Busted Grooves
for three retuned, computer-driven pianos

by Kyle Gann
2017
Technical Specifications

The 33-pitch tuning of the three pianos (the same in every octave) is as follows, given first in the number of cents above E-flat, and then as ratios to the E-flat 1/1:

<table>
<thead>
<tr>
<th>Piano</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1088</td>
<td>977</td>
<td>1044</td>
</tr>
<tr>
<td>Db</td>
<td>969</td>
<td>938</td>
<td>906</td>
</tr>
<tr>
<td>C</td>
<td>857</td>
<td>773</td>
<td>840</td>
</tr>
<tr>
<td>B</td>
<td>738</td>
<td>755</td>
<td>729</td>
</tr>
<tr>
<td>Bb</td>
<td>702</td>
<td>590</td>
<td>609</td>
</tr>
<tr>
<td>A</td>
<td>551</td>
<td>551</td>
<td>481</td>
</tr>
<tr>
<td>Ab</td>
<td>471</td>
<td>440</td>
<td>408</td>
</tr>
<tr>
<td>G</td>
<td>386</td>
<td>320</td>
<td>342</td>
</tr>
<tr>
<td>Gb</td>
<td>204</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>F</td>
<td>155</td>
<td>192</td>
<td>192</td>
</tr>
<tr>
<td>E</td>
<td>92</td>
<td>53</td>
<td>27</td>
</tr>
<tr>
<td>Eb</td>
<td>0</td>
<td>1103</td>
<td>1173</td>
</tr>
</tbody>
</table>

Note that no string needs to be raised higher than its natural tuning except for the B-flat on piano 1, which is 2¢ sharp (or if one prefers, 2¢ could be subtracted from all quantities).

For electronic realization of the piece, it can prove helpful to reconfigure the tuning as a reference pitch in cycles per second for each piano, and ratios derived from that standard:

<table>
<thead>
<tr>
<th>Tuning pitch</th>
<th>38.891 cps</th>
<th>36.7641 cps</th>
<th>38.2833 cps</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>15/8</td>
<td>225/121</td>
<td>13/7</td>
</tr>
<tr>
<td>Db</td>
<td>7/4</td>
<td>20/11</td>
<td>12/7</td>
</tr>
<tr>
<td>C</td>
<td>105/64</td>
<td>200/121</td>
<td>104/63</td>
</tr>
<tr>
<td>B</td>
<td>49/32</td>
<td>18/11</td>
<td>65/42</td>
</tr>
<tr>
<td>Bb</td>
<td>3/2</td>
<td>180/121</td>
<td>13/9</td>
</tr>
<tr>
<td>A</td>
<td>11/8</td>
<td>16/11</td>
<td>169/126</td>
</tr>
<tr>
<td>Ab</td>
<td>21/16</td>
<td>15/11</td>
<td>9/7</td>
</tr>
<tr>
<td>G</td>
<td>5/4</td>
<td>14/11</td>
<td>26/21</td>
</tr>
<tr>
<td>F#</td>
<td>9/8</td>
<td>150/121</td>
<td>25/21</td>
</tr>
<tr>
<td>F</td>
<td>35/32</td>
<td>13/11</td>
<td>143/126</td>
</tr>
<tr>
<td>E</td>
<td>135/128</td>
<td>12/11</td>
<td>65/63</td>
</tr>
<tr>
<td>Eb</td>
<td>1/1</td>
<td>1/1</td>
<td>1/1</td>
</tr>
</tbody>
</table>
In the configuration of certain tuning softwares, the following sequences might facilitate getting the required tuning:

Piano 1:
38.891 = Eb0
1/1, 135/128, 35/32, 9/8, 5/4, 21/16, 11/8, 3/2, 49/32, 105/64, 7/4, 15/8

Piano 2:
36.7641485 = Eb0
1/1, 12/11, 13/11, 150/121, 14/11, 15/11, 16/11, 180/121, 18/11, 200/121, 20/11, 225/121

Piano 3:
38.283333 = Eb0
1/1, 65/63, 143/126, 25/21, 26/21, 9/7, 169/126, 13/9, 65/42, 104/63, 12/7, 13/7

For purposes of analysis, the entire scale (which I refer to as my 8x8 scale) is given below, grouping its pitches into eight harmonic series’ on the 1\textsuperscript{st}, 3\textsuperscript{rd}, 5\textsuperscript{th}, 7\textsuperscript{th}, 9\textsuperscript{th}, 11\textsuperscript{th}, 13\textsuperscript{th}, and 15\textsuperscript{th} harmonics of E-flat, and naming each pitch in a typographical equivalent of Ben Johnston’s just-intonation notation:
In Johnston's notation, + raises a pitch by \( \frac{81}{80} \), # raises it by \( \frac{25}{24} \), b lowers it by \( \frac{24}{25} \), 7 lowers it by \( \frac{35}{36} \), ^ raises it by \( \frac{33}{32} \), 13 raises it by \( \frac{65}{64} \), and F-A-C, C-E-G, and G-B-D are all perfectly tuned 4:5:6 major triads.
A couple of notes on listening to *Hyperchromatica*:

Some people think the piano sounds seem “funny” or “unreal.” It is essential to the timbre of a normal piano that the intervals are slightly out of tune, and surrounded by the fuzziness of the resulting beats. Remove that out-of-tuneness and the piano can sound different than you’re used to. It has always been common for me to play La Monte Young’s *The Well-Tuned Piano* for people and have them respond, “Isn’t that electronic?” “It sounds more like bells than a piano.” Often one’s unfamiliarity with pure tuning is misperceived as a deficiency in the piano sound. Relatedly, when I issued a disc of Disklavier music in 2005, people sometimes commented, “Too bad you couldn’t use a real piano, because the electronic sounds are off-putting.” In fact, the Disklavier *was* a real, acoustic piano, with pluckable strings. It was tuned to 18th-century well temperament, the notes went by very fast, and so the divergences from normalcy made people’s brains convince them that it was an electronic piano, which was a false perception. Give yourself some time to listen to the pieces over and over, and you’ll probably get used to them. I can guarantee, after hundreds of listenings myself, that the harmonies make their own purely-tuned sense, and that their logic sinks in once you can anticipate what’s going to happen. One of the purposes of these pieces is to expand your musical perception.

The Disklavier (computer-driven piano, the digital manifestation of the player piano) is a different medium than the human-played piano. One can, and must, write for it differently. With a couple of deliberate exceptions, these pieces are not playable by humans. The composer forbids performance by humans (which can’t happen anyway), and will not cooperate with any such attempt. The computer-driven version is the final manifestation, and the only one contemplated or permitted. These pieces were written, after years of profound thought and experimentation, specifically for the Disklavier medium, without any compromise in what the music was intended to achieve. If it bothers you that the music you are listening to isn’t being played by humans, there are millions of piano recordings made by humans; go listen to them. There is too much music in the world for anyone to waste time listening to any music wishing it were something other than what it is. This music is produced mechanically, for mechanical rhythmic capabilities that I savor. I make this music public on the chance that there might be a handful of other people on the planet for whom the possibilities opened up here in terms of rhythmic and harmonic language might more than compensate for the loss of a few habitual comforts. If you are not one of those rare people, you can do the composer a favor by moving on without comment. I guarantee you will not alter his mind on the matter.

- Kyle Gann
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Pno1

Pno2

Pno3

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Busted Grooves
Busted Grooves
50

Pno1

Pno2

77

Pno1

f  mp

Pno2

Pno3

Busted Grooves
Busted Grooves
Busted Grooves
Busted Grooves
Busted Grooves
Pno2

\[ \begin{align*}
Pno3
\end{align*} \]

\[ \begin{align*}
\text{Busted Grooves}
\end{align*} \]
Busted Grooves
Busted Grooves
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Busted Grooves
$O_n \approx \sum \frac{1}{n}$

*Busted Grooves*
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$d = 54$

\begin{music}
\begin{music_stave}
\begin{music_staff}
\begin{music_notes}
$\text{Pno1}$
\end{music_notes}
\end{music_staff}
\end{music_stave}
\begin{music_stave}
\begin{music_staff}
\begin{music_notes}
$\text{Pno2}$
\end{music_notes}
\end{music_staff}
\end{music_stave}
\begin{music_stave}
\begin{music_staff}
\begin{music_notes}
$\text{Pno3}$
\end{music_notes}
\end{music_staff}
\end{music_stave}
\end{music}

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April 24 - May 25, 2017
Germantown, NY

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