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"The comparement of harmonic characteristics of guitar and Turkish stringed instrument; Cumbus"

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Abstract

This study deals with measurement, analysis and comparison of the timbre of guitar and cumbus. The measurements pointed us some spectral differences between guitar and Turkish instrument cumbus. Guitar's body dominantly affects the original harmonic ratios of the string. On the other hand cumbus's body displays a passive role compared to guitar, and it almost does not change the string's original ratios of harmonics. It is a remarkable fact that it almost behaves just like a resonator.

Keywords: harmonics, guitar, cumbus, acoustics, measurement

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1. Introduction

The Cumbus is a relatively young fretless instrument. It was developed in Istanbul in the early 1900's. The inventor was Zeynel Abidin Bey. The famous Ataturk Mustafa Kemal, Turkey's first president, dubbed it Cumbus, pronounced joom-bush.Cumbus, which is Turkish for revelry, just the mood this instrument inspires**.** This instrument has a different metal body looks like mandolin and has a leather plate on its center of body instead of sound hole. Before the measurements we got curious about the results because of the instrument's dissimilar nature.

Our curiosity and interest focused on the Cumbus's harmonic ratios to figure out this instrument's special timbre.

2. Materials and Method

During the experimental procedure we have used Rode M1 Dynamic Mic model microphone due to its almost linear response in 1-5 kHz spectral range which contains our working area ,

Sound Card: Line 6 UX1 Which has given a chance to us for recording sounds with 24-bit 48 kHz
Guitars: Cort CJ10X (Acoustic) Schecter Hellraiser FR (Electric),
Cumbus: Zeynel Abidin handmade. Computational analysis performed with Cubase software.

Before the measurements we first appointed the place of picking points and recorded the signals from all instruments. Then we analysed the intensities of at most first 8 harmonics by taking advantage of fourrier analysis which details is given at next section.

3. Mathematical Model

The mathematical model to calculate intensities of harmonics used in computational stage is based on simple Fourrier analysis of one dimensional model of deflected string (monocord) which its initial position is shown at Figure 1.

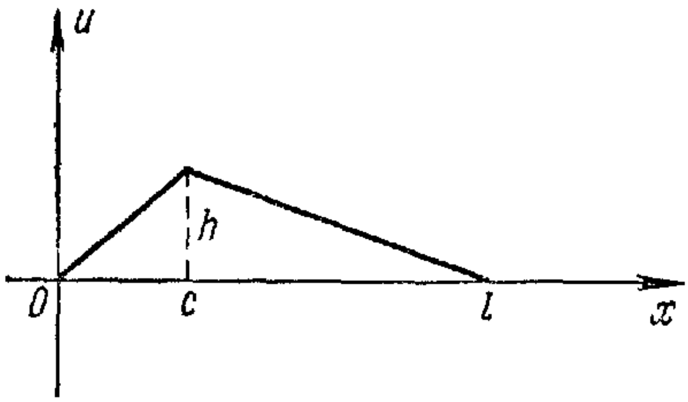

Figure 1

The source equation;which we obtain the intensities of harmonics**:**

$$a_k = \frac{2hl^2}{k^2\pi^2 c\,(l-c)} \sin\frac{k\pi c}{l} \quad \textbf{(1)}$$

where L is lenght of string, h is initial amplitude of picking point, k is number of mode, c is distance from pick to the bridge of guitar body and a_k is amplitude of k'th harmonic.

4. Experimental

4.1. Relative Intenstiy Comparements

Here we give experimental and computational work performed under the frame drawn above. The pictures given below includes the comparison of intensities of some patricular harmonics recorded from monocord and cumbus.

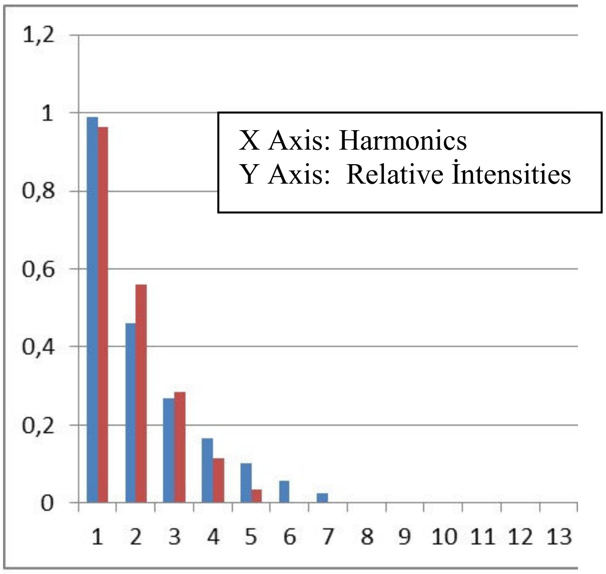

Figure 2. Blue spectrum represents monocord's theoritical results. Red spectrum represents cumbus.

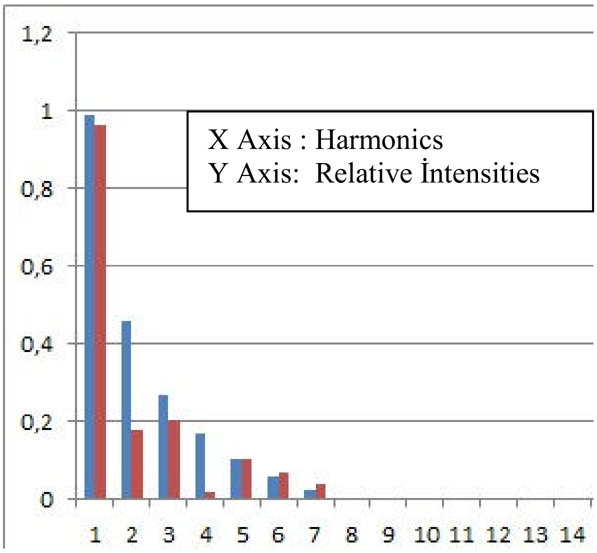

Figure 3. Red spectrum represents Acoustic Guitar Blue spectrum represents monocord's theoritical results

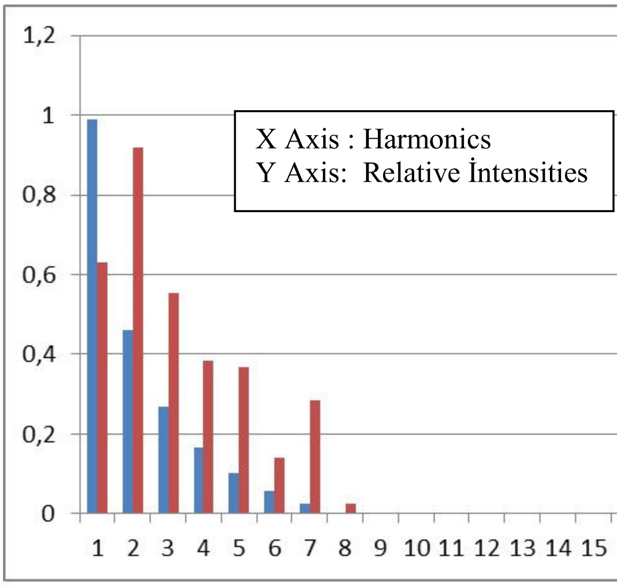

Figure 4. Red spectrum represents Electric Guitar. Blue spectrum represents Monocord's theoritical results

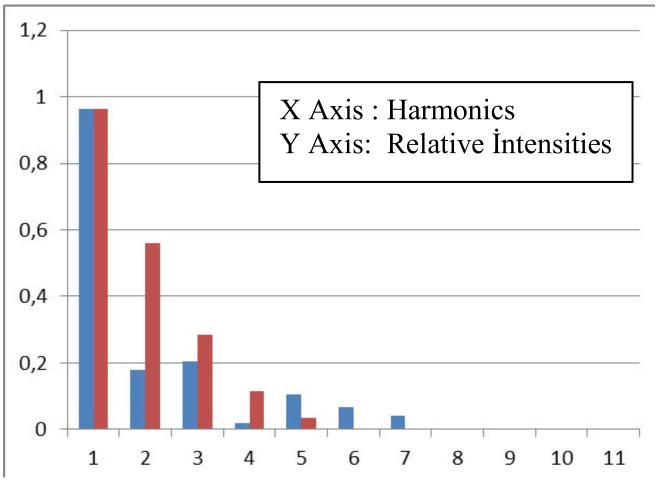

Figure 5. Red spectrum represents Cumbus.Blue spectrum represents Acoustic Guitar

4.2. Observation of beat freqencuies

Acoustic Guitar

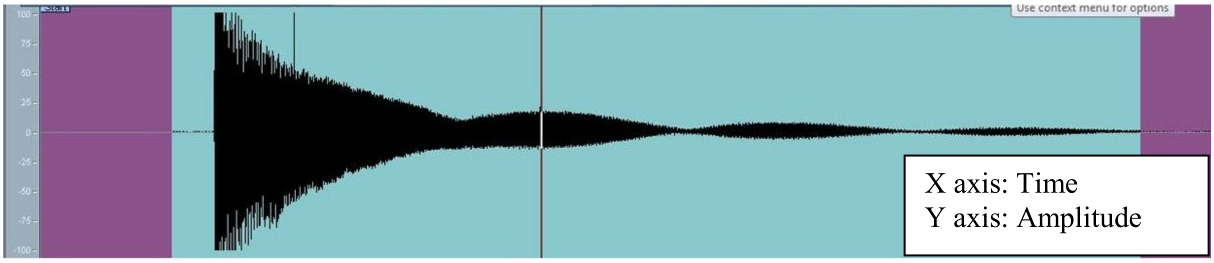

Figure 6. Beat chart of acoustic guitar. We emphasized the role of nodes

The frequency of beat can clearly distinguish from the nodes of oscillation. The beat is not so frequent; we can discover the oscillations of guitar's string and guitar's body are approximate.

Cumbus

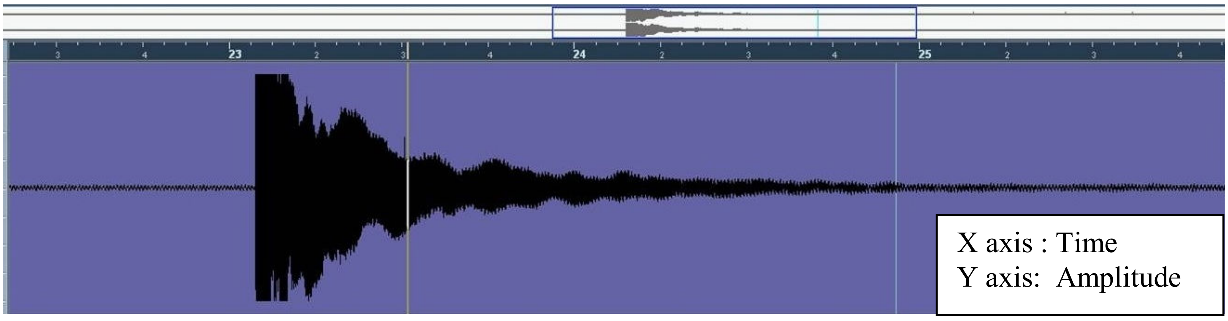

Figure 7. Beat chart of cumbus. We emphasized the role of nodes

The frequency of beat can clearly distinguish from the nodes of oscillation. The beat is frequent compared to acoustic guitar; we can discover the oscillations of cumbus's string and its body are not approximate, unlike guitar.

5. Discussions

In Figure 1 we see that cumbus contributes nearly no effect to normal expectation in monocord harmonic ratio and this feature of cumbus could be attractive for fanciers. But in Figure 2 acoustic guitar seemingly changed string's character a lot. First harmonic is most powerful as expected. Third harmonic more powerful than second harmonic. Fourth harmonic is almost damped. In Figure 3 electric guitar also seemingly changed string's original character. Second harmonic is more powerful than first harmonic. 4th and 5th harmonics have nearly same ratio. In Figure 4 we distinguish the difference between cumbus and acoustic guitar.

We can easily see the nodes of wave in Figure 5.These nodes shows us the interaction of the string and body.The frequency of beat is less compared to cumbus's beat frequency because the body of guitar and the strings oscillates in adjacent frequencies. That is why guitar's body is more effective on harmonic ratios.

The nodes of Figure 6 shows us the interaction of the string and cumbus's body. The frequency of beat is thicker than guitar's beat frequency because the body of guitar and the strings do not oscillates in adjacent frequencies. We believe that the main reason of the fact is that cumbus's body is not so effective on harmonic ratios unlike guitars.

6. Conclusion

From the measurements and calculations we made we can say the following:

- Cumbus is an instrument that behaves like a resonator which amplifies the wave without almost not changing its harmonic's ratios. This is an attention getting fact.
- It's non drilled structure plays also extremely big role in it's acoustic character.
- It's leather membrane leads strings to resonance and do major a job in amplifying.
- On the other hand acoustic and electric guitar's bodies change the harmonic spectra obviously.
- That is the main reason of the guitar body's importance.

At the same time, if we talk about the good and bad or beautiful and ugly in music we can't make generally accepted diagnosis for the wave's sounding and it's timbre. Precisely it depends on listener's sense of taste.

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