Notes to Accompany Partials, Beats, Roughness, and ERBs.xlsx

Jay Rahn, February 13, 2015

The Excel file Partials, Beats, Roughness, and ERBs.xlsx is accessible at http://yorkspace.library.yorku.ca/xmlui/handle/10315/28314 and displays relationships between adjacent upper partials in pairs of tones whose fundamental frequencies differ by 480 to 720 cents (hundredths of an ideal tempered semitone, i.e., 2^(1/1200)).

The spectra of these tones are understood as being harmonic, i.e., the 2nd partial's frequency is twice the fundamental frequency, the 3rd partial's frequency is three times the fundamental frequency, and so forth.

The upper partials of the lower tones are the 2nd to 6th; those of the upper tone are the 2nd to 5th (i.e., respectively, the 1st to 5th and 1st to 4th 'overtones').

The fundamental frequencies of the lower tones are 98, 196, 392, and 784 Hz (hertz, i.e., cycles per second), which correspond, respectively, to G2, G3, G4, and G5 in American Standard Pitch Notation (where A4 = 440 Hz); these correspond to the lowest line and highest space of the bass-clef staff, the second line of the treble-clef staff, and the space directly above the treble-clef staff.

If the difference between the frequencies of adjacent partials is equal to or less than 15 Hz, this value is entered and highlighted in **boldface**.

The formula employed to calculate the equivalent rectangular bandwith (ERB) for each pair of adjacent partials is as follows:

$$24.7*(4.37*f+1),$$

where f is the number of kilohertz (kHz, i.e., thousand hertz) in the two partials' central frequency and the resulting value is expressed in hertz (Glasberg and Moore 1990, 114).

The difference between two frequencies is divided by the value of their ERB to convey the number of ERBs between the two frequencies.

If the resulting quotient is equal to or less than 1.0, the quotient is highlighted in **boldface** and its roughness value is reported (also in **boldface**).

The roughness of two frequencies is calculated in hertz as an absolute value according to the following formula:

$$e^{-3.5*0.24/(0.0207*L+18.96*(U-L)} - e^{-5.75*0.24/(0.0207*L+18.96)*(U-L)}$$

where e=2.71828182845904 (cf. natural logarithms), and L and U are, respectively, the lower and upper frequencies in Hz (Vassilakis 2007, 320).

References

Glasberg, Brian R. and Brian C. J._Moore. 1990. Derivation of Auditory Filter Shapes from Notched-noise Data. *Hearing Research* 47/1-2: 103-38.

Vassilakis, Pantelis N. 2007. SRA: A Web-based Research Tool for Spectral and Roughness Analysis of Sound Signals. *Proceedings SMC'07, 4th Sound and Music Computing Conference, Lefkada, Greece*, 319-25. http://musicalgorithms.ewu.edu/learnmoresra/files/vassilakis2007smc.pdf