xCoAx 2020
Computation,
Communication,
Aesthetics & X
2020.xCoAx.org
Graz, Austria

Audio Data Compression Artefacts as Creative Material

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Keywords: MP3, Data Compression, Artefacts, Noise, Composition, Aesthetics.

Using a series of experiments, analyses, and composition studies, this research investigates data compression artefacts in audio and their potential for musical application. Experiments have consisted of cascading colours of noise and transient signals through an MP3 encoder set to low bitrates and sample rates. By doing this, artefacts have been generated and then analysed using spectrograms and spectromorphological listening approaches, allowing for a greater understanding of their causes and characteristics. Understanding this allowed me to anticipate and generate particular types of artefacts, which were then used as the raw material for composing with. Conducting a series of composition studies allowed for an understanding of the creative possibilities of these sounds, their potential for processing, and arrangement.

1. Purpose of Research

The research considers audio compression encoding artefacts for the purpose of musical composition. Experiments, in which colours of noise were cascaded through an MP3 encoder, led to the production of artefacts, such as birdies, signal gaps, and bandwidth limitation. Artefacts were then analysed using spectrograms and spectromorphology—the means of describing and analysing "sound spectra and the ways they change and are shaped through time" (Smalley 1997, 107). This has led to an improved understanding of artefacts and a development of a taxonomy of their causes and aesthetic qualities, which range in spectral and temporal complexity. Knowing how to produce certain artefacts and anticipate their aesthetic characteristics has been key for generating material for composing with. This, in conjunction with exploring techniques for arranging artefacts informed by microsound composition, is leading to a firmer grasp on artefacts' practicality as material for composing with.

While these artefacts might be considered side-effects, I have found them to be a fertile area for varied aesthetic qualities. Smooth sinusoidal timbres with internally dissonant microtonal relationships can be heard, sometimes analogous to howls or wails. Rapidly changing discrete pitched artefacts have the effect of creating animated shimmering textures. While at other times artefacts merge into one another creating an unbroken though unstable harmonically complex texture, which is rough, oscillating, and gestural.

I hope for this work to develop a deeper understanding of the creative potential of these sounds, while contributing to the tradition in electroacoustic music wherein the sounds of technological transformations are exploited for composing music.

2. Background and Related Work

Prior research into audio data compression provided a foundation for understanding encoding concepts and terminology. Studies outlined causes and characteristics of compression artefacts, supplied some taxonomies of artefacts, and described mitigation techniques.

The concepts and terminology discussed included sample rate, bitrate, and lossy and lossless format differences (Corbett 2012); windowing, window length, spectral analysis, and quantization (Iwai 1994); and the Nyquist theorem (Olshausen 2000). Papers often discussed the causes of artefacts (Erne 2001; Martinez 2007), while others provided taxonomies for compression artefacts (Artega 2016; Liu et al. 2008) giving descriptions of how they sound. Overall, however, research in this field has been concerned with developing novel techniques for mitigating compression artefacts such as birdies (Desrochers et al. 2015; Prakash et al. 2004), pre-echo (Iwai 1994; Samaali 2012), and aliasing (Princen 1986).

There are a number of artistic projects that have creatively engaged with MP3s, including *MP3 Deviation* by Yasunao Tone (Blake, et al. 2009) and *The Ghost in the MP3* by Ryan Maguire (Georgaki 2014). MP3 encoding errors were used by Tone to trigger sounds, and Maguire used audio that would normally be removed during MP3 encoding processes as the artistic focus. Additionally, Alberto Ricca's project *Most Beautiful Design* consisted of five musical works encoded as MP3s at a bitrate of 16 kbps creating intentional sonic artefacts and adding to the textures within the pieces (Ptwschool 2019). Though the record is only eleven minutes long, the project shows the potential for aesthetic exploration of MP3 artefacts.

3. Description of the Proposed Approach

3.1. Experiments

A series of experiments were conducted in which various colours of noise and transient signals were cascaded through an MP3 encoder. The use of violet, blue, white, pink, and red noise allowed for a better evaluation of how encoding variables react to various spectral characteristics, while transient signals showed how encoding can affect temporal and spatial characteristics.

3.2. Analysis

By encoding noise at bitrates of 8 and 16 kbps and sample rates of 8, 16, and 24 kHz, artefacts became more pronounced and easily perceivable. Using spectrograms to analyse artefacts led to a better understanding of their causes and characteristics, allowing me to recognise artefacts. Listening practices, such as spectromorphology (Smalley 1997), gave me a better ability to describe artefacts and then consider them within electroacoustic compositional processes.

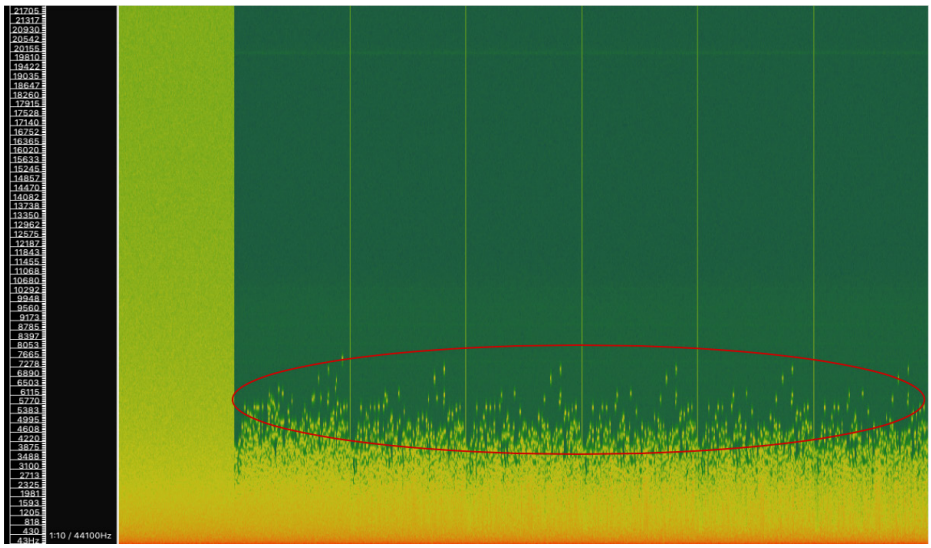

Fig. 1. Spectrogram of iterations of red noise encoded at a bitrate of 16 kbps and sample rate of 24 kHz creating the birdies artefact, which can be seen circled. https://vimeo.com/413614700.

3.3. Compositional Studies

Techniques developed by microsound composers Iannis Xenakis and Curtis Roads, which investigate sound densities and time scales in music, were used to explore the effectiveness of artefacts' aesthetics within arrangements. Encoded noise was cut up, arranged, and layered creating sound clusters and clouds (Solomos 2012), while time stretching artefacts gave a greater amount of time for the aesthetics of the artefacts to be voiced. Time stretching also allowed for the relationship between different sound object time scales to be considered (Roads 2001, 16–27). By pitch shifting artefacts, different sonic characteristics could be voiced more clearly, while the stereo field was explored in an attempt to create a sense of space and depth.

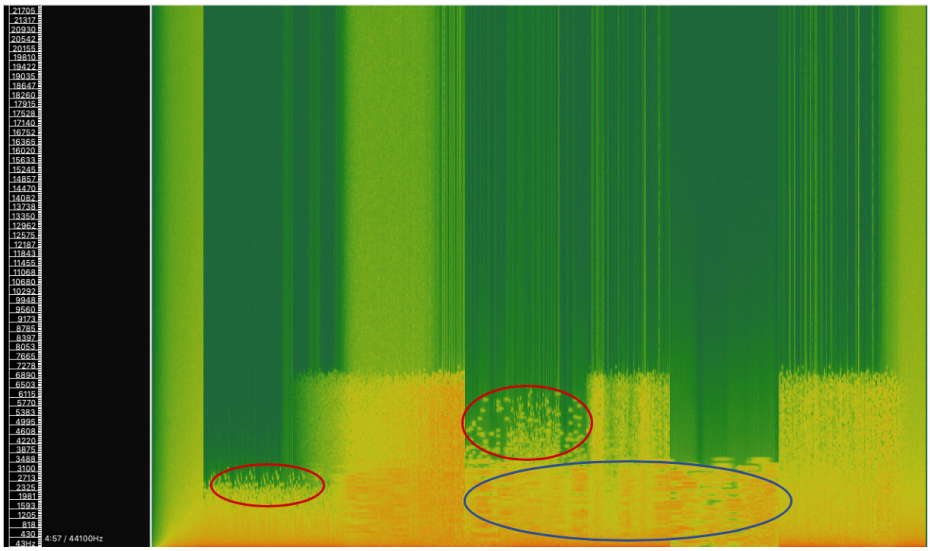

Fig. 2. Spectrogram of a composition using red and white noise at various bitrates and sample rates. Use of birdies for creating textures can be seen circled in red, while time stretched artefacts can also be seen circled in blue.
https://vimeo.com/413614970.

4. Expected Contributions

This research sits within the tradition of music composition which harnesses sounds that have been generated through technological transformations, from Luigi Russolo's "noise-sounds" (Umbro 2009, 75–76) to Kim Cascone's post-digital glitches (Cascone 2000). I hope for this research to contribute to this tradition, considering compression artefacts as creative material. A taxonomy of artefacts and musical works will be created, which will allow for a better understanding of the sonic effects of MP3 encoding, while also acting as a creative tool informing the application of artefacts for creating music.

5. Progress Towards Goals

The experiments, analyses, and compositions I have been producing over the past year have greatly informed my knowledge of MP3 artefacts' and their potential for creative use. While I have made a series of studies into frequency domain artefacts, finding new phenomena and alternative theories for artefacts' creation, there are still issues to be resolved including

greater investigation into time and spatial domains. The compositions and creative studies themselves are also ongoing, offering new insights into the creative potential of data compressed audio artefacts.

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