A new Audacity feature: room objective acoustical parameters calculation module

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Some reasons for a port:

- need for platform independent measuring tools
- need to go beyond the limits of a closed source main application
Acoustical Parameters

- is an independent module
- has a complex window → many functions can be reused for other modules
Main targets:

- Good listening for the audience.
- Good feedback for the speakers or the musicians.
Subjective vs. Objective

Listening is a subjective fact,

but

can be a project subjective?

A set of objective acoustical parameters is needed!
Subjective vs. Objective

Listening is a subjective fact,

but

can be a project subjective?

A set of objective acoustical parameters is needed!
Many acoustical parameters has been tested in the second half of 20th century.

⇓

An important set of them is collected in the ISO 3382 standard.
A Room Fingerprint: The Impulse Response
Reverberation Time

\[ T_{60} \]

Time needed by the sound pressure to decrease by 60 dB from a steady level.
Clarity And Definition Indexes

\[ C_{te}, \ D_{te} \]

They are logarithmic ratios between a fraction and the entire (or the remaining) IR energy.

\( t_e \) can be 50 ms or 80 ms: the first for speech, the latter for music.
Sound Strength

\[ G \]

It is a logarithmic ratio between the energy of the measured IR and a reference one.

It gives a measure of *how much* the environment increases (or decreases) the perceived loudness of a sound.
Spatial Indexes

\[ LF, LFC, LG, IACC \]

They give a listener surround capabilities measure of the room.

It is needed a more complex recording equipment:

- Omnidirectional + Figure-of-eigth microphones \((LF, LFC, LG)\).
- Binaural microphone \((IACC)\).
Stage Parameters

\[ ST_{\text{Early}}, \quad ST_{\text{Late}} \]

They are logarithmic ratios between early or late energy and the early one (first 100 ms) of the IR.

They are performer indexes
Aurora: A Multipurpose Plugin Suite

Aurora is a toolkit for Adobe Audition® written by Angelo Farina.

It includes:

- ISO 3382 Acoustical Parameters calculator
- toolset for measurements with MLS technique
- toolset for measurements with SineSweep technique
- various convolution tools
- Speech Transmission Index (STI) calculator
- ...
Since its first release *Aurora* is

- written in plain C code
- implemented as XFS *Cool Edit* plug-in
- available only on Windows platforms
Why a port?
ISO 3382 Acoustical Parameters
The Aurora suite
The Audacity implementation
In development

The Acoustical Parameters module window
Why Audacity?

- It is a multiplatform application
- It is a good quality software, with a growing set of features
- It is open-source
Why a port?
ISO 3382 Acoustical Parameters
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New Audacity Feature

The Porting Process

Some steps has ben followed:

- General code reordering
- Conversion from C to C++
- Conversion of GUI functions to wxWidgets ones
- Implementation as external Audacity library (thanks to Audacity developers group!)
Aurora For Audacity: Setup Window

- User Defined Reverberation Time Extremes:
  - Lower: 5.0 dB, Upper: 15.0 dB

- Enable Noise Correlation:
  - EDT without linear regression
  - Compute Stage Parameters (ST)
  - Average Mode instead of A-weight

- Direct Sound Trigger (dB below max):
  - 20.0 dB

- Peak SPL value corresponding to FS:
  - 120.0 dB

- Stereo Mode:
  - 2 Omnidirectional Microphones
  - Soundfield Microphone (NY)
  - Omni/Eight microphone - PU probe
  - P-P Sound Intensity Probe
    - d (mm): 12.0, c (m/s): 340.0
  - Binaural Dummy Head

- ICC Integration:
  - 0.80 ms (Early)

- Append Results to File:

- Cancel
- OK
Why a port?
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Aurora For Audacity: Main Window

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Aurora For Audacity: Graphbar

![Acoustical Parameters according to ISO 3382](image)

### Acoustical Parameters according to ISO 3382

<table>
<thead>
<tr>
<th>Channel</th>
<th>_signal</th>
<th>_freq (Hz)</th>
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</thead>
<tbody>
<tr>
<td>L</td>
<td>49.80</td>
<td>31.5</td>
</tr>
<tr>
<td></td>
<td>59.63</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>64.46</td>
<td>125</td>
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<td>74.45</td>
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<td></td>
<td>75.93</td>
<td>2k</td>
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<td></td>
<td>81.01</td>
<td>4k</td>
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<td></td>
<td>80.21</td>
<td>8k</td>
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<td>83.72</td>
<td>16k</td>
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<td></td>
<td>86.04</td>
<td>A</td>
</tr>
<tr>
<td>R</td>
<td>85.52</td>
<td>Ln</td>
</tr>
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<td></td>
<td>88.07</td>
<td>Noise (dB)</td>
</tr>
<tr>
<td></td>
<td>9.52</td>
<td>G (dB)</td>
</tr>
<tr>
<td></td>
<td>1.91</td>
<td>C50 (dB)</td>
</tr>
<tr>
<td></td>
<td>2.68</td>
<td>C50 (dB)</td>
</tr>
<tr>
<td></td>
<td>64.96</td>
<td>D50 (%)</td>
</tr>
<tr>
<td></td>
<td>88.66</td>
<td>T1 (ms)</td>
</tr>
<tr>
<td></td>
<td>2.25</td>
<td>EDT (s)</td>
</tr>
<tr>
<td></td>
<td>3.37</td>
<td>T2 (s)</td>
</tr>
<tr>
<td></td>
<td>3.37</td>
<td>T2 (s)</td>
</tr>
<tr>
<td></td>
<td>3.37</td>
<td>T3 (s)</td>
</tr>
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<td>4.07</td>
<td>Peakiness [dB]</td>
</tr>
<tr>
<td></td>
<td>41.51</td>
<td>M1000 [dB]</td>
</tr>
<tr>
<td></td>
<td>32.38</td>
<td>M1000 [dB]</td>
</tr>
<tr>
<td></td>
<td>20.32</td>
<td>Impulsive [dB]</td>
</tr>
</tbody>
</table>
A confrontation has been made with two commercial software:

- Brüel & Kjær *Dirac* version 3.0
- Morset Sound Development *WinMLS 2004* version 1.07
Comparison Of Results - $T_{20}$ @ 250 Hz

<table>
<thead>
<tr>
<th></th>
<th>Acoust. Param.</th>
<th>B&amp;K Dirac 3.0</th>
<th>WinMLS 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDT</td>
<td>$[s]$</td>
<td>4.82</td>
<td>4.76</td>
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<td>$T_{20}$</td>
<td>$[s]$</td>
<td>5.02</td>
<td>5.01</td>
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<td>$T_{30}$</td>
<td>$[s]$</td>
<td>4.98</td>
<td>4.96</td>
</tr>
<tr>
<td>$C_{80}$</td>
<td>$[dB]$</td>
<td>-4.40</td>
<td>-4.24</td>
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<tr>
<td>$D_{50}$</td>
<td>$[-]$</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>$ST_E$</td>
<td>$[dB]$</td>
<td>3.26</td>
<td>4.05</td>
</tr>
<tr>
<td>$ST_L$</td>
<td>$[dB]$</td>
<td>8.70</td>
<td>9.63</td>
</tr>
<tr>
<td>$IACC_E$</td>
<td>$[-]$</td>
<td>0.34</td>
<td>-</td>
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</table>
### Comparison Of Results - $T_{20}$ @ 1 kHz

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$EDT$ [s]</td>
<td>4.44</td>
<td>4.41</td>
<td>4.38</td>
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<td>$T_{20}$ [s]</td>
<td>4.10</td>
<td>4.10</td>
<td>4.11</td>
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<td>$T_{30}$ [s]</td>
<td>4.20</td>
<td>4.19</td>
<td>4.22</td>
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<tr>
<td>$C_{80}$ [dB]</td>
<td>-2.55</td>
<td>-2.65</td>
<td>-2.8</td>
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<tr>
<td>$D_{50}$ [-]</td>
<td>0.30</td>
<td>0.30</td>
<td>0.29</td>
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<tr>
<td>$ST_{E}$ [dB]</td>
<td>0.58</td>
<td>0.75</td>
<td>-</td>
</tr>
<tr>
<td>$ST_{L}$ [dB]</td>
<td>5.95</td>
<td>6.32</td>
<td>-</td>
</tr>
<tr>
<td>$IACC_{E}$ [-]</td>
<td>0.38</td>
<td>-</td>
<td>0.40</td>
</tr>
</tbody>
</table>
### Comparison Of Results - $T_{20}$ @ 4 kHz

<table>
<thead>
<tr>
<th></th>
<th>Acoust. Param.</th>
<th>B&amp;K Dirac 3.0</th>
<th>WinMLS 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>$EDT$ [s]</td>
<td>2.18</td>
<td>2.18</td>
<td>2.08</td>
</tr>
<tr>
<td>$T_{20}$ [s]</td>
<td>2.22</td>
<td>2.23</td>
<td>2.23</td>
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<tr>
<td>$T_{30}$ [s]</td>
<td>2.25</td>
<td>2.26</td>
<td>2.27</td>
</tr>
<tr>
<td>$C_{80}$ [dB]</td>
<td>2.93</td>
<td>2.93</td>
<td>2.6</td>
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<td>$D_{50}$ [-]</td>
<td>0.60</td>
<td>0.60</td>
<td>0.59</td>
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<tr>
<td>$ST_E$ [dB]</td>
<td>-2.60</td>
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<td>-</td>
</tr>
<tr>
<td>$ST_L$ [dB]</td>
<td>-1.96</td>
<td>-1.91</td>
<td>-</td>
</tr>
<tr>
<td>$IACC_E$ [-]</td>
<td>0.61</td>
<td>-</td>
<td>0.61</td>
</tr>
</tbody>
</table>

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New Audacity Feature
Other Plugins Are Waiting...

Our goal is a complete *multiplatform* acoustical measurements toolset.

or, in other words,

The conversion of the entire Aurora suite.