra of
          1. original SAF
          2. oversampled SAF
          3. critically sampled SAF
    2. Adaptive cross filters
       1. Cross filter matrix
       2. Pros-and-cons
       3. N-band critically sampled SAF structure with cross filters for adjacent subbands
    3. Multiband-structured SAF
       1. Block diagram
       2. Distinctive features
       3. Weight control mechanism
       4. Normalized subband spectra 🡪 equalized spectrum
          1. Elimination of band edge effect / aliasing distortion
       5. Computation cost reduction
    4. Closed-loop delayless structures (会在下一节详细讲述)
       1. Difference from conventional SAF
       2. Elimination of band edge effect / aliasing distortion
  1. Delayless subband adaptive filters
     1. Closed-loop configuration
        1. SAF structure
        2. Operating process
           1. Filtering – time domain
           2. Adaptation – subband domain
        3. Delay / convergence performance
     2. Open-loop configuration
        1. SAF structure
        2. Two types of error signals
        3. Delay / convergence / band edge / aliasing performance
     3. Weight transformation
        1. Definition & function
        2. Frequency sampling method
           1. Steps
           2. Interpretation from frequency-sampling perspective
        3. DFT filter bank with fractional delays (未看)
     4. Computational requirements (未看)
  2. MATLAB example

1. Critically Sampled and Oversampled Subband Structures
   1. Introduction
      1. Advantages of subband adaptive filtering
   2. Variants of critically sampled subband adaptive filters
      1. Introduction
         1. Drawback of critically sampled SAF
         2. Tradeoffs
      2. SAF with the affine projection algorithm
         1. AP algorithm
         2. Block diagram of the critically sampled SAF structure
            1. Unique features
            2. Assumption
         3. AP algorithm for subband adaptive filters
         4. Performance analysis
            1. MSE convergence
            2. Computational complexity
            3. AP algorithm in oversample SAF
      3. SAF with variable step sizes
         1. Squared subband error criteria & updating equation
         2. Variable step-size algorithm for SAF
         3. Performance analysis
      4. SAF with selective coefficient update
         1. Advantage
         2. Partial-update discrete cosine transform algorithm
         3. Fast wavelet transform-domain LMS algorithm with partial-update subband tap weights
         4. Performance analysis
   3. Oversampled and nonuniform subband adaptive filters
      1. Oversampled subband adaptive filtering
         1. Block diagram of the oversampled SAF with real-valued analysis & synthesis filters using different decimation factors
         2. Performance analysis
            1. Computational complexity
            2. Convergence (drawback of oversampled input signal)
         3. Improvements
            1. Oversampled SAF with increased bandwidth of the analysis filters relative to the synthesis filters
            2. Different prototype filters and decimation factors
      2. Nonuniform subband adaptive filtering
         1. Definition
         2. Classification
         3. Bandwidth adaptation method
         4. Performance analysis
   4. Filter bank design
      1. Generalized DFT filter banks
         1. Prototype analysis filter
         2. Complex modulation model of the generalized DFT filter bank
      2. Single-sideband modulation filter banks
         1. Difference between generalized DFT and single-sideband modulation filter banks
         2. Block diagram of the single-sideband modulation filter bank
         3. Two considerations for designing filter banks in subband adaptive filtering
      3. Filter design criteria for DFT filter banks (没看懂)
      4. Quadrature mirror filter banks
         1. QMF Block diagram
         2. Filter banks with different bandwidths
         3. Performance analysis
            1. Computation complexity
            2. Aliasing distortion
         4. Process of implementing QMF
         5. MATLAB implementation
      5. Pseudo-quadrature mirror filter banks
         1. Definition
         2. Filter bank design
         3. MATLAB implementation
      6. Conjugate quadrature filter banks
         1. Filter bank design
         2. Constraints and IO relation
   5. Case study: Proportionate subband adaptive filtering
      1. Multiband structure with proportionate adaptation
         1. Idea of
            1. Proportionate adaptation
            2. MSAF algorithm
            3. Combination of the two
         2. Proportionate MSAF algorithm
      2. MATLAB simulation & performance evaluation
2. Multiband-Structured Subband Adaptive Filters
   1. Introduction
      1. Limitations of conventional SAF
      2. Recursive weight-control mechanism – MSAF
   2. Multiband structure
      1. Structures
         1. Multiband-structured
         2. Multiband-structured SAF
      2. Formulas
      3. Polyphase implementation
         1. Direct form realization of an adaptive FIR filter
         2. Polyphase realization of an adaptive FIR filter
         3. MATLAB implementation
   3. Multiband adaptation
      1. Principle of minimal disturbance
         1. Principle of minimal disturbance
         2. Criterion ensuring convergence to optimum solution
         3. Effects of noise on the weight adaptation
      2. Constrained subband updates
         1. Constraint optimization for the multiband structure
         2. Multiband-structured SAF algorithm
      3. Computational complexity
         1. Summary of MSAF algorithm and its computation cost
         2. Comparison to the NLMS algorithm
   4. Underdetermined least-squares solutions
      1. Insight for MSAF algorithm
      2. NLMS equivalent
      3. Projection interpretation
   5. Stochastic interpretations
      1. Stochastic approximation to Newton’s method
         1. Definition of Newton’s method
         2. Weight adaption function as an approximation of Newton’s method
      2. Weighted MSE criterion
         1. Stochastic interpretations of the MSAF algorithm
         2. Decorrelation feature
      3. Decorrelating properties
         1. 2 decorrelation properties
         2. Effectiveness of decorrelation in MSAF
   6. Filter bank design issues
      1. The diagonal assumption
         1. Statement
         2. Assumption – consine-modulated filter bank
      2. Power complementary filter bank
      3. The number of subbands
   7. Delayless MSAF
      1. Properties of delayless MSAF
      2. Open-loop configuration
         1. Block diagram
         2. Implementation algorithm
         3. Convergence behavior & computational cost
      3. Closed-loop configuration
         1. Block diagram
         2. Implementation algorithm
         3. Convergence behavior & computational cost
   8. MATLAB examples
      1. Convergence of the MSAF algorithm
      2. Subband and time-domain constraints