Tuning The Stopper Equal Temperament With The Tunic PDA Software

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A new aural tuning method was proposed by using a duodecime tuning tool to achieve an equal tempered tuning based on aural pure duodecimes (the interval that spans an octave and a fifth): Stopperstimmung\(^1\). Pleasant sounding instruments and consistent slightly stretched octaves were achieved in a systematic way.

Here we show how to tune this tuning with the new TUNIC OnlyPure software.

I. THEORETICAL BACKGROUND: THE FIFTH CIRCLE PROBLEM

As we know, twelve fifths do not fit with seven octaves. This difference is known as pythagorean comma. The fifth circle can simply be expressed as: (p for the pythagorean comma)

\[
\left(\frac{3}{2}\right)^{12} = \left(\frac{2}{1}\right)^{7} p
\]

In historic tunings including standard equal temperament, the pythagorean comma is split in various ways on the side of the fifths, keeping all octaves on the other side pure. Diverse linear temperaments based on other intervals than pure octaves were proposed by composers. Real world instrument implementations considering nonlinearities (inharmonicity) by the relative harmonics matching process inherent in aural tuning followed, like the Cordier\(^2\) temperament (pure fifths) or Stopperstimmung\(^3\) (pure duodecimes). Also tuning evolution, at least among the best aural concert tuners, developed towards an amount of octave stretch, that can not be explained by inharmonicity alone within the standard equal temperament.

1. The natural fifth circle form

We can express the fifth circle in a different form by dividing out the fifths in its base parts octave(2) and duodecime(3):

\[
\frac{3^{12}}{2^{12}} = 2^7 p
\]

sorting the octaves yields:

\[
3^{12} = 2^{19} p
\]

This is the natural form of the fifths circle that describes a 12 duodecimes - 19 octaves circle, which relates to the harmonic series structure, while the standard fifth-circle form does not. The standard fifth circle form can not be found in the harmonics spectrum, there is a gap of an octave between the fifths present in the harmonics. The standard fifth circle form is therefore a kind of music-functional artifact. It is important to make a distinction between the two forms, because for equal temperament solutions the standard form suggests to split the pythagorean comma either in 12 parts on the fifths side (standard equal temperament) or in seven parts on the octaves side of the equation (Cordier temperament).

In Stopperstimmung the pythagorean comma is left on the octaves side of the equation (as is in Cordier), but divided into 19 parts which are then added to the 19 octaves. The factor starting from pitch equals the 19th root of 3 (instead of 12th root of 2 for standard equal temperament), and is slightly growing from note to note due to nonlinearity present in real world instruments.

2. Why taking exactly pure duodecimes?

- The answer to the question why not take any other equal temperament between pure octaves and pure fifths is given by the recent discovery of the inherent beat symmetries that only occur when the duodecimes are in tune, eliminating beats and therefore producing improved clarity and resonance, as with pure tuned intervals.

This explains also why tuning evolution has developed toward that said octave stretch, that cannot be explained by inharmonicity alone. Many professional tuners are using Stopperstimmung now, due the pleasant results this tuning provides and the straightforward way how consistent slightly stretched octaves can be achieved by this method.

3. How to set up Stopperstimmung aurally

One starts with tuning a pure duodecime starting from pitch with the duodecime tuning tool and building up an equal temperament that fits into the starting duodecime interval.

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Stopperstimmung duodecime tuning tool

The duodecime tool is then further used to tune all duodecime intervals outside the temperament, along with counterchecks for smooth progression of other useful intervals. Another enhanced aural method based on the use of the beat symmetry is the OnlyPure method, where the canceling effects are explicitly used to set up the temperament and tuning. (The aural methods are not discussed in detail in this paper)

II. TUNING WITH THE TUNIC ONLYPURE SOFTWARE

Tuning with an electronic tuning device is more and more asked by tuners today, to care from stress. The TUNIC OnlyPure software is a native Stopperstimmung software implementation and to keep its usage as simple as possible, with nothing but this tuning. The software manages necessary stretch due to nonlinearity completely automatic. The software measures effective pitch at high precision in quasi real time also in noisy environments.

No presampling of individual notes and setup of stretch curve is required prior to the tuning process: Just turn on the PDA, choose the required pitch for A4 and start tuning.

4. The coarse and fine tuning display

An eye friendly display for setting the correct pitch is given with the left and right moving triangles. The yellow triangles are showing pitch readings in a range of +/- 40 cents and the green triangles in a range of +/- 4 cents in a resolution down to a hundredth of cent. Tune the strings that way, that the triangles are overlayed and form a square finally.

Notes can be selected manually in note or octave steps, or with the autoswitch to the next note.

5. Tuning different instruments together

As the software can deal with nonlinearities, you can tune instruments with very different inharmonicity lines together with more than acceptable results.

6. Unison tuning

Especially in noisy environments it is preferably to tune unisons string by string with the software, they will be more precise than aurally there, whereas a skilled aural tuner may prefer tuning one string with the software and the other strings by ear.

7. System requirements

The software is actually available for Pocket PCs with a 400+ MHz processor and running one of the following operating systems:
Windows mobile 2003 SE
Windows mobile 5 or 6

You can choose between a QVGA resolution (320x240) version for standard PDAs or a native VGA version (640x480) for VGA PDAs.

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2 S. Cordier, Piano bien tempere et justesse orchestrale.