Harmonic Mixing Based on Roughness and Pitch Commonality

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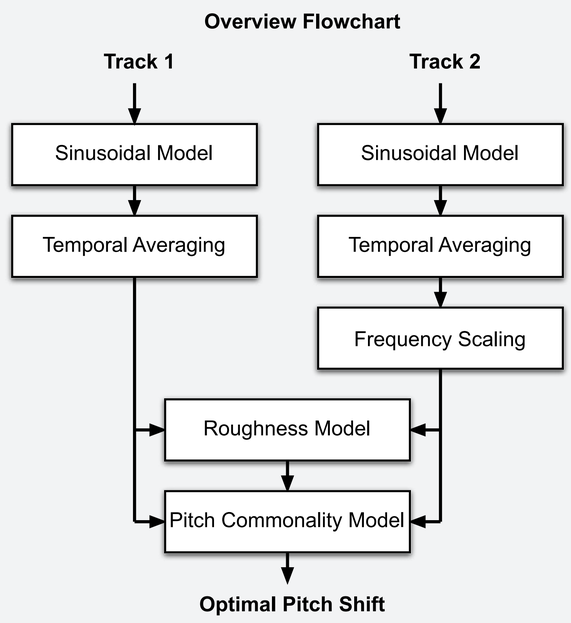
Overview

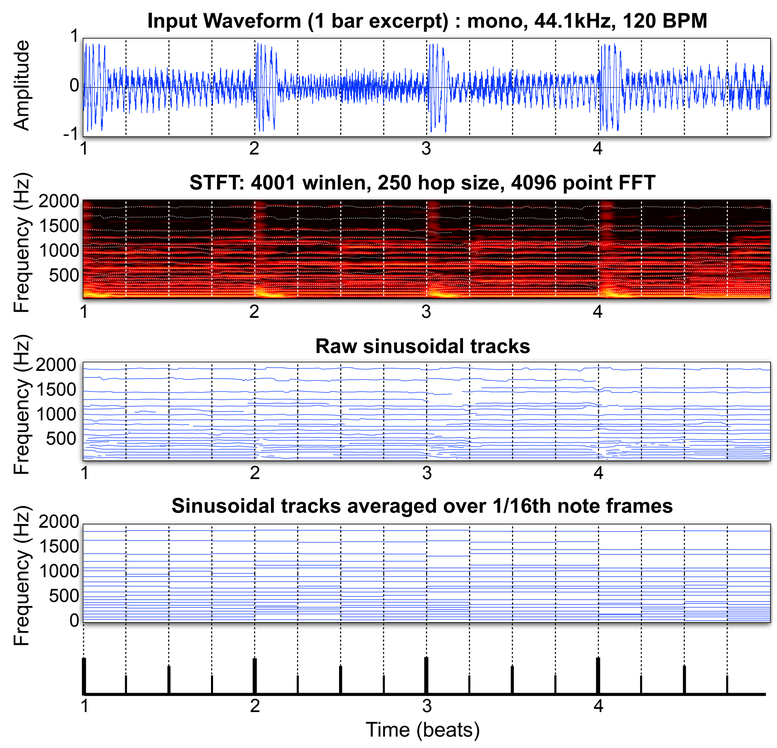
• To create a new method for harmonic mixing of two tracks, based on psychoacoustic principles to exceed the well-known key detection approach dependent on the circle of fifths.

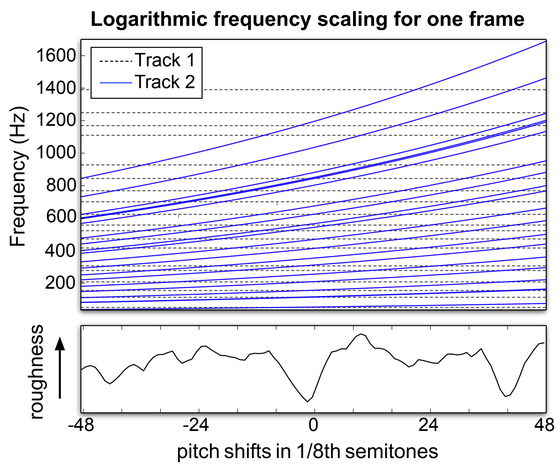
• To develop a system that determines the optimal, consonance-maximising pitch-shift between two tracks built upon the analysis of sensory roughness and pitch commonality.

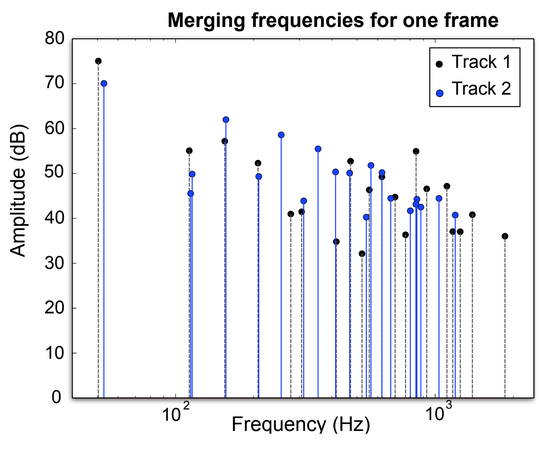


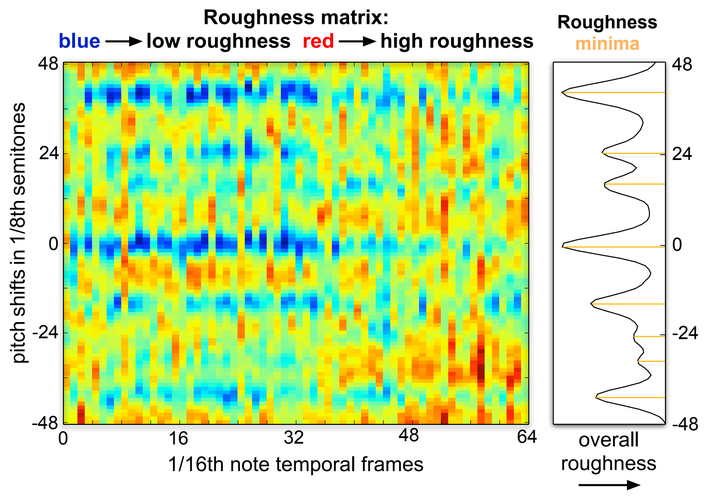
Method

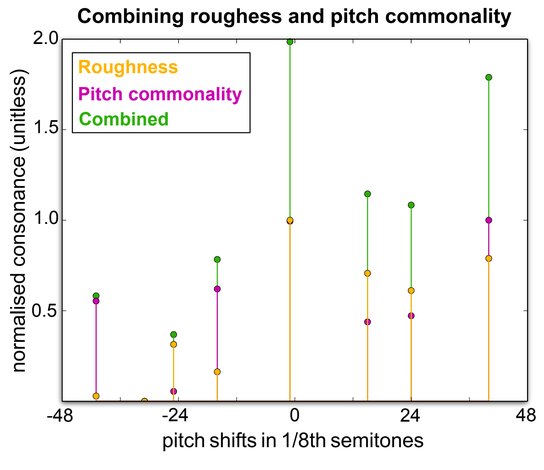
- Extract set of 20 frequencies and amplitudes from both tracks using Serra's [1] sinusoidal model and average over short temporal frames (16th note)
- Scale the frequencies of one track over the range of one full octave (+/- 6 semitones) in 1/8th semitone steps
- Merge the scaled frequencies of one track with those of the other and measure roughness using a modified version of Parncutt's [2] implementation of Hutchinson & Knopoff [3]
- Find the local minima of the roughness curve to indicate consonant pitch shifts
- Feed local minima to model for harmonic consonance based on extraction of harmonic structure by adapting Parncutt & Strasburger model [4]
- Analyse pitch commonality by adapting Hofmann-Engl's method [5]
- Join values for roughness and pitch commonality model to degree of overall consonance to adjust optimal pitch shift
- Use a pitch-shifting algorithm (e.g. Rubberband) to implement the selected pitch shift and then mix the tracks together











Evaluation

- Listening test to evaluate perception of consonance and pleasantness for resulting mixes
- **28** musically trained participants were asked to rate both consonance and pleasantness of **10** different combinations mixed in **5** different categories each:

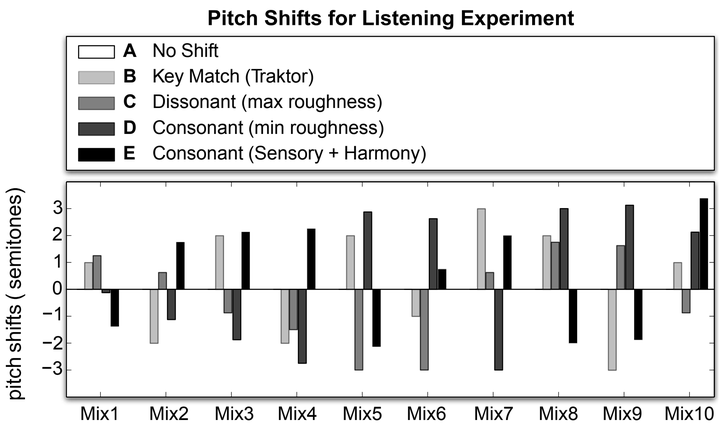
A No Shift: Mix resulting from no pitch shift executed

B Key Match (Traktor): Mix resulting from circle of fifths based alignment using key detection inside Native Instrumets' Traktor Pro 2

C Dissonant: Mix resulting from the pitch-shift ascribed the highest roughness values by our model

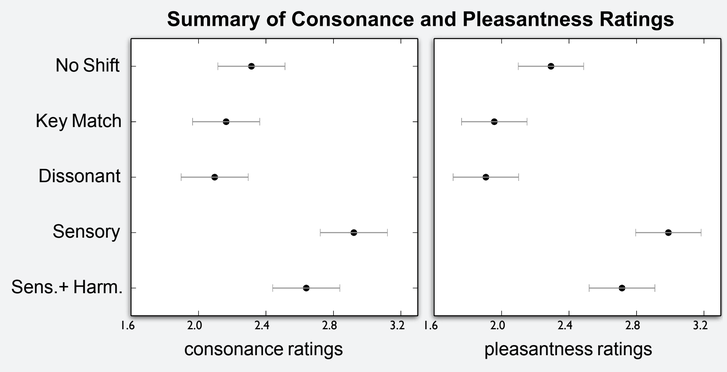
D Consonant (Sensory): Mix resulting from the pitch-shift ascribed the lowest roughness values by our model

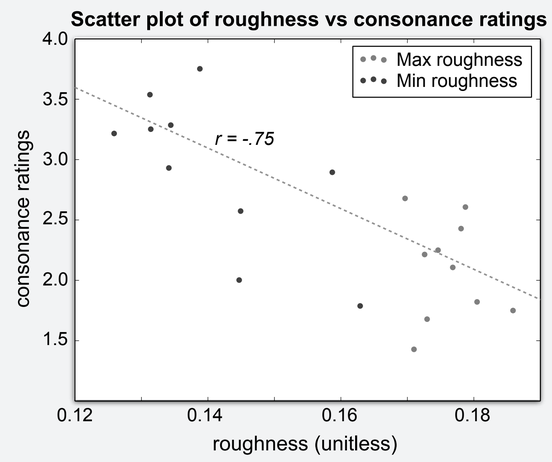
E Consonant (Sensory & Harmony): Mix resulting from the pitch-shift suggested by the combination of roughness and pitch commonality values of our model



Results

- Both the isolated roughness model and the harmonic model rated higher than mixes resulting from existing software in 8 of 10 cases for consonance and in all cases for pleasantness.
- Observations support our hypothesis that the consonance-based system can produce better results than key based approach Consonance and pleasantness ratings are highly correlated (r=0.94)
- Roughness seems to have major effect on the rating of consonance and pleasantness





References

[1] Available as free Python source code at https://github.com/MTG/sms-tools

[2] R. Parncutt, "Parncutt's implementation of Hutchinson & Knopoff (1978)," Available at http://uni-graz.at/ parncutt/rough1doc.html, accessed May 11, 2015.

[3] W. Hutchinson and L. Knopoff, "The acoustic component of western consonance," Interface, vol. 7, pp. 1–29, 1978.

[4] R. Parncutt and H. Strausburger, "Applying psychoacoustics in composition: "harmonic" progressions of "non-harmonic" sonorities," Journal of the Acoustical Society of America, vol. 32, no. 2, pp. 1–42, 1994.

[5] L. Hoffman-Engl, "Virtual pitch and the classification of chords in minor and major keys," in Proceedings of ICMPC10, Sapporo, Japan, 2008.

Example mixes can be heard here: http://telecom.inesctec.pt/~mdavies/dafx15/