The 'Nirai' Guitar ('Ichigo ichie') of Okinawa Japan

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The 'nirai' instrument is a mix of 'sanshin' and guitar. In this study, the sound was analysed with a PicoScope oscilloscope. The 'sanshin' tuning is a fifth, root, and fifth. In the key of C, these notes are G, C, G (GCG). When a low C is added in 'nirai' it makes the tuning a root, fifth, root, fifth. The 'nirai' was tuned to the key of G; the 4th, 3rd, 2nd and 1st string was G2 (100 Hz), D3 (147 Hz), G3 (197 Hz), and D4 (296 Hz). String 4, 3, 2 and 1 displayed 25, 25, 19 and 12 partials frequencies, respectively. The 24th, 17th and 13th harmonics are missing in string 4, 3 and 2. The difference in numbers of partials reflect dissimilar timbre. The findings provide information on hybrid instruments. Understanding of musical aspects aspires to modern, creative and technological demands by looking at the design, construction, and cultural importance. The results contribute to creating new hybrid instruments that blend the sounds, styles and aesthetics of other musical traditions, making them more widely available. By informing educational initiatives, instrument production and performance techniques, these findings can foster innovation and cultural preservation in the world of music.

DOI: 10.15376/biores.20.2.2643-2655

Keywords: 'Nirai' instrument; Fast Fourier Transform (FFT); Harmonics

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INTRODUCTION

Japan is the birthplace of the lesser known but important 'nirai' ('Ichigo ichie') acoustic guitar. The 'nirai' is a distinctive fusion of Japanese workmanship, cultural characteristics, and innovation in acoustic instrument design, even though it lacks the worldwide renown of brands like Yamaha or Takamine. To provide insight into the 'nirai' acoustic guitar contribution to the acoustic guitar landscape, this paper summarizes the instrument's design, historical background, material usage, and cultural relevance. Coates (2023) suggested that it is crucial to comprehend the history of vintage Japanese guitars to appreciate their uniqueness. Japanese guitar makers started creating premium instruments in the 1960s and 1970s, which were marketed under several different brand names. These guitars had excellent construction, premium components such as solid wood bodies and necks, and state-of-the-art electronics. By the 1980s, Japanese-made guitars were among the most sought-after in the world due to the rapid growth in popularity of these instruments. American guitar manufacturers such as Gibson and Fender were competing

with instruments made by businesses including Yamaha, Ibanez, and Greco. Japan has a long history of producing guitars, and Japan is the home to some of the most well-known guitar brands worldwide. This movement was started by companies including Yamaha and Takamine, but in recent decades, smaller, more specialized firms such as K Yairi guitars have appeared, each contributing in a different way to this tradition. Day (2023) wrote briefly about Japan's industry making the acoustic guitar. A young man called Kazuo Yairi began the family business of making classical guitars in the 1950s in the small town of Kani. He was trained under his father's guidance before becoming a master luthier. Yairi had produced 'nirai' guitar (Fig. 1). Large amounts of tone wood are stored for decades before being used, and the region's consistent winds are used to season the wood. Long-term instrument stability is ensured by this procedure. Inadequately seasoned wood will not be stable, which can lead to a variety of issues such as splitting, top lifting, neck warping, and uneven intonation.

Fig. 1. Mr. Kazuo Yairi with nirai guitar (source: *Mr Kazuo Yairi*. (n.d.). K Yairi Guitars. https://www.yairi-france.com/portfolio/mr-kazuo-yairi)

Learning the chords for the guitar takes time, with only four fingers to play six strings. The 'nirai' instrument combines the carefree simplicity of the 'sanshin' with the ability to play and sing like a guitar, which is so much easier. It is a mix of the 'sanshin' and the guitar. Since adding more strings to the 'sanshin' is not an option, so reducing the number of strings on the guitar is another alternative. Instead of using the guitar's tuning, 'nirai' is tuned like a 'sanshin'. In a guitar, standard tuning defines the string pitches as E, A, D, G, B, and E, from the lowest pitch (low E_2) to the highest pitch (high E_4). The standard 'sanshin' tuning is a fifth, a root, and a fifth, so in the key of C, that would be G, C, G (GCG). Then a low C is added, such that the tuning becomes root, fifth, root, fifth. The chords can be played with just one finger. The 'nirai' shares the exact sound structure.

Its appearance is simpler, as it omits all decorative inlays while maintaining the design and sound of the 'Ichigo ichie', giving it more of a folk instrument feel. Therefore, elements such as knots, blemishes, and wood grain patterns are considered part of the instrument's unique character. The antique-style colour tones and rough finishing deliver a rich sound using the best materials, which have been naturally dried for over 10 years. The 'Ichigo ichie' is a musical instrument that is still in the process of development. Even now, as it is being produced, continuous improvements are being made. The specifications may undergo minor changes.

Dawe (2013) mentioned that the guitar's legitimacy as a tangible item and a cultural symbol is occasionally questioned. He mentioned that there have been times when people have questioned the 'nirai' authenticity as a material object and as a cultural symbol. The debates concerning its design, adaptability and function in embodying various cultural values. Johnson (2013) examined two new Japanese lutes 'guitar-ness' in detail. He investigated how the 'nirai' reflected traits connected with the guitar, including design, playing style and symbolic meaning by analysing the concept of 'guitar-ness' in these instruments. These viewpoints highlight the 'nirai' undeniable influence, which is demonstrated by its presence in music, cultural identity, and the invention of new instruments.

The guitar's impact is evident. The term "音が来る", which is read as "Oto-Ga-Kuru", meaning "Sound comes". Because the phrase "nirai kanai" has been used in Okinawa culture from ancient times, BEGIN (a group of musicians) named the instrument after this term. It retains the fundamental design and sound but is more straightforward and has a more folk instrument feel. The guitar company K. Yairi (based in Kani city in Gifu prefecture, is in the central part of Honshu, Japan's largest island) and the band BEGIN (from Ishigaki Island, in the Yaeyama islands, Okinawa prefecture) collaborated to create the 'Ichigo ichie', which has many guitar-like features, at the beginning of the twenty-first century. As a result, the maker-player symbiosis of K. Yairi and BEGIN features intriguingly dynamics relations, and Okinawa can now be viewed as both a local producer and a global consumer of the instrument (Johnson 2013; Dawe 2013). Johnson (2013) suggested the limitations of some instruments influence by historical and cultural circumstances that can constantly test instrument designs. The band BEGIN currently uses the 'Ichigo ichie' and the 'sanrere' (An Okinawan musical instrument, a mix of the sanshin and the ukulele 'Sanrere') to allude to their Okinawan Island identity both on stage and in their recordings. It is obvious that the manufacture of these instruments can be explained by both acoustic and cultural factors. This approached establish the relationship between musicians and luthier, which contribute to the birth of 'nirai' guitar. Johnson (2013) refers to as the old, new, and borrowed in the cultural imaginary. The 'nirai' guitar or 4 strings lutes are old because they are derived from well-established musical forms (the 'sanshin', guitar, and ukulele). It is new because it is manufacture through the influence of both domestic and international cultural flows. It is borrowed because the guitar was assimilated from western and other global cultures. The ukulele, despite having Hawaiian and Portuguese roots, was brought to Japan as part of the larger flow of material culture and ideas (Dawe 2013; Johnson 2013). Therefore, 'nirai' guitar offered a new aspect of musicianship for instrument to both musical production and performance. To play the 'nirai' guitar, the following conditions must be met. There are three methods: tuning, pressing, and strumming the strings.

Tuning

The key tuning of 'nirai' guitar depends on the song itself, and the choices from the musician themself. The 'nirai' guitar has 4 open strings, which are tuned as the perfect 5th in the scale degree system of music. For example, if the guitar is being tuned into the key of G, the 4th string of 'nirai' guitar can be identified as G2 (97.99 Hz), 3rd string as D3 (146.83 Hz), 2nd string as G3 (196 Hz), and 1st string as D4 (293.67 Hz). Although the default tuning of 'nirai' guitar is in G, some musician perhaps will change the tuning depending on the colour or timbre of tone that is preferable for the tune that is being played. If it is tuned 1 key below (in the key of F) it will impart a more bassy sound (the reproduction of sound that overemphasizes low-frequency sounds), instead of tenor sound. It can also be adjusted to the original key of the song or to a selected key in the range of F to A (in the key of A it is tuned 1 key above G) (Table 1). If the key is outside the range of F to A, it will be necessary to change the gauge (thickness) of the strings. Figure 2 shows an excerpt playing by a musician using a 'nirai' guitar, which is being played in the key of F major.

Table 1. The Tuning of 'Nirai' Guitar in the Range of Key F to Key A

string	Tuning in key F	Tuning in key G	Tuning in key A
4th string	F (Fa)	G (So)	A (La)
3rd string	C (Do)	D (Re)	E (Mi)
2nd string	F (Fa)	G (So)	A (La)
1st string	C (Do)	D (Re)	E (Mi)

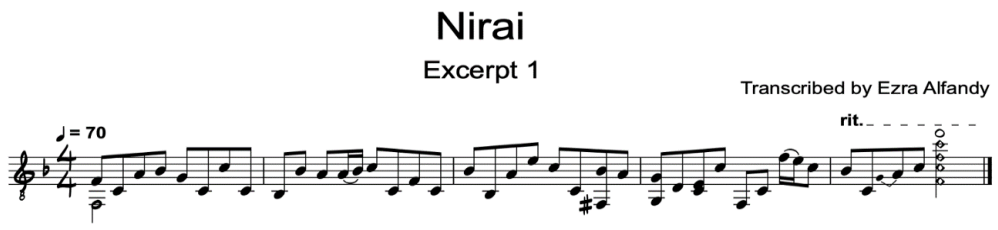


Fig. 2. The excerpt playing of 'nirai' guitar from the BEGIN band tune (Source: 一五一会属の音色比較.; https://www.youtube.com/watch?v=FWUMzO9JZK8)

Pressing Chords

Pressing strings produces chords, which are a crucial component of a song. To play a song comfortably, chord changes must be fluid. Playing the 'nirai' guitar is as simple as pressing the strings with one index finger. It has evolved into a more ethnic musical instrument – similar to a certain Finnish instrument, which was created by evolving the playing techniques and compositions while maintaining the basic design tone and simplicity. Using this method, a power chord is obtained, often referred to as a fifth chord. This is a term used informally to describe a chord on a guitar, that consists of the root and the fifth note, along with possible octaves of those notes (refer to Fig. 3, second bar, the 3rd and the 4th beat). However, in some cases the musician can play more than the index finger, depending on the sound, chords, creativity, or melody that they emphasize (as in Fig. 2).

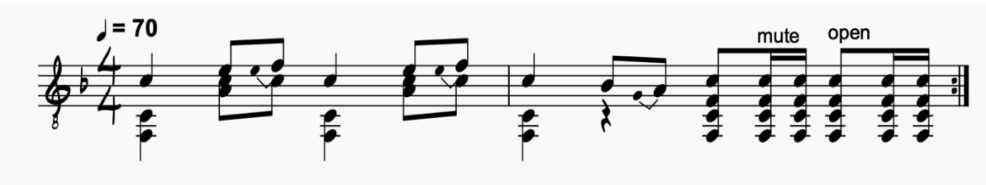


Fig. 3. Excerpt score of nirai in the introduction of BEGIN band. (source: BEGIN／一五一会弾き方 ; 0.:07-0:21)

Strumming

The strumming of 'nirai' guitar is similar to the playing of a guitar. The stroking sound of 'nirai' guitar can be done by pressing down on the strings while rhythmically plucking them. An upstroke is when one plucks from the bottom to the top, and a downstroke is when one plucks from the top to the bottom (see Fig. 4 and Fig. 5). The rhythm will therefore become more vibrant if the player masters a combination of methods such as "empty picking," which involves not actively plucking the strings, and "muting," which involves pressing the string with the back of the right hand after plucking it. The tone is influenced not only by the force with which the string is struck with the pick, but also by the depth at which the player holds the pick and the location of the pluck (Fig. 3).

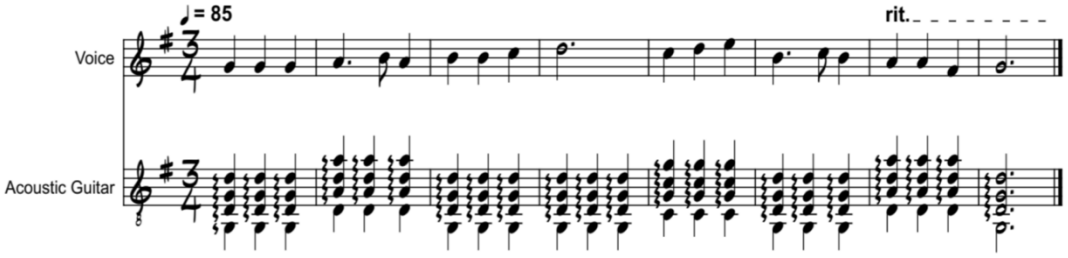


Fig. 4. A strumming pattern by BEGIN band with vocal lines. (source: BEGIN／一五一会弾き方; 6:42-6:58)

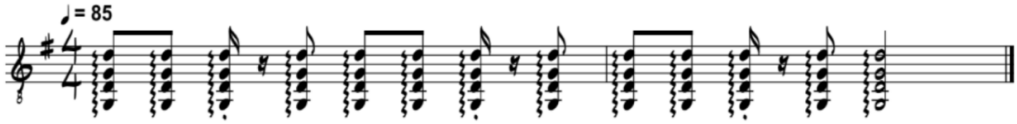


Fig. 5. Another strumming pattern to play for Nirai. (source: BEGIN／一五一会弾き方; 40:20-40:28)

In July 2003, the new musical instrument 'Ichigo ichie', produced by the artist BEGIN, was announced and has been receiving overwhelming praise. Alongside the production of the 'Ichigo ichie', the release of the much-requested junior version of the 'Ichigo ichie' were also prepared to create a simpler and more affordable model. Some parts of this process were shown on NHK's 'Ningen Document', (NHK stand for Nippon Hoso Kyokai (Japan Broadcasting Corporation), founded 1960), and the full version was broadcast in May on 'ETV (Educational television) Special'.

EXPERIMENTAL

The 'nirai' is made entirely of solid wood to achieve a good sound. The top material type is from spruce, the body, neck, side and back material are from mahogany, and the fingerboard is from rosewood. Figure 6 shows the components of the 'nirai' guitar with its dimensions. The 'nirai' sounds were digitally captured using a PicoScope oscilloscope and microphone data acquisitions. The recording apparatus was the Steinberg UR22mkII audio interface, Audio-Technica AT4050 microphone, XLR cable (balance), with microphone position on axis (20 cm), and microphone setting with low cut (flat) 0 dB. The PicoScope computer software (Pico Technology, 3000 series, Eaton Socon, UK) was used to view and analyze the time signals from PicoScope oscilloscopes (Pico Technology, 3000 series, Eaton Socon, UK) and data loggers for real time signal acquisition. PicoScope software enables analysis using FFT, a spectrum analyzer, voltage-based triggers, and the ability to save/load waveforms to a disc. The microphone was positioned at 20 cm from the string, as shown in Fig. 7. This 20 cm microphone position promotes natural sound output and resonance and is most indicative of normal playing circumstances. In order to capture the authentic acoustic qualities, the microphone was positioned in front at a constant distance and angle during the recording process. This arrangement makes sure that the recordings accurately capture the tonal qualities without adding any distortion. The instrument was played and recorded under identical settings to minimize any abnormalities or deviations. The microphones were positioned at the same height and angle above them to guarantee that the recordings accurately captured the acoustic qualities of the instrument without adding any bias.

The oscilloscope from Pico Technology's 3000 series in Eaton Socon, UK was utilized to perform the Fast Fourier transform (FFT). The resulting digital time record was mathematically transformed into an FFT spectrum using an algorithm known as the FFT. The FFT is simply a set of operations that implements Fourier's theorem. The resulting FFT spectrum shows the frequency components of the input signal. The outcomes were subsequently examined utilizing PicoScope software (version 6), emphasizing FFT, voltage-based triggers, and spectrum analysis. To reduce variances, the use of Pico Scope software was thoroughly rehearsed with the precise plucking motions before the recordings. The impact of human variability is lessened thanks to this methodological rigor, which improves the reproducibility and dependability of the experimental outcomes. This decision guarantees that the comparison makes sense and is pertinent. To ensure durability and dependability, sound data for the 'nirai' were gathered in numerous rounds. Following this, the recordings from these several iterations were averaged to smooth out irregularities and produce a more trustworthy comparison that gave a thorough and accurate depiction of the acoustic characteristics of the 'nirai'. By utilizing multiple rounds of data collection and averaging the results, the described approach ensures that the comparison is robust and reliable. This detailed methodology strengthens the validity of our findings and provides a clear and accurate comparison from these several iterations.

The sound recordings were obtained at a sampling rate of 48 kHz. The experiment took place in the Music Department of Universiti Malaysia Sarawak (UNIMAS) within an anechoic room. The Time Frequency Analysis (TFA) was conducted in Adobe Audition, focusing on the specific intensity in hertz to differentiate the power of partial frequencies, using measurements in seconds. Partial frequencies, also known as partials, are the frequency components that make up a complex sound, such as a vibrating musical instrument. A complex sound is made up of many different frequencies or pitches, called

partials. The collection of partials is called the harmonic series or overtone series. The fundamental frequency is the first partial and is usually the strongest frequency to the ear. It defines the pitch of the sound. Overtones are the partials above the fundamental. The relative strength of the overtones gives the sound its tone color or timbre. Tone systems are commonly studied in sound analysis and re-synthesis using this approach (Hamdan *et al.* 2020).

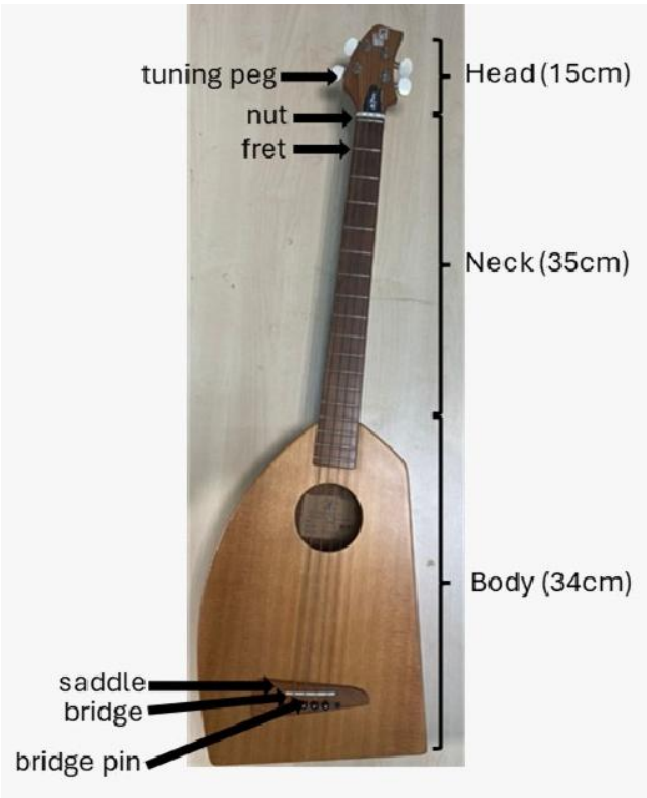


Fig. 6. The component of the 'nirai' guitar with its dimensions

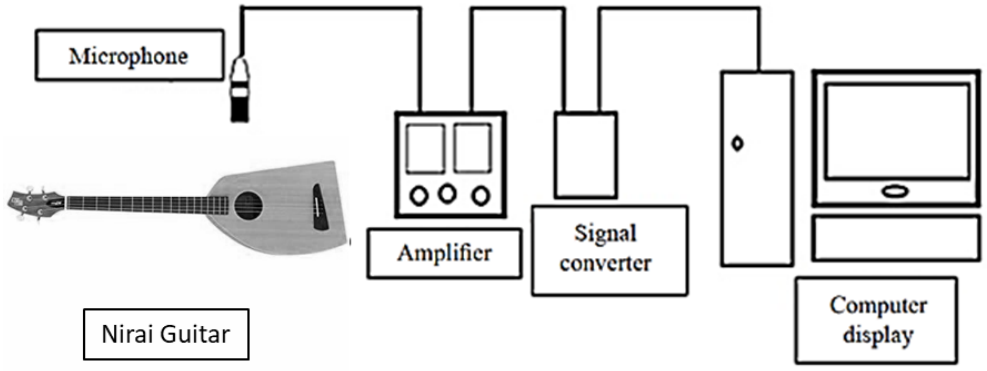
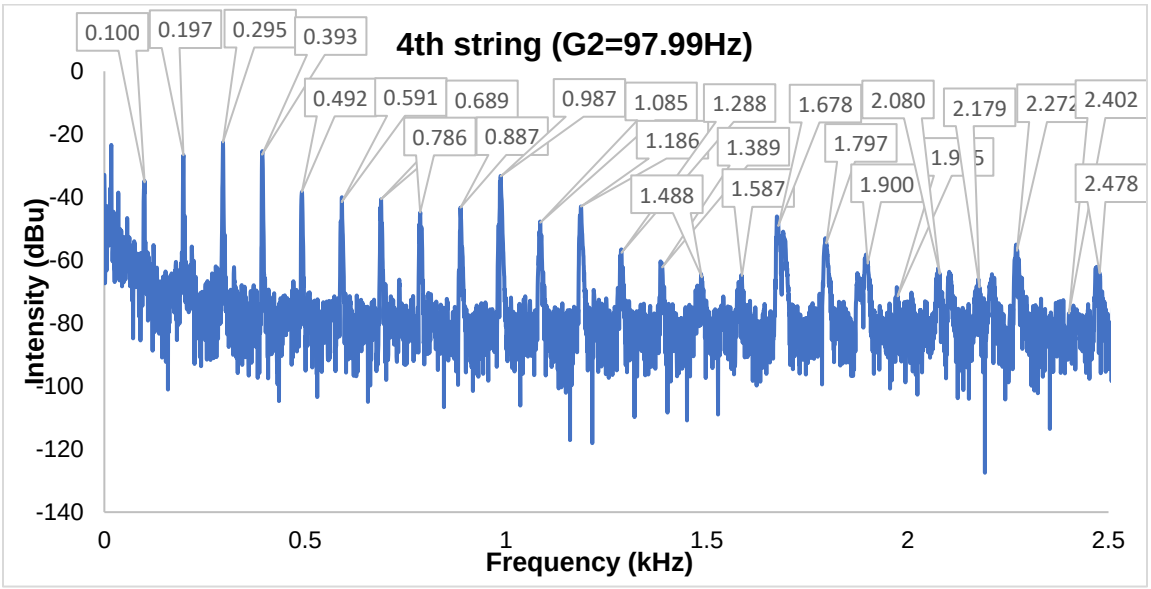


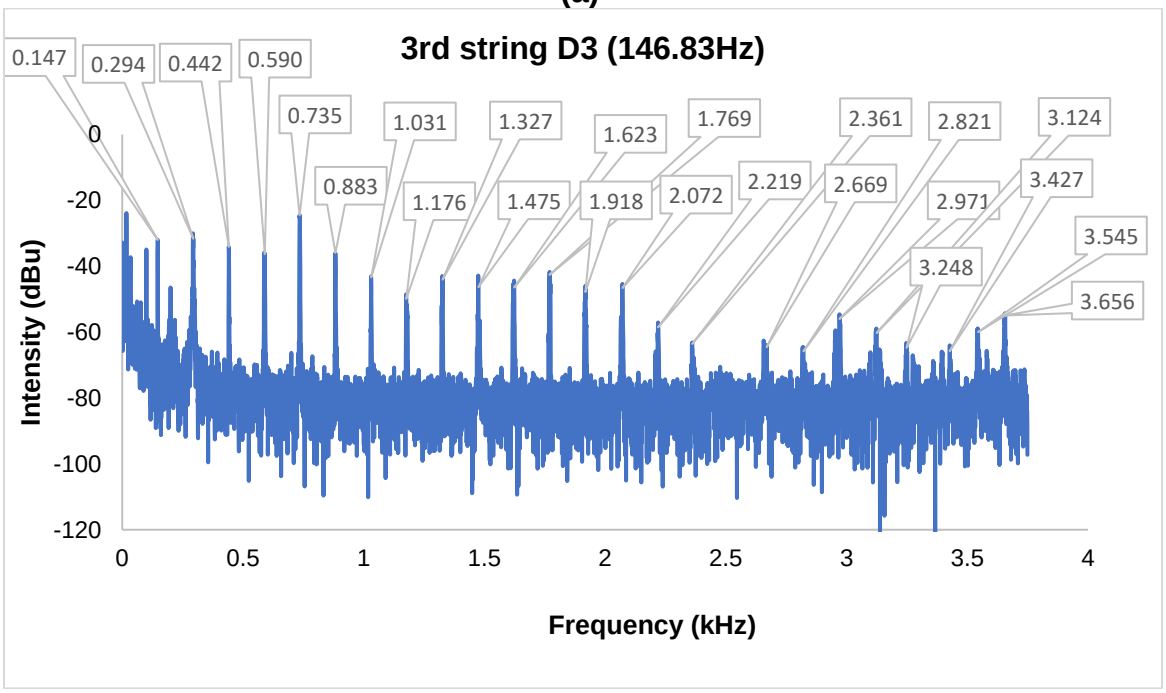
Fig. 7. Schematic diagram of microphone data acquisitions

RESULTS AND DISCUSSION

Figure 8 shows the 4th, 3rd, 2nd and 1st strings spectrums with the fundamental and partial frequencies for notes G2, D3, G3, and D4, respectively. The 4th, 3rd, 2nd, and 1st string displayed fundamental frequency features at 100 Hz (G2=97.99 Hz), 147 Hz, (D3=146.83 Hz), 197 Hz (G3=196 Hz), and 296 Hz (D4=293.67 Hz), respectively. String 3 and 4 displayed 25 partials frequencies. String 1 and 2 displayed only 12 and 19 partials frequencies respectively. Table 2 displays all the harmonic numbers from the 4th, 3rd, 2nd and 1st strings, *i.e.* G2, D3, G3 and D4 notes, respectively, with the fundamental and partial frequencies.



(a)



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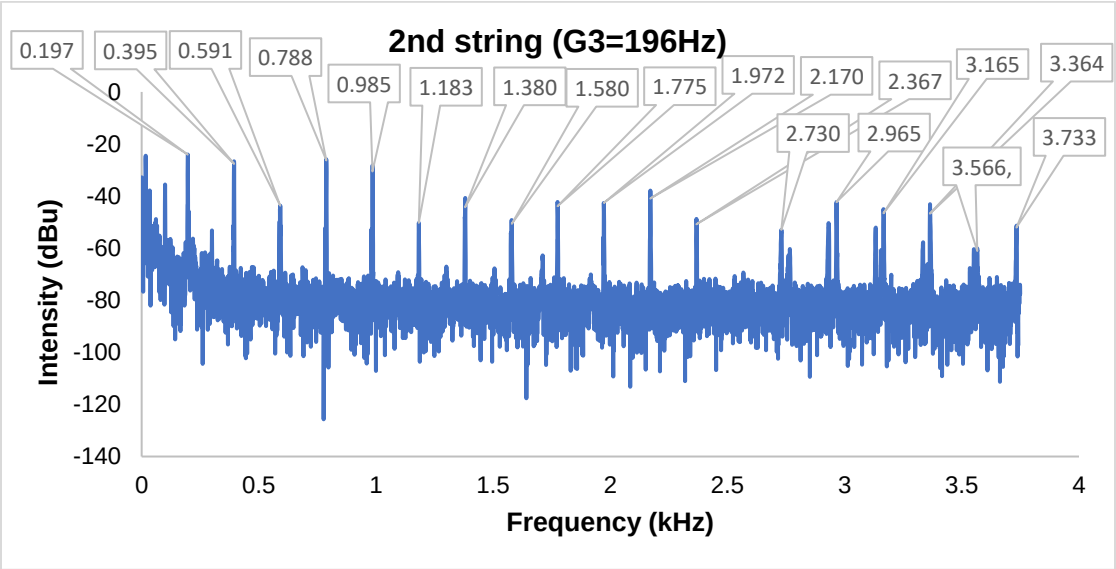
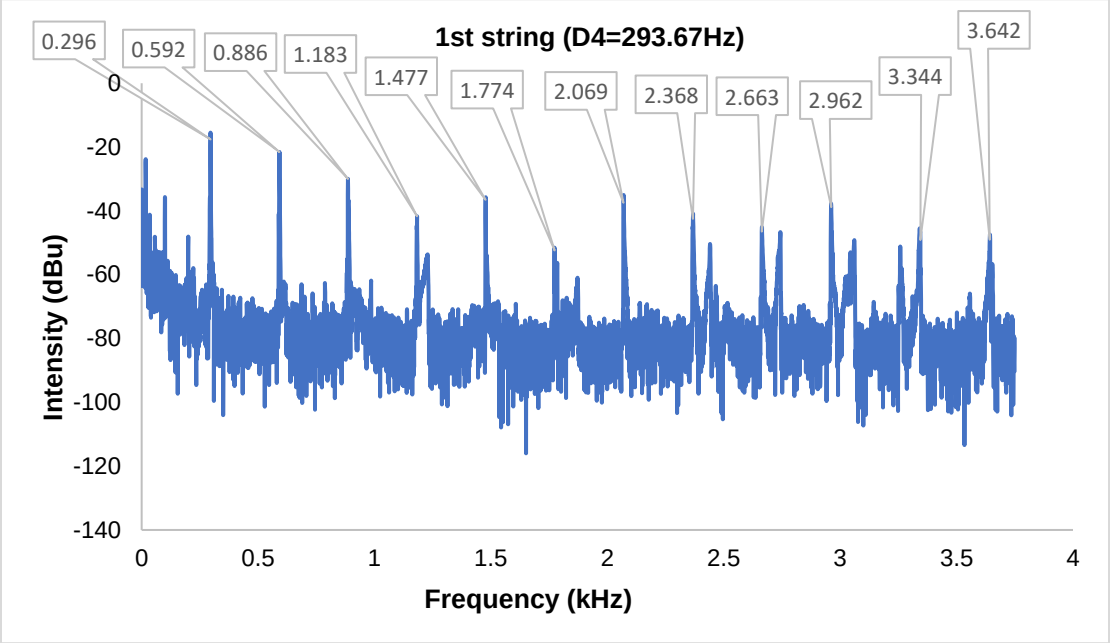


(c)



(d)

Fig. 8. (a) 4th string spectrums with the fundamental and partial frequencies for notes G2; (b) 3rd string spectrums with the fundamental and partial frequencies for notes D3; (c) 2nd string spectrums with the fundamental and partial frequencies for notes G3; (d) 1st string spectrums with the fundamental and partial frequencies for notes D4

From Table 2, it can be observed that the 4th and 3rd strings had higher harmonic numbers because a thick string vibrates longer due to the higher mass. String 1 had the least harmonic numbers because the thin string vibrates faster. The partials were all integer number of harmonics with 24th, 17th, and 13th harmonics missing in string 4, 3, and 2. All harmonics appear in string 1. The partials of the overtones confirmed the typical sound quality of 'nirai' guitar. The thin string had less partials compared to the thick string. Even though the numbers of partials were different, with the sensation of a wooden guitar-like

sound, the ‘nirai’ guitar displayed similar timbre from every string.

Table 2. The 4, 3, 2, and 1 String with the Fundamental and Partial Frequencies for G2, D3, G3, and D4 Notes, Respectively

4th String (G2)		3rd String (D3)		2nd String (G3)		1st String (D4)	
f (Hz)	f/f0	f(Hz)	f/f0	f(Hz)	f/f0	f(Hz)	f/f0
100	1	147	1	197	1	296	1
197	1.97=2	294	2	395	2.01=2	592	2
295	2.95=3	442	3.01=3	591	3	886	2.99=3
393	3.93=4	590	4.01=3	788	4	1183	3.99=4
492	4.92=5	735	5.01=5	985	5	1477	4.98=5
591	5.91=6	883	6	1183	6.01=6	1774	5.99=6
689	6.89=7	1031	7.01=7	1380	7.01=7	2069	6.98=7
786	7.86=8	1176	8.01=8	1580	8.02=8	2368	8
887	8.87=9	1327	9.02=9	1775	9.01=9	2663	8.99=9
987	9.87=10	1475	10.03=10	1972	10.01=10	2962	10.01=10
1085	10.85=11	1628	11.07=11	2170	11.01=11	3344	11.29=11
1186	11.86=12	1769	12.03=12	2367	12.01=12	3642	12.30=12
1288	12.88=13	1918	13.04=13	13th missing			
1389	13.89=14	2072	14.09=14	2730	13.85=14		
1488	14.88=15	2219	15.09=15	2965	15.05=15		
1587	15.87=16	2361	16.06=16	3165	16.06=16		
1678	16.78=17	17th missing		3364	17.07=17		
1797	17.97=18	2669	18.15=18	3566	18.10=18		
1900	19	2821	19.19	3733	18.94=19		
1975	19.75=20	2971	20.21=20				
2080	20.81=21	3124	21.25=21				
2179	21.79=22	3248	22.09=22				
2272	22.72=23	3426	23.30=23				
24th missing		3545	24.11=24				
2478	24.78=25	3656	24.87=25				

Figure 9 shows the results of time frequency analysis (TFA) from strings 4, 3, 2 and 1 with the fundamental and partial frequencies for G2, D3, G3, and D4 notes respectively. Although all the FFT spectrum shown in Fig. 8 clearly displays all the harmonics for all strings, the TFA clearly showed distinct differences for all strings. The high number of harmonics in G2 and D3 (from Fig. 8(a) and Fig. 8(b): FFT spectrum in string 4 and 3, respectively) are shown as bright and dense partials in the TFA. The low number of harmonics in G3 and D4 (from Fig. 8(c) and Fig. 8(d): FFT spectrum in string 2 and 1, respectively) are shown as bright and distinct partials in the TFA. In Fig. 8(d): FFT spectrum in string 1, the small number of harmonics in FFT spectrum of D4 (only 12) are shown as clear individual partials in TFA. From Fig. 9, the spectrogram showed that the ‘nirai’ guitar had a bright sound.

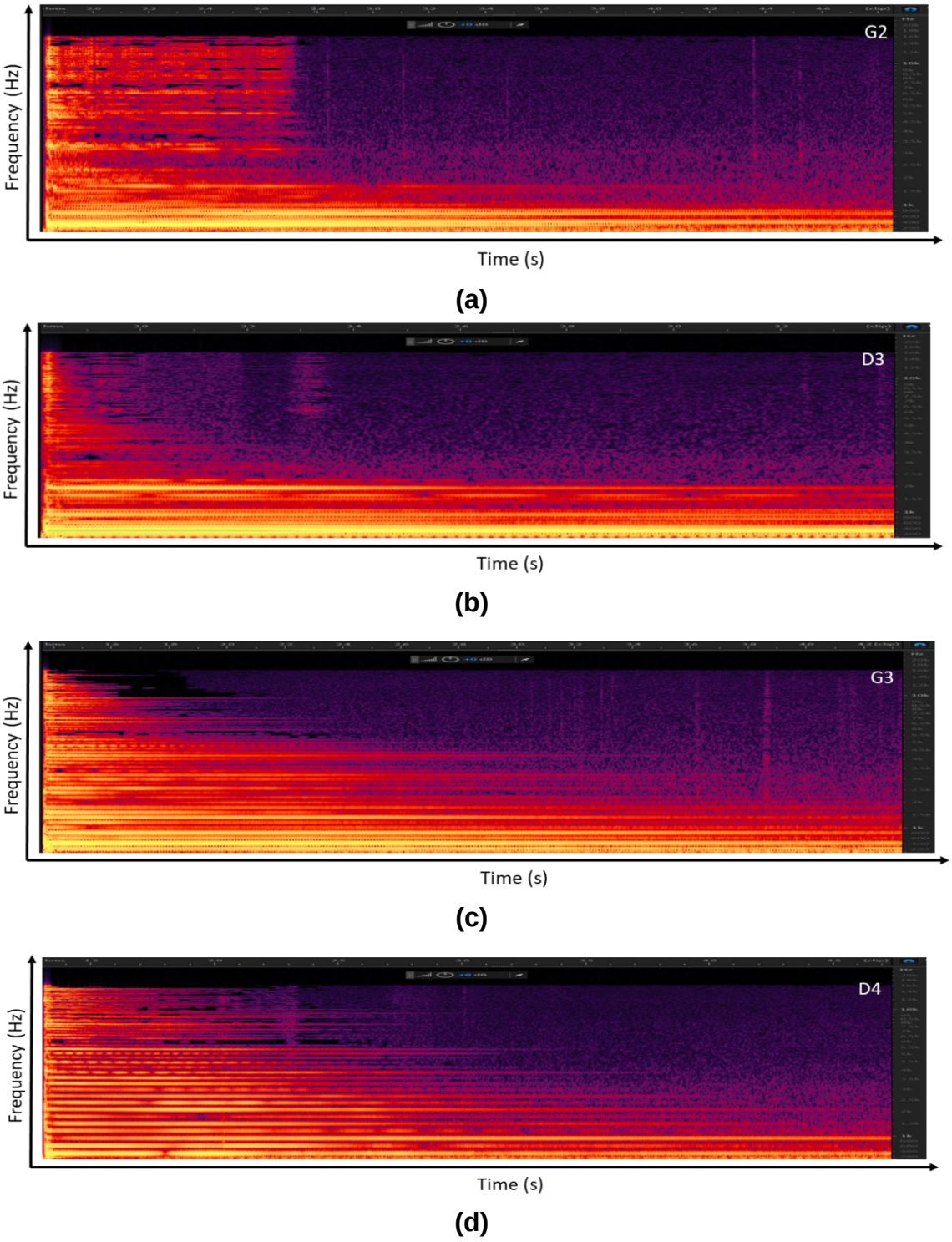


Fig. 9. Time Frequency Analysis of (a) G2 with the fundamental and partial frequencies for string 4; (b) D3 with the fundamental and partial frequencies for string 3; (c) G3 with the fundamental and partial frequencies for string 2; and (d) D4 with the fundamental and partial frequencies for string 1

CONCLUSIONS

1. In a guitar, standard tuning defines the string pitches as E, A, D, G, B, and E, from the lowest pitch (low E_2) to the highest pitch (high E_4), whereas in the 'nirai' instrument it is a mix of the 'sanshin' and the guitar. The standard 'sanshin' tuning is a fifth, a root, and a fifth, so in the key of C, that would be G, C, G (GCG). Then a low C (C) string is added in the 'nirai', such that the tuning becomes root, fifth, root, fifth, *i.e.* G, C, G, C (GCGC).
2. Strings 3 and 4 displayed 25 partials frequencies. String 1 and 2 displayed only 12 and 19 partials frequencies, respectively. The different in numbers of partials reflect dissimilar timbre. Strings 3 and 4 have higher harmonic numbers (25 partials frequencies) because a thick string vibrates longer due to the higher mass. String 1 had the least harmonic numbers (only 12 partials frequencies) because the thin string vibrates faster due to its lower mass.
3. The high number of harmonics in D3 and G2 (FFT spectrum in string 3 and 4, respectively) are shown as bright and dense partials in the TFA.
4. The low number of harmonics in D4, and G3 (FFT spectrum in string 1 and 2, respectively) are shown as bright and distinct partials in the TFA.

ACKNOWLEDGMENTS

The authors would like to acknowledge Universiti Malaysia Sarawak (UNIMAS) and Universiti Putra Malaysia for the technical and financial support. Special thanks to Anis Fasihah Ismail for doing the translation from the Japanese manuals.

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Article submitted: November 17, 2024; Peer review completed: January 4, 2025; Revised version received and accepted: January 7, 2025; Published: February 14, 2025.
DOI: 10.15376/biores.20.2.2643-2655