Intelligent Equalization

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Spectral Analysis

$$\bar{X}(k) = \frac{\sum_{\tau} |X(k,\tau)|}{\left(\frac{x_{len}}{w_{len}}\right) + 1}$$

$$\bar{X}_{AV}(k) = \frac{\sum_{k} \bar{X}(k)}{S} \left(\overline{X_c(k)} - \overline{X_c(k-1)}\right)$$

Spectral Analysis

4096 Point Averaged STFT

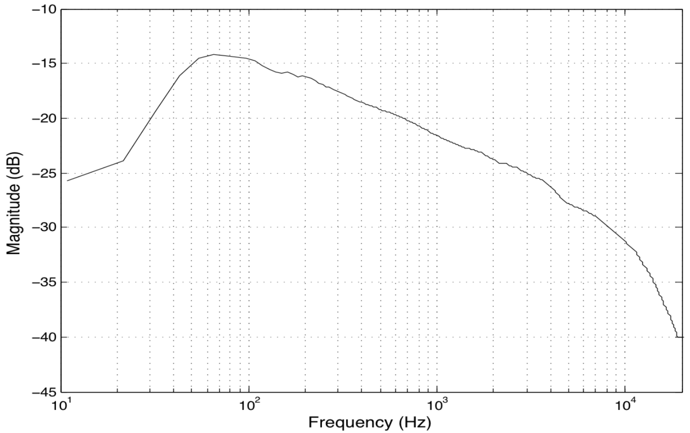

Figure 2. Smoothed version of the average spectrum as the target equalization curve

Loudness Measurement

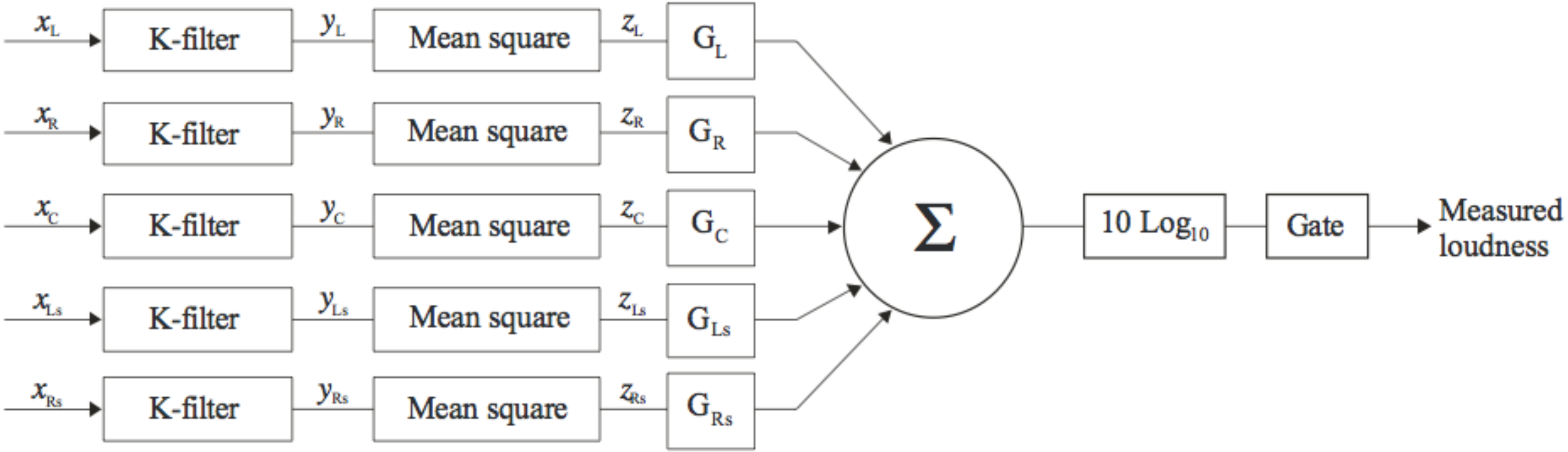

Figure 4: Simplified block diagram of the ITU-R BS.1770 loudness calculation (14).

Morph to the Target

$$|H_d(\omega)| = \frac{|T(\omega)|}{|X(\omega)|}, \quad \omega \in (0, \pi)$$

Calculated at the center frequencies: 16, 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, 4000, 5000, 6300, 8000, 10000, 12220, 16000, 20000.

Morph to the Target

Filter Curve Smoothing:

$$H'_d(\omega_n) = \alpha \cdot H'_d(\omega_{n-1}) + (1 - \alpha) \cdot H_d(\omega_n)$$

Apply The Filter:

$$y[n] = b(1) \cdot x[n] + b(2) \cdot x[n-1] + \cdots + b(17) \cdot x[n-16] - a(2) \cdot y[n-1] - \cdots - a(17) \cdot y[n-16]$$

Morph to the Target

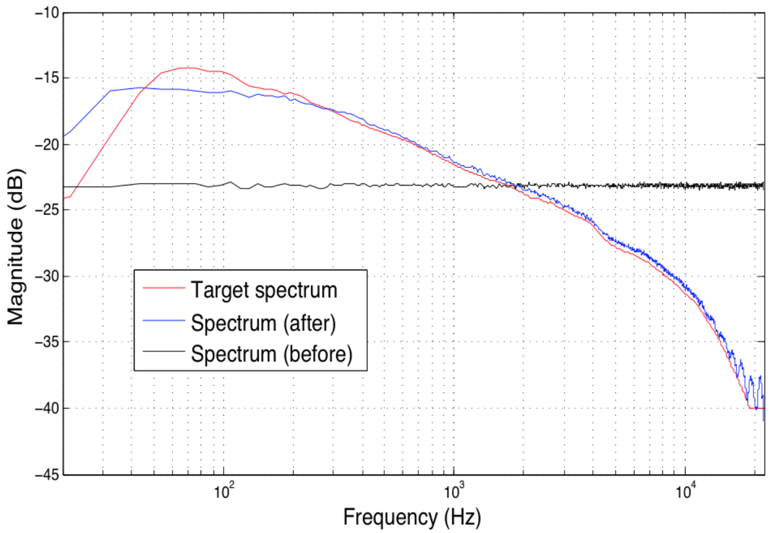

Figure 6. Testing result using white noise signal.

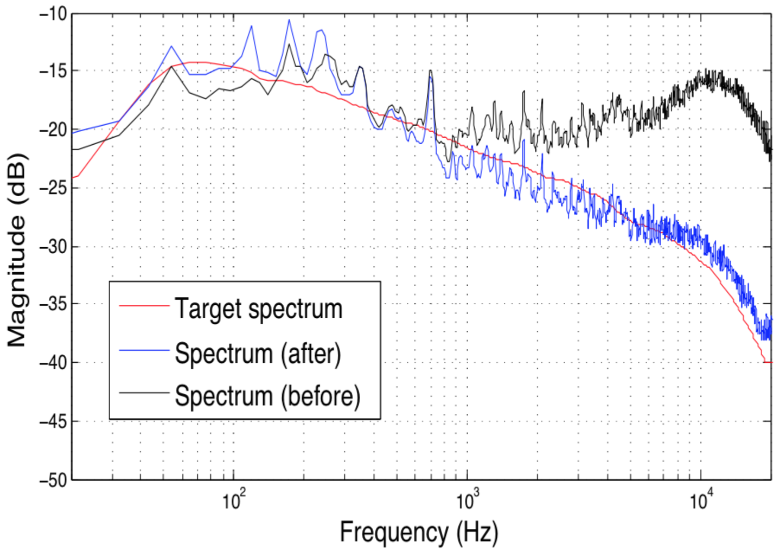

Figure 7. Test result using real music signal.

References

Ma, Zheng, Joshua D. Reiss, and Dawn AA Black. "Implementation of an intelligent equalization tool using Yule-Walker for music mixing and mastering."*Audio Engineering Society Convention 134*. Audio Engineering Society, 2013.