Rock Music: Granular and Stochastic Synthesis based on the Matanuska Glacier

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Abstract

Geological data from measurement of sediment granulation over a 24 hour period in a lake formed by the Matanuska Glacier in Alaska was applied to synthesis parameters. The parameters measured include time, grain size and grain frequency. Several mapping strategies were employed to generate different types of additive and granular synthesis sound materials: 1) time to event grouping, sediment grain size to grain duration, grain frequency to grain frequency, 2) time to time at the event level, grain size to grain frequency (in equal temperament or harmonic series systems), grain frequency to amplitude, 3) time to waveform, size to partial frequency and frequency to waveform amplitude, and 4) grain size vs. frequency to produce a waveform. The data was also applied to control parameters of the STK Toolkit physical modeling stochastic instrument Shakers, to create percussive sound events. Two compositions, "Matanuska Etude," and "Bathymetric Voyage" were composed from this sound material and a multimedia presentation from aerial photos was created.

1 Introduction

The sonification of data can be a research tool and aid to blind in perceiving aspects of natural processes. The study of geology, as with other earth sciences involves the analysis of data that occurs in unique and often repeating patterns. The mapping of geological data in musical form provides the geologist with the ability to compare data as a musician might compare musical phrases. In some situations aural representations may reveal more than more commonly used visual displays of information. With increased use of the sonification of scientific data, it may be possible to discern a deeper connection that is not obvious to the naked eye. The International Community for Auditory Display (http://www.icad.org/) is a focal point for activities in this area. Creating art from natural data can both reveal aspects of nature and inspire new approaches to composition based on physical phenomenae. The many examples of music based on nature include Beethoven's "Symphony No. 6" and Olivier Messiaen's "Oiseaux exotiques," which use orchestral imitations of bird calls. Larry Austin's 1981 radiophonic composition "Canadian Coastlines: Canonic Fractals for Musicians and Computer Band" contains mappings of coastal shape to pitch, textural and rhythmic aspects of the work. Charles Dodge used data from "Earth's Magnetic Field" as a sound source in his work of this name.

The goal of this project is to find ways to generate interesting sonic materials for musical composition from measurements taken of sedimentation in a glacial-formed lake in Alaska. The granularity of the sedimentation is correlation to granular synthesis parameters. The data is also applied to the parameters of Perry Cook and Gary Scavone's STK Toolkit physical model instrument Shakers, which generates stochastic sound events similar to the sounds of maracas, rattles and sleigh bells.

2 Glacial Sediment Data

Figure 1. Matanuska Glacier.

The Alaskan lake studied was created from melting water from the Matanuska Glacier. This ice-marginal lake now has an inlet from a meltwater-fed stream at the east and discharges at the west. Since the lake had recently switched drainage direction due to the collapse of an ice-cored moraine, the newly formed inlet provided the opportunity to study sediment storage in the lake. Hourly water samples were obtained over a 24-hour period from both the inflowing stream and the late outlet to determine the amount of sediment entering storage in the late and to examine the relationship between grain-size distribution of the suspended load and stream discharge. The suspended-sediment concentration of all samples increases with increasing discharge througout the diurnal cycle. The d10

Figure 2. Lake Map, aerial photograph showing north vent (upper left) inlet and outlet (lower left).

plot shows the frequency of the smallest 10% of grains increasing irregularly throughout the day of sediment measurement.

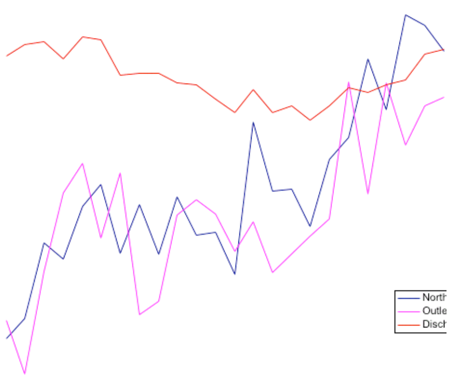

Figure 3. d10 Grain Sizes vs. Discharge (top) Chart.

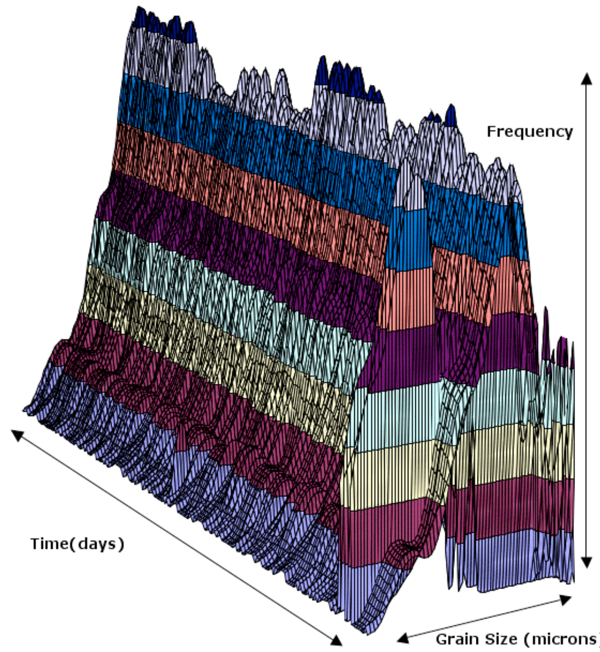

Figure 4. The grain size frequency became less consistent over the measured time period.

3 Mapping Strategies

The data has been mapped to additive, granular and physical modeling synthesis parameters. Decisions about how to map parameters were made on the basis of how closely the data structures for lake data resembled musical parameters for various algorithms (i.e. mapping grain size to grain duration), how aspects of the data could be simulated in sound (i.e. mapping a multiple instance data (grains) to multiple attack instrument), and were influenced by aesthetic considerations of what would make more interesting music (i.e. densities and instrument selection). Three levels of mappings occur: 1), micro-level generation of waveforms for additive and granular synthesis only, 2), event-level control of timings, frequency, and timbre, and 3), macro-level structural controls.

3.1 Wavetable and Additive Synthesis

Micro- and event-level correlations were made between sediment measurements and synthesis.

Wavetable Synthesis. The diurnal cycle of d10 grain frequencies was mirrored to produce the period of a waveform. This waveform produced a complex set of partials for drones. An elliptical filter was used to trace patterns related to discharge amounts through the drone's spectrum.

Additive Synthesis. Sediment grain frequency data was mapped to partial frequency, and grain size to duration. This simple mapping resulted in some interesting events with non-harmonic pitch relations. Then, sediment grain size was mapped to partial frequency and grain frequency was mapped to amplitude. This strategy produced long dense slowly changing events.

3.2 Granular Synthesis

Several strategies were used: 1) mapping sediment grain frequency to grain rate, and grain size to grain frequency, 2) mapping sediment grain frequency to grain frequency and grain size to grain duration, 3), using components of StochGran (Helmuth, 2002), generating events of grain distributions in which the perferred values for frequency were derived from sediment grain sizes and rates were derived from sediment grain frequencies, and variations on this method.

3.3 Shakers, a stochastic physical model

The Shakers synthesis physical model instrument in Perry Cook and Gary Scavone's Synthesis ToolKit (STK) creates stochastic sound like multiple-attack shaker instruments such as maracas. This instrument was chosen because the granularity of the source data is conceptually similar to a multiple-attack sound. Control parameters include number of objects, energy, resonance and decay, while the "instrument" parameter affects timbre and register most clearly. After trying a number of methods, the most interesting sounds came from mapping grain frequency to the number of objects, grain size to energy, with all 22 instruments playing at randomly varied time about 10 times per second. The gradual ascents and descents in energy and density created a complex pulsing texture.

3.4 Macro-level Structural Control

A short composition, "Matanuska Etude," was created from the lake data. The control of structural aspects of music involved mapping grain parameters to event density cycles both vertically and over time, for "sectional" change or, more accurately, gradual evolution from one state to another. The increasing frequency of larger grains found at the later measurements is mapped to a greater number of additive synthesis event layers and higher grain rates near the end of the Matanuska Etude. Increased number of objects and higher "energy" and resonance values in the Shakers' model sounds also occur at the end of this work.

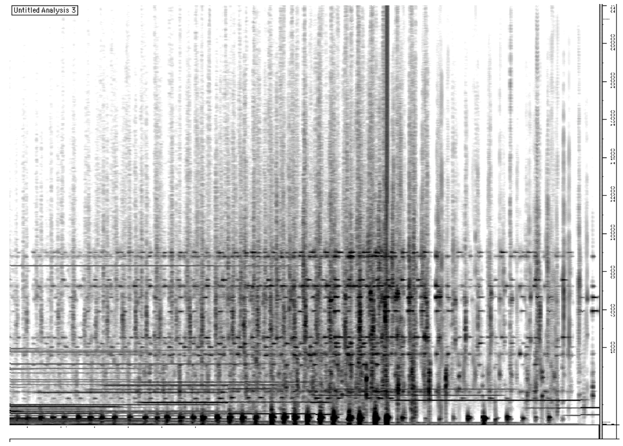

Figure 5. Sonogram of "Matanuska Etude" excerpt.

Sound examples are at the URL http://meowing.memh.uc.edu/~mara/mata.

3.5 Spatially Oriented Granular Synthesis

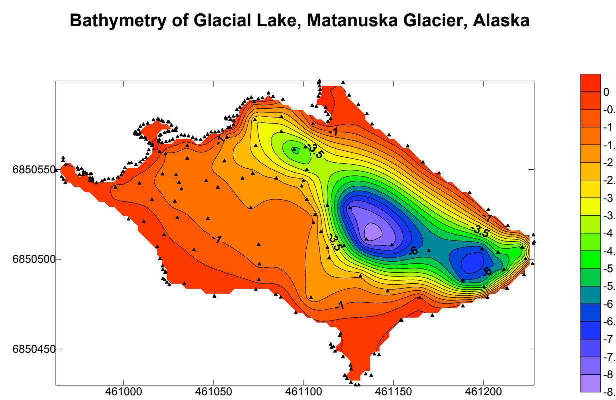

Figure 5. Bathymetry of Lake.

Random walks through GPS points with depth measurements, and through the lake grain data produced a more abstract mapping of spatially oriented data. Spatial data was mapped to location parameters in Douglas Scott's RTcmix room simulation instrument MOVE. The music produced in "Bathymetric Voyage" is based on the movement of grains in the lake based on a randomly produced GPS pattern.

3.6 Random Ride with Video

A final experiment was created by creating a short video based on a series of aerial photographs of the lake. This multimedia work uses previously described mapping techniques and is a combination of documentary and artistic work.

4 Summary

This interdisciplinary approach to musical composition has resulted in some promising results. Trends in the data are sometimes obviously reflected in the sounds generated, and the sounds seem likely to produce interesting material for music. Mapping of geological grain frequency and size to event level control seems to be most successful approach so far. Future work will include refinement of the mapping techniques and creating a longer work based on the geological data.

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