Isomorphic keyboard

An **isomorphic keyboard** is a musical input device consisting of a two-dimensional grid of note-controlling elements (such as buttons or keys) on which any given sequence and/or combination of musical intervals has the "same shape" on the keyboard wherever it occurs – within a key, across keys, across octaves, and across tunings.

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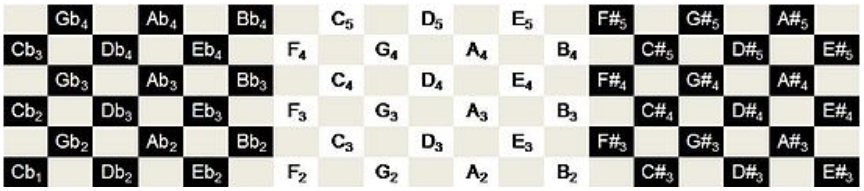

Fig. 1: The Wicki isomorphic keyboard note-layout, invented by Kaspar Wicki in 1896.

Examples

Helmholtz's 1863 book *On the Sensations of Tone* gave several possible layouts. Practical isomorphic keyboards were developed by Bosanquet (1875), Janko (1882), Wicki (1896), Fokker (1951), Erv Wilson (1975–present), Wesley (2001) https://patents.google.com/patent/US6501011B2/en and Antonio Fernández (2009).[1] Accordions have been built since the 19th century using various isomorphic keyboards, typically with dimensions of semitones and tones. The keyboards of Bosanquet and Erv Wilson are also known as generalized keyboards. The keyboard of Antonio Fernández is also known as Transclado. The Ragzpole is a recently developed cylindrical MIDI controller having dimensions in fifths and major thirds. The Harpejji, while not strictly a keyboard, uses an isomorphic pattern of frets and tapped strings. It has been adopted by many keyboard players, most notably Stevie Wonder.

Invariance

Isomorphic keyboards can expose, through their geometry, two invariant properties of music theory:

1. transpositional invariance,[2] exposed in all isomorphic layouts by definition. Any given sequence and/or combination of musical intervals has the same shape when transposed to another key, and
2. **tuning invariance**,[3] only exposed in certain layouts like Wicki and Bosanquet. Any given sequence and/or combination of musical intervals has the same shape when played in another tuning of the same musical temperament.

Theory

All isomorphic keyboards derive their invariance from their relationship to rank-2 regular temperaments of just intonation. A two-dimensional lattice is generated by two basis vectors. A keyboard lattice generated by two given musical intervals, which are mapped to those basis vectors, is isomorphic with any rank-2 temperament that is also generated by those same two intervals. For example, an isomorphic keyboard generated by the octave and tempered perfect fifth will be isomorphic with both the syntonic and schismatic temperaments, which are both generated by those same two intervals.

Benefits

Two primary benefits are claimed by the inventors and enthusiasts of isomorphic keyboards:

1. Ease of teaching, learning, and playing

   According to some authors,[4][5][6][7] the invariance of isomorphic keyboards facilitates music education and performance. This claim has not been rigorously tested, so its validity has been neither proven nor disproven.

2. Microtonality

    Isomorphic keyboards' provision of more than the usual 12 note-controlling elements per octave may facilitate the performance of music that requires more than 12 notes per octave.

A third potential benefit of isomorphic keyboards, dynamic tonality, has recently been demonstrated, but its utility is not proven. Using a continuous controller, a performer can vary the tuning of all notes in real time, while retaining invariant fingering on an isomorphic keyboard. Dynamic tonality has the potential to enable new real-time tonal effects such as polyphonic tuning bends, new chord progressions, and temperament modulations, but the musical utility of these new effects has not been demonstrated.

Comparisons

Isomorphic keyboards can be compared and contrasted using metrics such as the thickness of an octave's *swathe* of buttons on the keyboard and the number of *repetitions* of a given note on the keyboard. Different isomorphic keyboards are suited for different uses; for example, the Fokker keyboard is well-suited to tunings of the syntonic temperament in which the tempered perfect fifth stays in a narrow range around 700 cents, whereas the Wicki keyboard is useful over both this and a much broader range of tunings.[8]

See also

- Array mbira
- Chromatic button accordion
- Harpejji
- Wicki-Hayden note layout
- Dodeka Keyboard Design

References

1. http://www.upm.es/observatorio/vi/index.jsp?pageac=patente.jsp&idPatente=449
2. Keislar, D., *History and Principles of Microtonal Keyboard Design* (http://ccrma.stanford.edu/STANM/stanms/stanm45/stanm45.pdf), Report No. STAN-M-45, Center for Computer Research in Music and Acoustics, Stanford University, April 1988.
3. Milne, A., Sethares, W.A. and Plamondon, J., Invariant Fingerings Across a Tuning Continuum (http://www.mitpressjournals.org/doi/pdf/10.1162/comj.2007.31.4.15), *Computer Music Journal*, Winter 2007, Vol. 31, No. 4, Pages 15-32.
4. ThumMusic System. (http://www.thummer.com/blog/2007/09/thummusic-system.html)
5. Wholetone Revolution. (http://chroma.jp/main.jsp) Archived (https://web.archive.org/web/20080605080934/http://chroma.jp/main.jsp) 2008-06-05 at the Wayback Machine
6. C-Thru Music. (http://www.c-thru-music.com/cgi/?page=layout)
7. The Shape of Music. (http://www.theshapeofmusic.com/note-pattern.php) Archived (https://web.archive.org/web/20120219085411/http://www.theshapeofmusic.com/note-pattern.php) 2012-02-19 at the Wayback Machine
8. Milne, A., Sethares, W.A. and Plamondon, J., Tuning Continua and Keyboard Layouts (http://sethares.engr.wisc.edu/paperspdf/tuningcontinua.pdf), *Journal of Mathematics and Music*, Spring 2008.

External links

- Balanced Keyboard (http://www.balanced-keyboard.com) A modified symmetrical layout of the standard keyboard. The website shows how to build your own.
- Generalized Keyboard (http://anaphoria.com/wilsonkeyboard.html) papers of Erv Wilson
- Demo (https://www.youtube.com/watch?v=cK4REjqGc9w), Demonstration of the advantages of the isomorphic keyboard (Janko version) by Paul Vandervoort, considered to be the world's foremost player of the device. Program: "Kitten on the Keys" by Zez Confrey; explanation of the Janko note arrangement and advantages over a standard keyboard; demonstration of musical passages which are difficult or impossible to play on a standard keyboard; "C#-Major Prelude" from the Well-Tempered Clavier by J.S. Bach; Boogie-woogie rendition of "Bye Bye Blackbird".
- Isomorphic Instruments (http://musicnotation.org/wiki/instruments/isomorphic-instruments/) at The Music Notation Project Wiki (http://musicnotation.org/)
- Dodeka Keyboard (https://www.dodekamusic.com/dodeka-innovative-musical-instruments/) Another example of an isomorphic keyboard layout developed by Dodeka.

- クロマトーン　Inspiration 9:59 #1/11 (https://www.youtube.com/watch?v=e68ew3lKUuM) played on the Chromatone (kuromatōn / クロマトーン), a Janko-like isomorphic keyboard. The first in a series of 10 such "Chromatone Inspiration" videos.
  - MUTO Notation (http://musicnotation.org/system/muto-notation-by-muto-foundation/)

Software

- Relayer (http://www.dynamictonality.com/relayer.htm) – a free application for Windows and Mac that enables musicians who play the AXiS-49, the QWERTY computer keyboard, or the Thummer, to play in a wide variety of isomorphic note layouts and tunings using either a Dynamic Tonality synth or a standard multitimbral synth.
- Hex (http://www.dynamictonality.com/hex.htm) – a free software MIDI sequencer, which uses a generalized keyboard in place of the standard piano keyboard. Lanes are extended from the keys and MIDI notes can be drawn into each lane, and edited, with the mouse (as in a standard MIDI sequencer like Logic, Reaper, SONAR, etc.). The layout can be sheared to ensure that the vertical height of each key (and note lane) is proportional to its pitch height—regardless of the tuning used. A wide variety of isomorphic layouts are possible, including Bosanquet and Wicki.[1]
- Musix (http://www.shiverware.com/musix.html) – iPhone and iPad app. Musix is a fully customizable multiple-layout isomorphic musical keyboard.
- IsoKeys (http://www.tuningbell.com/isokeys) – Android app. IsoKeys is a free customizable isomorphic musical keyboard that supports several popular layouts.
- Hexiano (https://play.google.com/store/apps/details?id=org.gitorious.jamesjrh.isokeys) – Android app. Hexiano is a free and open-source (https://web.archive.org/web/20131219141020/https://gitorious.org/hexiano) customizable isomorphic musical keyboard that supports several popular layouts.
- Navichord (https://itunes.apple.com/us/app/navichord-harmony-explorer/id916452748?mt=8) – iPad app. Uses isomorphic keyboard for chords and piano keyboard for melody creation.
- Qwertonic (https://web.archive.org/web/20160701104940/http://www.qwertonic.com/) – free UK site containing Java, Flash, and PC applications to enable users to play their alpha-numeric keyboard to sound 12 equal tempered pitches using Wicki/Janko layout.
- Xenharmonic Keyboard (https://www.microsoft.com/en-us/store/p/xenharmonic-keyboard/9ppbl2brsk6z?rtc=1) - Windows 10 app. Xenharmonic Keyboard is an isomorphic microtonal MIDI keyboard. It supports all possible regular two dimensional isomorphic keyboards with any shaped key. It also supports any regular musical temperament.
- Dodeka Music (https://www.dodekamusic.com/dodeka-music-app/) - iPad app. Dodeka Music is a free mobile application that allows users to play several songs on Dodeka's linear keyboard layout.
- Terpstra Keyboard (https://keyboard.snelgrove.science) - Web and mobile app. Virtual Terpstra Keyboard is a free and open-source application that supports a large selection of keyboard layouts, configurable micro-tonal scales, QWERTY keyboard and touch screen integration.

1. Prechtl, A., Milne, A. J., Holland, S., Laney, R., and Sharp, D. B. (2012). A MIDI sequencer that widens access to the compositional possibilities of novel tunings (https://www.academia.edu/963729/A_MIDI_sequencer_that_widens_access_to_the_compositional_possibilities_of_novel_tunings). Computer Music Journal, 36(1):42–54.
