Graphical Control of a Parametric Equalizer

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Problem Setting

• Graphic EQ
  – Versatile magnitude response
  – Easy-to-understand interface

• Parametric EQ
  – Minimally invasive: naturally soft magnitude and phase response
  – Low computational load

• Combine the best of both worlds!
Objective

- On the outside: graphic EQ
- On the inside: parametric EQ

Demo
Outline

- Related work
- Architecture
- Optimization process
- Five user interface modes
- Optimization speed
- Conclusion
Related Work

• Standard UI for Parametric EQ with movable dots: only approximation

• Optimization of filters (in particular Ramos/López 2006)

• Genetic optimization of a mix (Kolasinski, this AES Convention)
Architecture

- Model a standard parametric EQ
- Up to five bands
- One band may be low-shelving, one may be high-shelving
- **Optimization can control** all parameters including the number and types of bands
- **User may override** the optimization through standard controls
Optimization Process

- Minimize deviation of magnitude response from user input
- Evolution; population: 100; seeding; tournaments; crossover of EQ bands
- Mutation: slightly vary f, Q/slope, gain
- In parallel: real-time audio processing
  - Uses current best genotype
  - Which may be affected by mutations or may be superseded
Mode 1: Automatic Gain Adaptation

- User input:
  - One dot per EQ band
  - One additional dot to control the overall level
- Optimize gain settings only
- Types, f and Q/slope as set by the user
- Doesn’t actually require genetics

Demo
Mode 2: Connecting the Dots

- User input: any number of dots
- Optimize for f, Q/slope, gain
- Optimize for the number and type of bands: If RMS error in magnitude response is < 1 dB, error measure favors simpler EQ

- Demo
Mode 3: Freehand Curve

- User input: freehand curve
- Optimize for f, Q/slope, gain
- Optimize for the number and type of bands
- Multiscale analysis to seed genetic algorithm

- Demo
Detour: Multiscale Analysis

• Convolve with Difference of Gaussians (DoG) at “all” widths
• Look for extrema (after correct scaling)
• Map width of DoG to Q or slope
Mode 4: Lower and Upper Bounds

- User input: freehand corridor
- Optimize for f, Q/slope, gain
- Penalize magnitude responses that leave the corridor
- Multiscale analysis of midline to seed genetic algorithm

- Demo
Mode 5: Strokes plus Importance

- Specify response where it’s important
- User input: partial curves with different importance (displayed as opacity)
- Error measure based on importance
- Optimize for f, Q/slope, gain, number and type of bands

- Demo
Optimization Results

- Small tweaks incorporated within fractions of a second
- Coarse changes typically in less than one second
- Late changes occur
- Multiscale helps a lot
Conclusion

• Interactive control, real-time operation
• Unexpected solutions (benefit?)
• Future work:
  – Audio glitches when best filter is replaced: Blend? (Phase problems?)
  – Non-determinism: same input, different control
  – Interactive tweaking of curves: Smudge tool?
  – Better UI for shelving filter?
Questions?