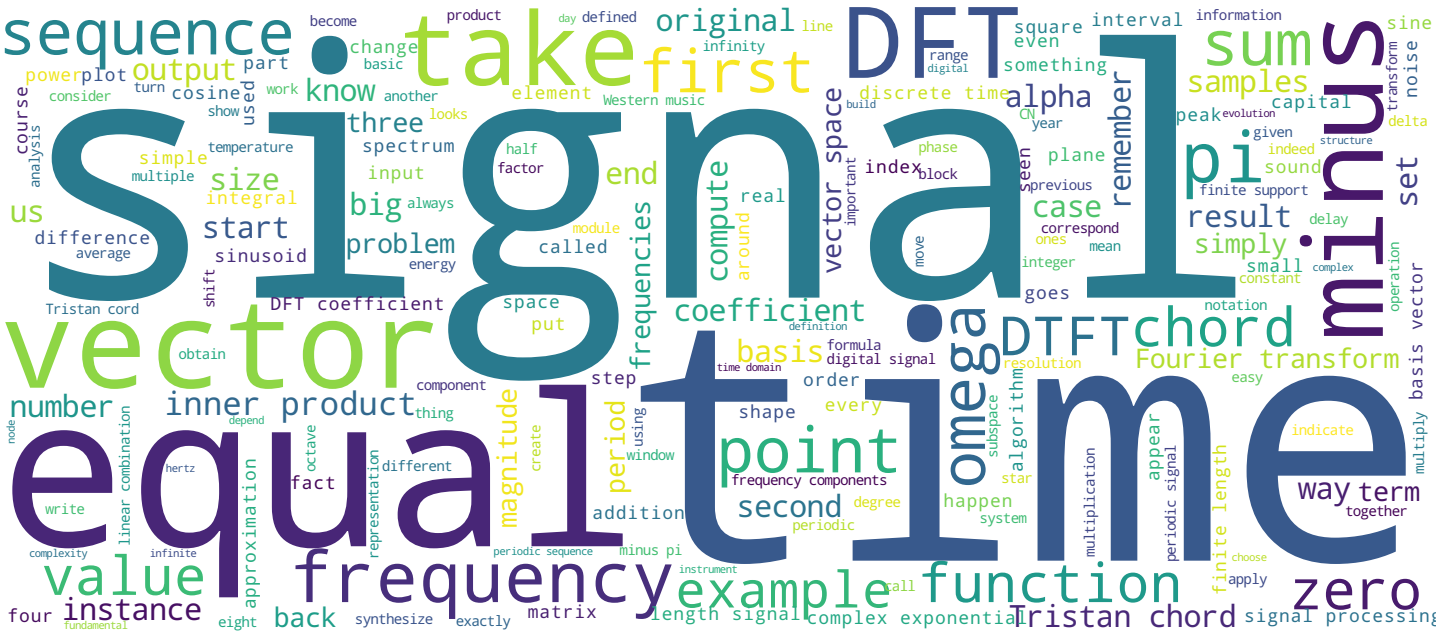
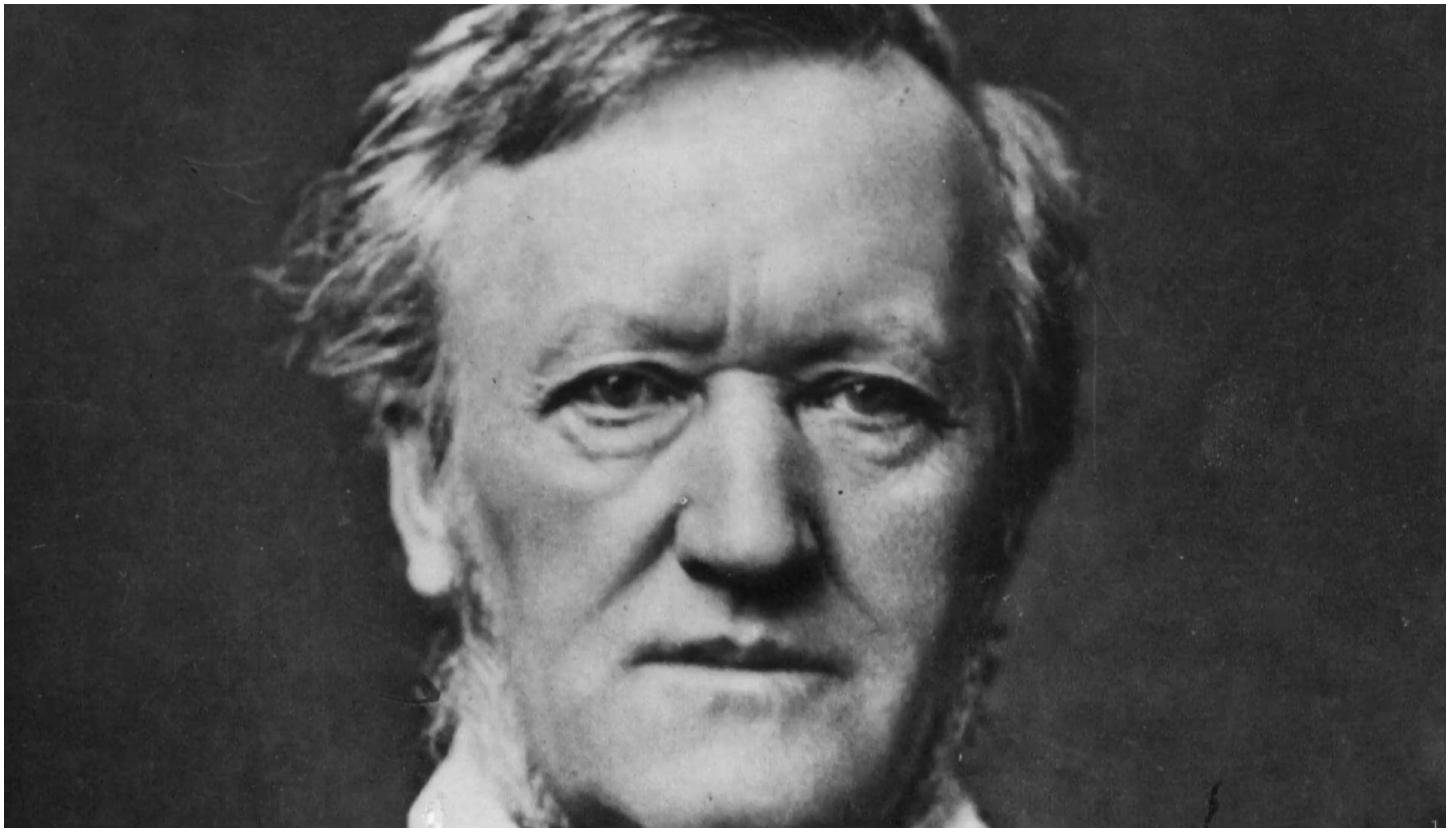
Digital Signal Processing

Signal of the Day: Tristan Chord





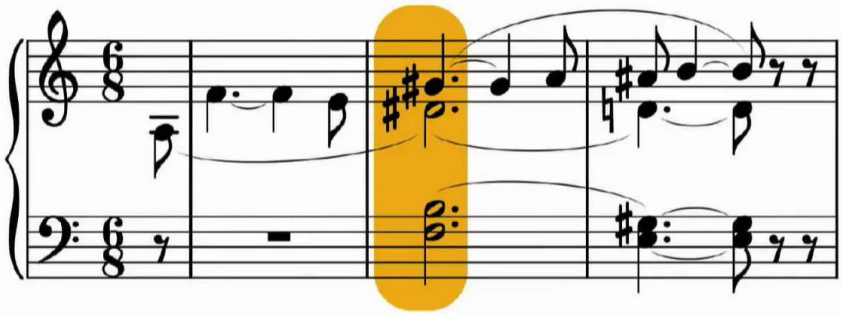
Today's signal of the day deals with one of the most revolutionary chords in Western music history, and it is called the Tristan Chord. Tristan Chord is the first chord in Wagner's opera, Tristan Undolde, first performed in 1865. This opera tells the story of the impossible love between a Cornish knight, Tristan and an Irish princess Isolbe married to Tristan's king. Their passion only finds a tragic resolution in the death of the two characters at the end of the opera. Unfortunately, Wagner is not only famous for his music, but also for his controversial political and social beliefs. The fact that we refer to him and his opera in this example, is for purely signal processing reasons, and it does not imply our acceptance of those beliefs, which we strongly condemn.

Notes

Summary

0m 01s

Tristan Chord



- The first bars play stop
- Tristan chord play stop

2

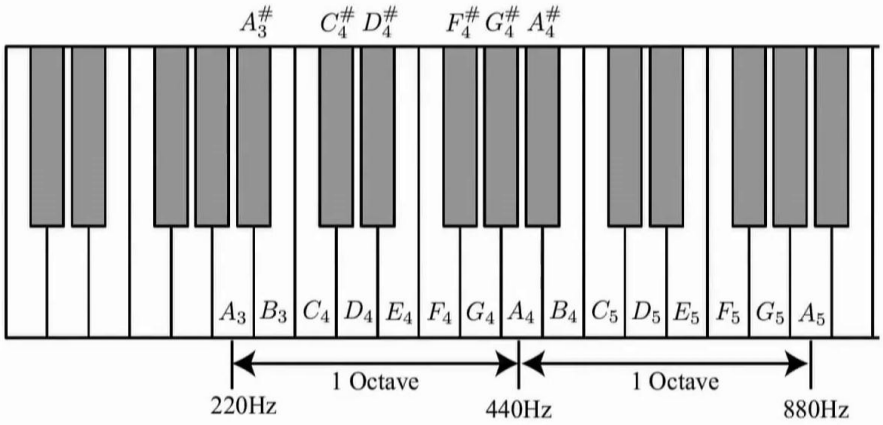
The Tristan cord first appears in the introductory bars of the prelude of the opera. It may not sound revolutionary, but it must have surprised the first listeners. The Tristan chord is a dissonant chord. It does not sound pleasing to the ear. Instead of evolving to a consonant chord that is one that is pleasing to the ear, like musical convention of that time would have expected, it evolves towards another dissonant chord, it just creates a never ending tension of longing and desire, which reflects the impossible love between Tristan and Isolde.

Notes

Summary

0m 58s

A Detour on Western Music Conventions



- Each note has a unique frequency, $A_3 = 220Hz$, $A_4 = 440Hz$ and $A_5 = 880Hz$
- An octave corresponds to doubling/halving frequency
- Octaves are separated into 12 evenly spaced half-tones

$$f_h = f_0 \cdot 2^{h/12}$$

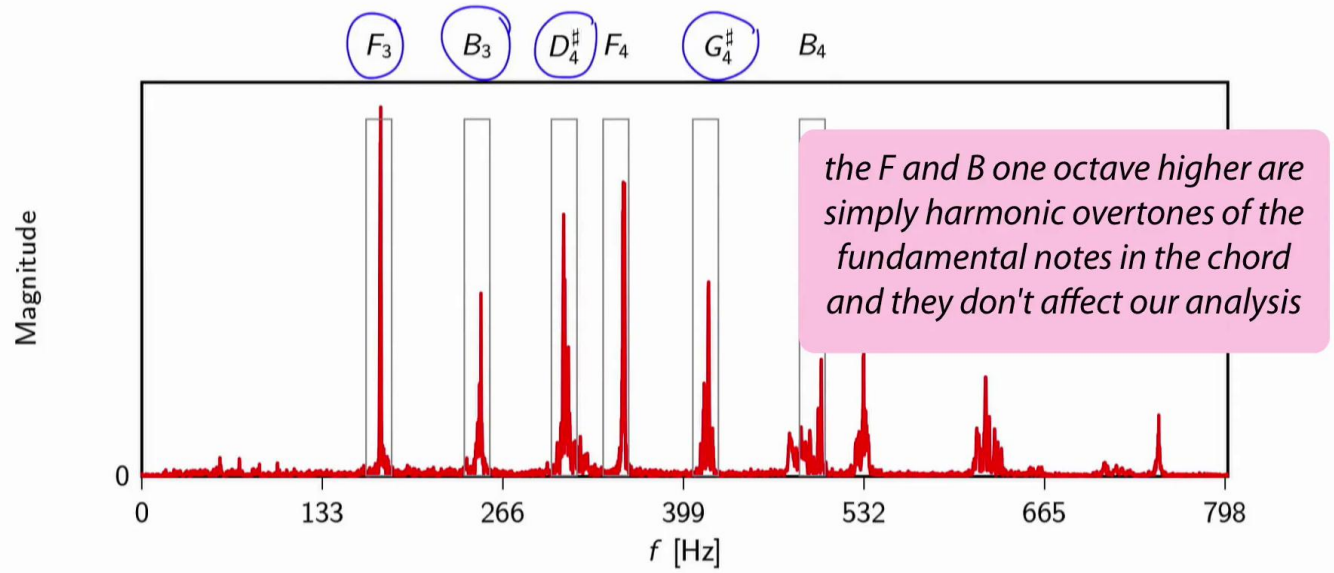
Before furtherlysing this chord, let us make a quick detour through Western music conventions, since the time of Johan Sebastian Bach, the reference note in the Western Music system is A4, which Is Associated with frequency 440 hz. There exist various intervals between two nodes, and the most basic one is the octave that corresponds to a Doubling or halving of the original frequency. For example, A3 has a frequency of 220 hertz and A5 one of eight hundred 80 hertz or a quadrupling of the frequency that is two octaves. Each octave is evenly distributed in 12 half tones. Thus the frequency of each node can be calculated by multiplying the reference frequency to the 12th root of two, raised by the power of the number of half tones separating the two frequencies.

Notes

Summary

1m 49s

Fourier Analysis of The Chord



Let us now apply the fast fully transform to this chord to analyze its frequency components. From this analysis, we see that there are many components, so we will need to do an educated guess, which ones are really part of the orchestration. We can see that there is an F3, a B3, a D4# and a G4#. In addition, there appears to be an F4, which is a regular octave, but also a B4.

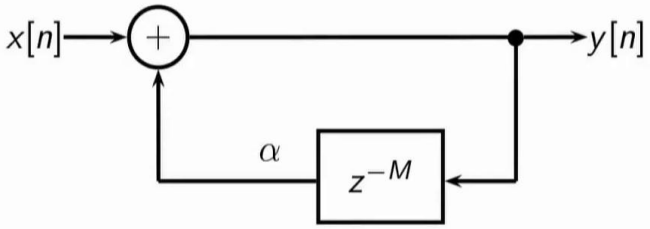
Notes

Summary

2m 49s

Karplus-Strong Synthesis of Tristan Chord

- Simulate each note



- The synthesized notes: F_3 play B_3 play $D_4^{\#}$ play $G_4^{\#}$ play

Now that we know the frequency components of this chord, we can try to synthesize it, for example, using the carp plus strong algorithm we have studied during the lecture. This algorithm allows us to synthesize each node separately by setting the frequency at which the algorithm works so we can synthesize indeed the F3, the B3, D4#, G4#.

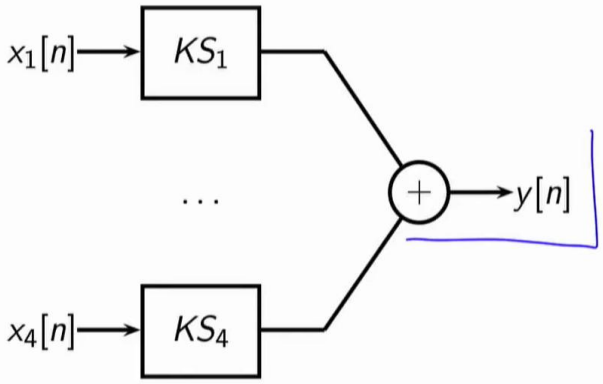
Notes

Summary

3m 35s

Karplus-Strong Synthesis of Tristan Chord

- Sum the synthesized notes together



- The synthesized chord play stop

To synthesize a chord, we use four karplus-trong algorithms in parallel, each for producing a specific note and simply add the results to attain the chord. Let us listen to the result. The chord does not sound as nice as in the original version. The reason for this is that we are only reproducing one element of the chord, the frequency components, but we have ignored an important element, the timber of an instrument. The timber characterizes the way the frequencies components decay over several multiples of the bass frequencies. They depend on the way the chord is excited. Despite having the same frequency, a chord will produce a completely different sound, depending on whether it is plucked, pinched or pressed. Using an electromechanical system, it is even possible to excite a cord in such a way that its timber resembles that of a wind instrument, for example.

Notes

Summary

4m 09s

The Tristan chord is so important in music theory that it has its own entry on Wikipedia. This is certainly not the first time this chord was used by a composer, but it is a context in which it appears and its resolution that makes it so special. The Tristan cord has had a huge influence on music and the seminal in the evolution of the use of harmony in the 20th century classical music. Many composers such as Ravel, Debussy or Mahler have used the Tristan chord as a tribute to Wagner's genius. The influence of the Tristan chord goes far beyond the universe of classical music and spans all sorts of arts. The Famish Dutch painter Van Gogh said that he had been influenced by it. More recently, the film director Gus Van Sant was so touched that it became a recurring pattern in the soundtrack of his movie, Melancholia.

Notes

Summary

5m 10s

Coming back to Wagner, the Tristan cord reappears all over the opera as a leit motif, but its resolution only appears at the end. We now leave the stage to Valrow Meyer interpreting this grand final at the Bayre Festival.

Notes

Summary

6m 06s