New tonalities with the Thummer and The Viking

Conference or Workshop Item

New Tonalities with the *Thummer* and *The Viking*

Andrew Milne
University of Jyväskylä
Department of Music, P.O. Box 35
40014 Jyvaskyla, Finland
anjomiln@cc.jyu.fi

Anthony Prechtl
University of Jyväskylä
Department of Music, P.O. Box 35
40014 Jyvaskyla, Finland
aprechtl@gmail.com

ABSTRACT
In this paper we explain the theoretical background of Dynamic Tonality using the *Thummer*, a new musical interface, and *The Viking*, a software synthesizer written especially for it. *Dynamic Tonality* is a musical audio routine that allows for novel tunings and enables the user to relate – to an arbitrary degree – these tunings with the partials of their notes. *The Viking* features Dynamic Tonality and works with any MIDI instrument, but when paired with the *Thummer* (or another two-dimensional interface) it creates a system of fingering invariance across chords and tunings. Thus, the *Thummer* and *The Viking* render non-standard tunings more physically, pedagogically, and aesthetically accessible.

Author Keywords
Thummer, *The Viking*, Dynamic Tonality, fingering invariance, microtonality.

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User interfaces.

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INTRODUCTION
The *Thummer* is a new MIDI instrument currently being developed by Thumtronics, Inc. in Austin, Texas [10]. Its name reflects a set of thumb-specific buttons and joysticks designed to manipulate a variety of user-assignable parameters. Note selection is performed via two button lattices (see Figure 1), where the user finds – when in standard tuning – the flats on the left, the sharps on the right, and the diatonic notes in the middle. This layout can be regarded as two-dimensional in that its buttons are arrayed on both horizontal and vertical axes.

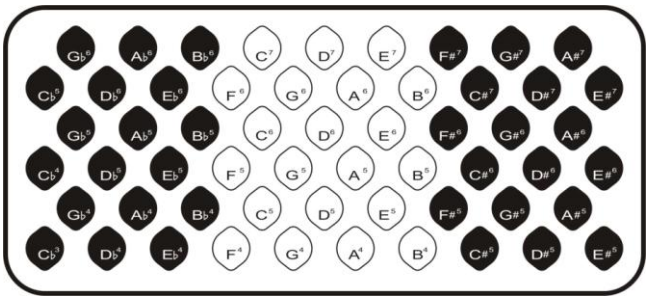

Figure 1. The *Thummer*'s button lattice.

In order to fully reap the benefits of a two-dimensional layout, we introduce *The Viking*, a software synthesizer designed to interpret both one- *and* two-dimensional MIDI interfaces. This paper will focus on that part of *The Viking*, namely Dynamic Tonality, which utilizes two-dimensionality to allow for – and provoke the exploration of – new tonalities.

DYNAMIC TONALITY
Dynamic Tonality uses a small number of parameters that enable the user to:

- Choose between a number of different tuning continua, each of which allow both conventional and novel scales.
- Freely move between a number of equal temperaments, non-equal temperaments, circulating temperaments, and closely-related just intonations.
- Use the same fingering pattern for all tonal intervals across all possible keys and tunings (when they are played on any musical controller that has a two-dimensional lattice of buttons or keys) [3].
- Freely move the timbre from being perfectly harmonic to perfectly optimized to the tuning.

Tuning Continua
A *tuning continuum* is a range of tunings over which all possible melodies built from harmonic consonances, and the voice-leading intervals between them, have the same contour [4]. Musically useful continua can be generated using only two intervals of variable size (such as a perfect fifth and an octave, which generate the familiar pentatonic, diatonic, and chromatic scales) [11,1].

Continua generated from quite different intervals result in radically different scale structures [2]; *The Viking* implements two non-standard continua: "Magic", which is generated by a variable major third and octave, and "Hanson", which is generated by a variable minor third and octave. Both of these continua produce scales that are relatively unfamiliar, but which still feature numerous well-tuned major and minor triads.

Dynamic Tuning

In a musical scale generated by a perfect fifth and an octave, varying the size of the fifth produces a wide range of useful tunings. For example, string and aerophone players often prefer Pythagorean tuning for expressive melodies, and ¼-comma meantone for sustained chords [8]. There are also numerous "non-standard" tunings used in non-Western music such as the 5-TET of Indonesian Slendro [9] and the 7-TET of traditional Thai music [5].

When playing *The Viking* with a *Thummer*, the size of the perfect fifth can be controlled simply by moving one of the thumb controllers. This enables *Thummer* players to easily mimic the intonation devices used by string and aerophone players, and to easily move between different tunings throughout a performance.

Fingering Invariance

Perhaps one of the most important aspects of Dynamic Tonality is that it allows for fingering invariance. On any musical controller with keys or buttons, intervals are played by a specific set of buttons that outline a geometric shape. However, on one-dimensional interfaces like the piano keyboard, a given interval often requires different shapes. For example, D–F# and F–A are each major thirds, but form different shapes on a piano keyboard. Contrarily, on a *Thummer*, all major thirds are exactly the same shape; in fact, all intervals on the *Thummer* require only one fingering. Similarly, piano keyboards require multiple fingerings across a tuning continuum, while *Thummers* only require one fingering. This property of invariance across tunings and keys is called *fingering invariance* [3].

With fingering invariance, musicians need only learn the fingering of a given interval or chord once, and thereafter apply that shape to all occurrences of that interval or chord, independent of its location within a key, across keys, or across tunings. This reduces rote memorization considerably and engages the student's visual and tactile senses in discerning the consistency of musical patterns. Though it has not yet been empirically tested, we expect that fingering invariance will be of benefit for both beginners and experts; hopefully of sufficient advantage to mitigate the initial effort required to learn a new interface.

Dynamic Timbre

As described above, scales and tunings can vary significantly throughout a tuning continuum, and even more significantly between different tuning continua. With fingering invariance, these scales and tunings can even be easy to play and learn. However, we have not yet addressed the aesthetic significance of Dynamic Tonality. There are many reasons why 12-TET is the standard, so why bother with non-standard tunings?

There is strong evidence that an instrument's timbre determines the tunings it plays in best, and that by taking the reverse approach each tuning also has *related* timbres that sound most consonant [7]. Most non-standard tunings have no access to a related timbre, due to the limitations of acoustic instruments. Dynamic Tonality addresses this issue by adjusting the timbre to match the current tuning specified by user. More precisely, it allows the user to specify to what degree the *partials* (also known as *overtones* or *harmonics*) should match the tuning. To date, this feature has been almost entirely unexplored in music and research, but we have found – and will demonstrate – that using a related timbre greatly mitigates the dissonance of non-standard tunings.

SYNTHESIS WITH *THE VIKING*

With regard to the many synthesis methods available today, Dynamic Tonality really only has one requirement: the frequency of each partial must be adjustable in real-time. *The Viking* uses additive synthesis, which generates each partial with its own sinusoidal oscillator. Frequencies are determined automatically by Dynamic Tonality parameters, while amplitudes are determined automatically by a traditional waveform selector and further modified by familiar subtractive synthesis filters and envelopes. *The Viking*, therefore, enables sounds similar to those produced by the "classic" subtractive synthesizers (e.g., Moog, ARP) to be adjusted spectrally.

The Viking was written in Outsim's *Synthmaker* [6]. It works with any MIDI interface, and is available for Windows as a VSTi at www.dynamictonality.com. A version for Mac OS X may be forthcoming in the near future.

CONCLUSION

In order to reap the many benefits of two-dimensional musical interfaces, there is a need for a computational routine that can understand both dimensions in a meaningful manner. Dynamic Tonality does this by interpreting two-dimensionality as a logical tuning mechanism that is both flexible and easy to learn. Moreover, in order to make alternate tunings more aesthetically accessible, it also enables the relation of timbre and tuning with a simple and intuitive interface. We hope that each of these offerings will eventually motivate a new exploration of tonality.

As mentioned previously, *The Viking* is an additive synthesizer; however, there are other synthesis methods capable of employing Dynamic Tonality. The forthcoming *TransFormSynth* uses analysis-resynthesis to allow both pre-recorded and live sound to be manipulated per the parameters described above. Information on all Dynamic

Tonality synthesizers as well as information on how to implement Dynamic Tonality in your own software can be found at www.dynamictonality.com.

REFERENCES

1. Carey, N., and Clampitt, D. Aspects of well-formed scales, *Music Theory Spectrum 11* (1989), 187-206.
2. Erlich, P. A middle path between just intonation and the equal temperaments, part 1, *Xenharmonikon 18* (2006), 159-199.
3. Milne, A., Sethares, W. A., and Plamondon, J. Isomorphic controllers and dynamic tuning: Invariant fingering over a tuning continuum. *Computer Music Journal 31*, 4 (2007), 15-32.
4. Milne, A., Sethares, W. A., and Plamondon, J. Tuning continua and keyboard layouts. *Journal of Mathematics and Music 2*, 1 (2008), 1-19.
5. Morton, D. The Music of Thailand. In May, E., ed. *Music of Many Cultures.* University of California Press, Berkeley, California (1980) 63-82.
6. Outsim Ltd. http://synthmaker.co.uk/.
7. Sethares, W. A. *Tuning, Timbre, Spectrum, Scale, 2nd ed.* Springer-Verlag, London, 2004.
8. Sundberg, J., Friberg, A., and Frydén, L. Rules for automated performance of ensemble music. *Contemporary Music Review 3*, 1 (1989), 89-109.
9. Surjodiningrat, W., Sudarjana, P. J., and Susanto, A. *Tone Measurements of Outstanding Javanese Gamelan in Yogyakarta and Surakarta.* Gadjah Mada University Press, Yogyakarta, Indonesia, 1993.
10. Thumtronics Ltd., *Thumtronics: The new shape of music*. http://www.thummer.com.
11. Wilson, E. Letter to John Chalmers pertaining to moments of symmetry/Tanabe cycle (1975). http://www.anaphoria.com/mos.PDF