Small Room Spectrogram Analysis

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INTRODUCTION

The following is a short report on small room acoustics via analysis of spectrogram data. Four different instruments are played and recorded twice each with identical pitch at two contrasting dynamic level. Microphone placement approximates critical distance for each instrument. Audio file is then imported in Spectrogram for analysis, reporting on harmonic content, overtone structure and spectral distribution relating to the interaction of the instrument's inherent harmonic structure and room acoustic influences.

EURODESK REC AREA

Room and Recording Specs

DIMENSIONS: L = 4.44m, W = 3.46m, H = 2.6m

INSTRUMENTS: crash cymbal and acoustic guitar

MIC SPECS: NT-2A set to cardioid approx. 1.5 metres away for both instruments

MATERIALS:

- wall to wall laminated floors
- thin rug measuring 2.3 x 3.2 laid out in the centre of room
- padded walls and padded ceiling
- smooth door surface in one corner of the room
- glass window surface on one wall
- miscellaneous objects include air-conditioning unit, mic stands and stools

THE CRASH CYMBAL

Crash Cymbal Characteristics

Crash cymbals tend to produce loud and dense sound that cover a wide range of frequencies. In conducted tests measuring frequency spectrum of the crash cymbal Boyk (as cited in Reid, 2002), have observed that the "…cymbals spectrum 'shows no sign of running out of energy at 100 kHz."

White (2008) gives a description that serves as a frequency guide for the crash's sound characteristics; 'clunk' from 100-300Hz; ringing overtones at 1-6kHz; and sizzle at 8-12kHz.

Loud Crash Cymbal Analysis

- as per Boyk's claim, energy is present in frequencies as high up as 23kHz and beyond (see Appendix Fig 1.1)
- fundamental frequency of 276Hz containing the most energy and the longest sustain (Fig 1.2)
- general shorter decay time for higher overtones while low mids up to 534Hz are being sustained for longer
- persistent partials at 6.9kHz, 7.6kHz and 8.4kHz as per White's description of ringing overtones frequency range
- appears to contain inharmonic partials (overtones do not align with the fundamental when using the ruler tool)
- strong frequency information between 3.3kHz and 4.3kHz and between 15.7kHz and 16.7kHz within 1 sec of the initial attack portion of the signal
- approximate noise floor value of -75dBFS and peak value of -15dBFS
- loud details in the infrasonic range of 10Hz to 20Hz

Soft Crash Cymbal Analysis

- similar to the 'loud' crash sample, energy is present in frequencies in the ultrasonic range (Fig 2.1)
- a fundamental frequency of 279Hz although partial at 400 Hz seem to contain more energy and appears to sustain as long as the fundamental (Fig 2.2) which may be due to other parts of the stick making contact with the crash simultaneously (not a clean hit)
- quicker decay time for higher frequencies while low mids up to 516Hz have the longest sustain time
- persistent partials at 1.6kHz
- concentration in energy between 14.3kHz and 16.3kHz during the attack portion of the signal
- approximate noise floor value of -81dBFS and peak value of -21dBFS
- again, loud infrasonic information between 5Hz and 20Hz (in fact much more intense than the previous sample)

THE ACOUSTIC GUITAR

Acoustic Guitar Characteristics

"The acoustic guitar is a full-bodied and rich instrument. It has a wide frequency range consisting of thick lows and brilliant highs" (Benediktsson, 2010).

Molenda's (1999) frequency guide to an acoustic guitar's sound characteristics are as follows; bass boominess from 80-100Hz; body, fullness at 250-500Hz; punch, midrange, 'clang' at 800-3000Hz; clarity and liveliness at 3-5kHz; and detail and 'jangle' at 10-12kHz.

Loud Acoustic Guitar Analysis

- again, there is frequency information beyond 20kHz (Fig 3.1)
- fundamental frequency of about 332Hz, corresponding to pitch E3
- much more high-mid to high frequency information
- strong indication of evenly distributed melodic partials (Fig 3.2)
- a gradual average decay slope with overtones up to approx 3.6kHz with the longest decay rate
- approximate noise floor value of -69dBFS and peak value of -9dBFS
- again, information in the infrasonic range is present at 5Hz to 20Hz

Soft Acoustic Guitar Analysis

- frequency information beyond 20kHz (Fig 4.1)
- similar fundamental frequency to the ‘loud’ sample of about 330Hz, corresponding to pitch E3
- less high-mid to high frequency information
- still a strong indication of evenly distributed melodic partials but with the third harmonic at 1kHz appearing to have an abnormal much shorter decay time compared to the rest of the harmonic spread (Fig 3.2)
- a gradual average decay slope with overtones up to approx. 2.3kHz with the longest decay rate
- approximate noise floor value of -74dBFS and peak value of -14dBFS
- again, information in the infrasonic range of 5Hz to 20Hz at average of -25dBFS

EURO ROOM SUMMARY

With the room’s dimension, room modes were calculated using a spreadsheet template with Rayleigh’s equation and found convergent frequencies from 208Hz-294Hz occurring 88 times and 298Hz-372Hz occurring 89 times. The fundamental frequencies of both instruments lie within this range. With this in mind, it’s fair to assume that the fundamental frequencies and other related low-mid frequencies of the crash cymbal are getting emphasised within this room.

Heavily padded walls and ceiling may contribute greatly to the absorption of higher frequencies 6kHz onwards. This environment is great for capturing clear direct sound but maybe a bit too mid-heavy for some recording exercises.

TOFT REC AREA

Room and Recording Specs

DIMENSIONS: n/a

INSTRUMENTS: snare drum and vibraslap

MIC SPECS: NT-2A set to cardioid approx one metre away for both instruments

MATERIALS:

- top half of walls are padded and the bottom half are wooden boards
- padded ceiling
- laminated floor with small mat
- two door surface areas
- glass window surface area

THE SNARE DRUM

Snare Drum Characteristics

"…the harder you strike a snare drum, the louder it becomes, and the more energy is radiated at higher frequencies [and] the more that the snare interacts with the drum, the wider the modes become…the 'noisier' the sound becomes, eventually changing into a complex noise spectrum" (Reid, 2002).

Owsinski (2006), gives the following description of snare characteristics and their corresponding frequencies; fatness at 120-240Hz, point at 900Hz, crispness at 5kHz; and snap at 10kHz.

Loud Snare Drum Analysis

- very short transient sound with signal only lasting about 1.3s (Fig 5.1)
- fundamental frequency of 473Hz and overtones at 611Hz and 735 Hz containing the most energy (Fig 5.2)
- extremely short decay time for high frequency overtones
- slightly delayed reaction time (18ms) by higher frequencies from 5.2 upwards which maybe due to the slight delay in the activation of the snares which is the main source of the higher frequency information
- longer decay time for low-mid overtones up to 1.1kHz
- inharmonic structure of partials, no harmonic series can be measured
- non linear spectral distribution
- approximate noise floor value of -69dBFS and peak value of -9dBFS

Soft Snare Drum Analysis

- transient sound duration of about 1.07s (Fig 6.1)
- fundamental frequency of 473Hz, the same as the 'loud' sample and overtones at 606Hz and 789 Hz containing the most energy (Fig 6.2)
- extremely short decay time for high frequency overtones from 1.4kHz and above
- slightly delayed reaction time (16ms) by higher frequencies from 5.2 upwards similar to 'loud' sample
- longer decay time for low-mid overtones up to 983Hz
- inharmonic structure of partials, no harmonic series can be measured
- non linear spectral distribution
- approximate noise floor value of -76dBFS and peak value of -16dBFS

THE VIBRASLAP

Vibraslap Characteristics

The instrument consists of a cowbell shaped hollowed box which contain loosely fastened pins and rivets that vibrate and rattle when the instrument is struck. Because of its short percussive quality its range is hard to determine (Virginia Tech, n.d.)

Loud Vibraslap Analysis

- short percussive sound with duration of about 700-800ms (Fig 7.1)
- fundamental frequency of 862Hz, with bands 862-1036Hz, 2.1-2.4kHz, 3.7-4.2kHz with greatest amount of energy during the attack portion of signal (Fig 7.2)
- extremely short decay times especially for high frequency above 11kHz
- repeating waveform peaks which is most likely due to the rattling metal 'teeth' in the box
- inharmonic structure of partials, no harmonic series can be measured
- non linear spectral distribution
- approximate noise floor value of -73dBFS and peak value of -13dBFS

Soft Vibraslap Analysis

- much shorter duration of about 400ms (Fig 8.1)
- fundamental frequency of 847Hz, with mids up to 1kHz containing the most energy especially in the attack phase (Fig 8.2)
- extremely short decay times
- repeating waveform peaks similar to 'loud' sample
- inharmonic partials
- non linear spectral distribution
- approximate noise floor value of -79dBFS and peak value of -19dBFS

TOFT ROOM SUMMARY

The room was not measured due to its non-parallel walls. The glass and door surfaces would most likely cause the space to be quite reflective. However, this was hard to determine from the spectrograms alone. There was no real evidence of any high frequencies persisting in any of the samples of the two instrument. It may have been more useful if a pitched instrument was used to excite the modes to determine this scenario.

It was also difficult to gauge the low frequency response of the room as there no clear indication of any anomalies from the spectrograms. In general however, the noise floor was lower in the Toft compared to the Euro by about 10dB or so.

BIBLIOGRAPHY

Benediktsson, B. (2010). *How to Record the Acoustic Guitar.* Retrieved December 15, 2011 from http://audio.tutsplus.com/tutorials/recording/basix-how-to-record-the-acoustic-guitar/

Owsinski, B. (2006). *The Mixing Engineer's Handbook.* Boston: Thomson Course Technology PTR.

Reid, G. (2002). *Synth Secrets: Synthesizing Drums: The Snare Drum.* Retrieved December 15, 2011 from http://www.soundonsound.com/sos/Mar02/articles/synthsecrets0302.asp

Reid, G. (2002). *Synth Secrets: Synthesizing Realistic Cymbals.* Retrieved December 14, 2011 from http://www.soundonsound.com/sos/Jun02/articles/synthsecrets0602.asp

Molenda, M. (1999). Studio sense: Great-sounding Acoustic Guitar Tracks. *Keyboard*, *25*(3), 74-75. Retrieved from http://search.proquest.com/docview/1362054?accountid=59092

Vibra-slap (n.d.). Retrieved December 16, 2011, from http://www.music.vt.edu/musicdictionary/textv/Vibra-Slap.html

White, P. (2008). *What's The Frequency? A Guide To Effective EQ.* Retreived December 14, 2011 from http://www.soundonsound.com/sos/dec08/articles/eq.htm