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A CONTRIBUTION TO TEACHING VIETNAMESE MUSIC: KEY NOTES IN CONTEXT AND PITCH CONTOUR GRAPH[1]

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Abstract

*Areas of difficulty in teaching Vietnamese traditional and folk music to non-Vietnamese include the aural-oral traditions, the use of non-Western European scales and extensive multiple pentatonic scales, their associated airs and modes, the heterophonic texture when musicians improvise a tune simultaneously in an ensemble, and the Vietnamese-specific sentence-based poetic structure of the piece—sometimes described as non-metrical. By analyzing voices and instruments, a group of educational community organizers attempt to set up an initial guide for understanding and teaching Vietnamese folk music. This involves, for example, searching for original or commonly accepted musical pieces and identifying the scales, ranges, background knowledge, melodic contour, sequences, motives, and temporal characteristics before the best visual representation of pieces can be suggested for documentation. We use the famous song Ru con miền Nam ("Lullaby from south Vietnam") to demonstrate the method. Specifically, we first attempt a context-sensitive key notes in context, or **knic**, that lays out the frequencies of occurrences of two, three, etc. adjacent pitches that may reveal repeated pitch patterns in the piece. We also attempt a pitch-time graph. This shows the pitch curve as the piece is performed in real time. We aim to show the characteristic rhythmic patterns and metrical structure spread over the time axis. Most importantly, it may reveal the Vietnamese-specific microtones therein, if any, which help music learners to replicate the feel of Vietnamese music.*

Keywords: key notes in context, microtone, peak frequency, pentatonic, PIC graph, pitch/intensity contour.

INTRODUCTION

Teaching Vietnamese traditional and folk music to children is very challenging to any teacher, new or experienced, the authors included. One author has taught piano to children for the past 10 years. The other has taught *đàn tranh* ensemble classes for the past 7 school years. Teachers, who are in-demand, have to improvise teaching tools to compensate for the shortage of basic research in Vietnamese traditional and folk music.

BACKGROUND: THEORETICAL VS. PRACTICAL ISSUES

The following Figure 1 summarizes the known pentatonic scales and the 8 Vietnamese *điệu* "modal systems" and *hơi* "airs." The Vietnamese northern pentatonic scale is slightly different from the Chinese and the standard western scales. For example, if *hò* is at C (at 0 Ellis *cents* [*c*]) in the Vietnamese pentatonic scale, then all other pitches are off the western tempered scale with

[1] The authors thank the *Mekong Traditional Vietnamese Instrumental Ensemble Troupe* (MTVIET) for the ideas coming from an MTVIET discussion on March 4, 2016.
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intervals finer than semitones (100*c*), i.e., microtones: *xự* is just below D (200*c*) at 171*c*; *xang* is just above F (500*c*) at 514*c*, *xê* is just lower than G (700*c*) at 685*c*, *cống* is just lower than A (900*c*) at 887*c*. As a consequence, the extended pitches are also short, specifically, *xư* is shorter than E (400*c*) at 342*c*, and *phàn* is shorter than B (1100*c*) at 1028*c*. Thus, no pitch in the Vietnamese pentatonic scale aligns with the western tuners.

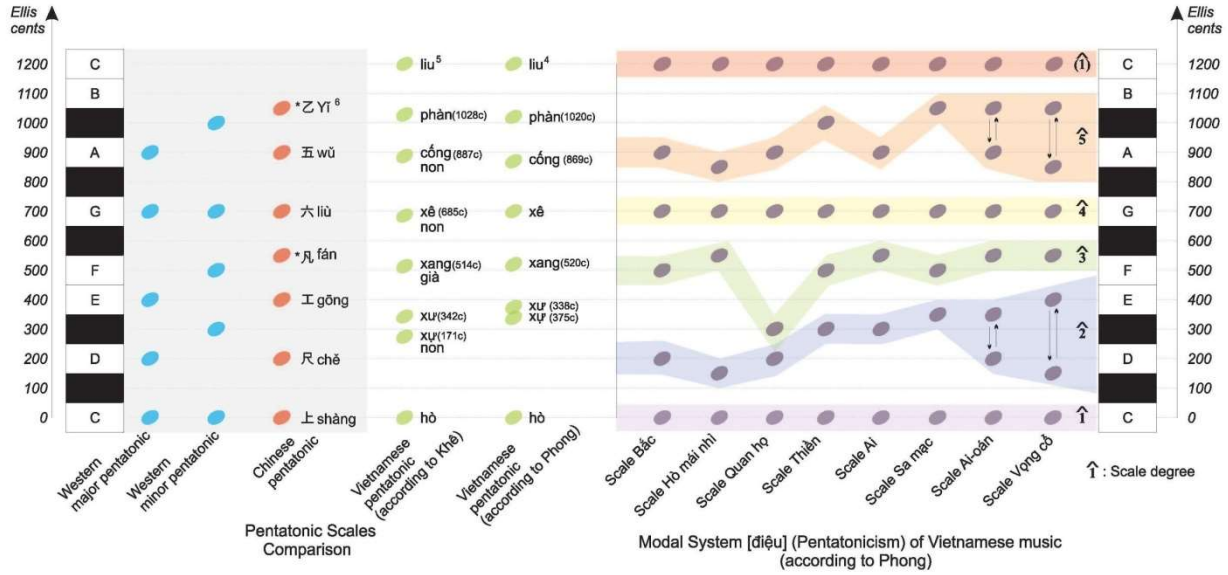

Figure 1. Pentatonic scales used in the Vietnamese artistic tradition.[4,5,6,7]

Another potential issue is the existence of Vietnamese microtones being the language specific *thanh điệu* linguistic tone system as well as *luật bằng trắc* tonal harmony. Due to the traditional poetic-music unity, the traditional and folk song's melody pitch must be congruent with word's tone, thus creating subtle changes in diction.

The third issue comes from the Vietnamese-specific sentence-based poetic structure of the piece—sometimes described as non-metrical in free personal style, making it difficult to identify or transcribe into regular meters.

In addition, the traditional and folk music, as we know today, belong to extensive and elaborated sets of pentatonic scales, and their associated *hơi* "airs" and *điệu* "modal systems" as shown on the right-hand side of Figure 1. Thus, to formulate a methodological approach to teach Vietnamese music is complicated due to the dynamic interplay of *hơi* "airs" and *điệu* "modal systems."

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4 Trần Văn Khê, in "Vài ý kiến về thất cung thiên nhiên và việc dùng comma để đo cung bực trong nhạc Việt [Some opinions on the natural octave and the use of comma to measure steps in Vietnamese music]," *Nghiên Cứu Việt Nam*, Huế, No. 3 Fall 1966, p. 10.

5 Extracted from Nguyễn Phú Phong (2008), p. 253 with "[a]verage deviation: 20 cents." He writes, "Finely adjusted intervals, even microtones, are typical of folk songs. Two to twelve tones may be selected from the twelve-tone system of tuning available in Vietnamese music."

6 Cf. https://en.wikipedia.org/wiki/Gongche_notation 工尺譜 Gongche [*công xê phổ*] was invented by the Tang Dynasty [*nhà Đường*, 唐朝 6/18/618 - 6/1/907] and became popular by the Song Dynasty [*nhà Tống*, 宋朝 960 - 1279]. 凡 *fán* is simply characterized as "between F and F#", and 乙 *yĭ*, "between tib and ti."

7 Phong (2008), p. 255.

The song usually has at least one "skeletal" version and its instrumental arrangements—they are usually different. In addition, musicians of different instruments improvise a tune simultaneously in an ensemble, creating the heterophonic character in Vietnamese music. Teachers are not usually equipped, nor required, to grasp these phenomena, less to understand their underlying principles and rules.

At this point in time, teaching student to replicate the fine arts of Vietnamese music is extremely difficult. This paper attempts to experiment in ways to study less-known musics. Using our proposed process, music teachers and music enthusiasts may only need a Vietnamese music recording in order to teach, play, analyze, and understand Vietnamese folk music. The precise measurements, done through spectrography and the discovery of the internal patterns of pitches, lay a foundation for a systematic approach.

METHODOLOGY — THE MTVIET ENSEMBLE SONG ANALYSIS

By analyzing voices and instruments, a group of educational community organizers attempted to prepare an initial guide for understanding and teaching Vietnamese folk music.

The procedure consists of several successive steps: selecting, graphing, identifying, key notes in context (or ***knic***) analysis, and application. First, selected pieces must be well-known among community members. Because many songs have a history of version development, there are multiple versions. The most authentic or the most popular version is selected, in that order of priority. Second, the chosen version is fed through a software program to obtain a more precise visual representation of its music recording. This presentation includes: lyrics, a music staff, note assignment, significant microtones, phrases, and how each pitch fluctuates due to *vibrato*, *thanh điệu* tones, and articulations. We call this representation a pitch contour graph. Third, we identify the piece's key and the base scale (i.e. *hò)*, and its voice range through collecting frequencies of occurrence of the song's pitches. This step helps with transposition and improvisation when needed. From the graph, it is now easier to select a skeletal version of the performed piece. Fourth, from the sequence of pitches that constitute a music piece, we would like to know how pitches are strung out, how string patterns are formed, and how different pitches "seek" the others. The process is called *key notes in context*, or ***knic***. We finally perform a ***knic*** analysis of the piece to each music phrase, first of two adjacent pitches, then three adjacent pitches, etc. in order to determine the highest frequencies of occurrence of these strings. This step determines preferred sequences of pitches in a music piece. The obtained data from the previous four steps is hoped to help the teachers prepare challenging exercises, and the students understand the inner structures of the music, esp. non-Vietnamese studying Vietnamese music.

DATA DESCRIPTION AND RESULTS — A LULLABY

In this paper, *Ru con miền Nam* "Lullaby from the South" was chosen for a demonstration.

1. Selecting

a. Versions of the lyrics

There are different lyric versions for this lullaby, many of them by great composers, four of which were composed by Phạm Duy in *Trường ca Mẹ Việt Nam* "Mother of Vietnam", Section

Núi Mẹ "Mother Mountains"[8]. Nevertheless, the following version is still the most popular and is considered a masterpiece.

		Tentative translation:
"*Gió mùa thu… mẹ ru mà con ngủ…*	1.	Autumn breeze helps Mother to lull her baby to sleep.
Năm … canh dài…	2.	Five times the timekeeper had struck
Năm … canh dài,	3.	for ten hours straight...
thức đủ vừa năm…	4.	I have been up all ten.
Hỡi chàng… chàng ơi!	5.	Oh, lover… please, lover!
Hỡi người… người ơi!	6.	Oh, man… please, man!
Em nhớ tới chàng.	7.	I am thinking of you,
Em nhớ tới chàng!	8.	I really miss you!
Hãy nín… nín đi, con!	9.	Hush… don't cry, baby!
Hãy ngủ… ngủ đi, con!	10.	Go to sleep… sleep well, baby!
Con hời mà con hỡi!	11.	Oh child, please hush, oh baby!
Con hỡi, con hời…	12.	Oh child, please hush, oh baby!
Con hỡi, con hời, hỡi con!"	13.	Baby, please baby, oh please!"

Curiously, most other versions of the lullaby[9] and 4 versions from Phạm Duy tell different stories as to where the father is at the moment of her distress.

b. Versions of the music

The chosen version for analysis here is the most popular (and refined) version—on Youtube,[10] sung by Ms. Bích Tuyền, accompanied by the *đàn bầu* "monochord" by Hoàng Thịnh, date unknown. A *dạo* "promenade" of *đàn bầu* "monochord" takes up the first 30 seconds and recital of a *ca dao* of four six-eight syllable verses takes up the first 1:50 minutes before the main song continues for another 1:23:20 minutes. The main song sung by Bích Tuyền was extracted in m4a and mp3 format to be analyzed. We call this extracted recording *Ru con*, for short.

2. Graphing — The pitch/frequency/intensity contour graph

The analysis of the spectrogram of the *Ru con* input is graphed with values on a vertical axis indicating the frequency in *hertz* (Hz), the pitch name in Ellis *cents* (c), intensity in *decibels* (dB), and values on a horizontal axis indicating time in *milliseconds* (*ms*). This can be called a frequency/pitch/intensity contour of the song. Specifically, the following set of figure is generated by *Sonic Visualiser*, a freeware program "for viewing and exploring audio data for semantic music analysis and annotation."[11] For example, at point 9.139 *sec* into the recording, the peak frequency spectrogram pane shows the following data:

at Time range: 9.139 — 9.233 *sec*
Peak Frequency: 183.2 — 185.187 *Hz* — Bin Frequency: 172.266 — 183.032 *Hz*
Peak Pitch: F♯3-18*c* — F♯3+2*c* — Bin Pitch: F3-23*c* — F♯3-18*c*
dB: -36 — -29 — Phase: -1.63752 — 2.1971

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8 4 versions of four seasons by Phạm Duy can be found at http://www.tuanpham.org/EnglishLyricsFull.htm.
9 3 versions can be found at http://dotchuoinon.com/2015/01/18/dan-ca-dan-nhac-vn-hat-ru-con-mien-nam/.
10 Cf. https://www.youtube.com/watch?v=xGHLTQzib3Y.
11 As described in the About *Sonic Visualiser* page of the freeware.

Analysis by the *Silvet Note Transcription*[12] plugin does not seem to identify pitches, pitch onsets and offsets distinctly due to low level recording of input where all channels are mixed. Manual intervention is thus required in this case. A music staff layer was superimposed on the pitch contour thanked to its Ellis measurement, and music notes were then assigned at onsets of spectrographic pitches with significant duration (by Phan Gia Anh Thư). The graph, cut into 4 pieces to fit the page in Figure 2, represent what was actually sung (and spoken) on a familiar music staff. We call it the enhanced pitch/intensity contour graph (PIC graph) of *Ru con*.

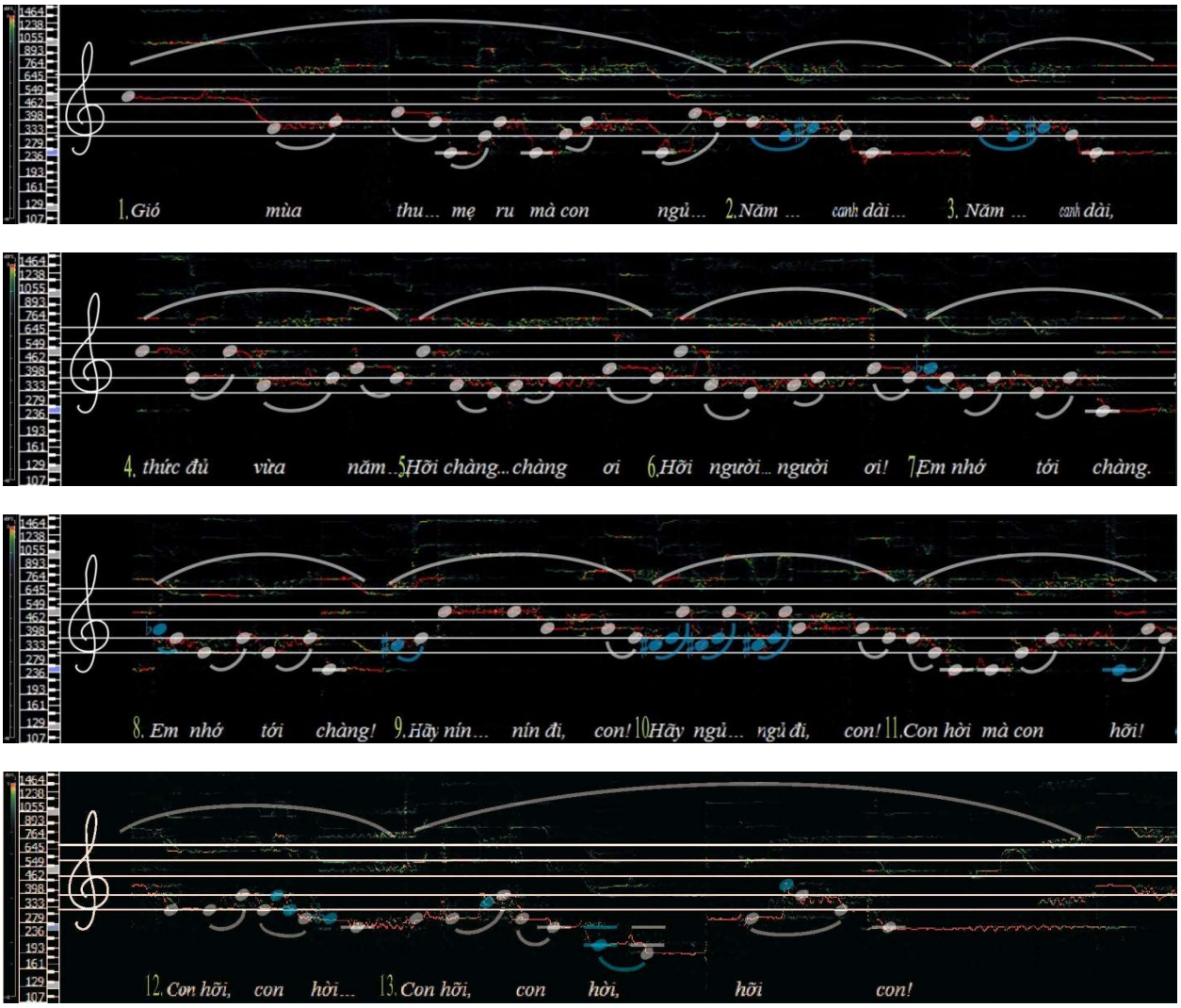

Figure 2. A pitch contour graph of *Ru con* with superimposed music staff.

3. Identifying

The size of the song *Ru con* is therefore 108 pitches, identified from its PIC graph, covering a duration of 1:23:20 minutes.

a. Phrasing

[12] Shift-Invariant Latent Variable Transcription (Silvet), a Vamp plugin from Queen Mary, University of London for polyphonic music, listens to audio recordings of music and tries to work out what notes are being played.

The lyric of the lullaby is composed of 6 sentences. The melody can be decomposed into 13 music phrases, blocked by over-arched phrase marks, usually covering the lyric line added under the PIC graph of Figure 2. A music phrase is thus identified by the corresponding lyric phrase, and further broken by lyric repetitions, if any. A performed music phrase, stripped of decorations, linguistic tone deviations, performance variations as well as the artist's dialectal and idiolectal styles, while its duration is kept intact, is called a skeletal phrase. Skeletal versions of songs are widely used in traditional music schools, usually printed in song books, and played in an ensemble as the music theme.

b. The voice range, pitch classes, and frequencies of occurrence of pitches

From the pitch contour graph above, the range of *Ru con* is G^3 to C^5, one and a half octaves, as shown on the x-axis in Figure 3 below.

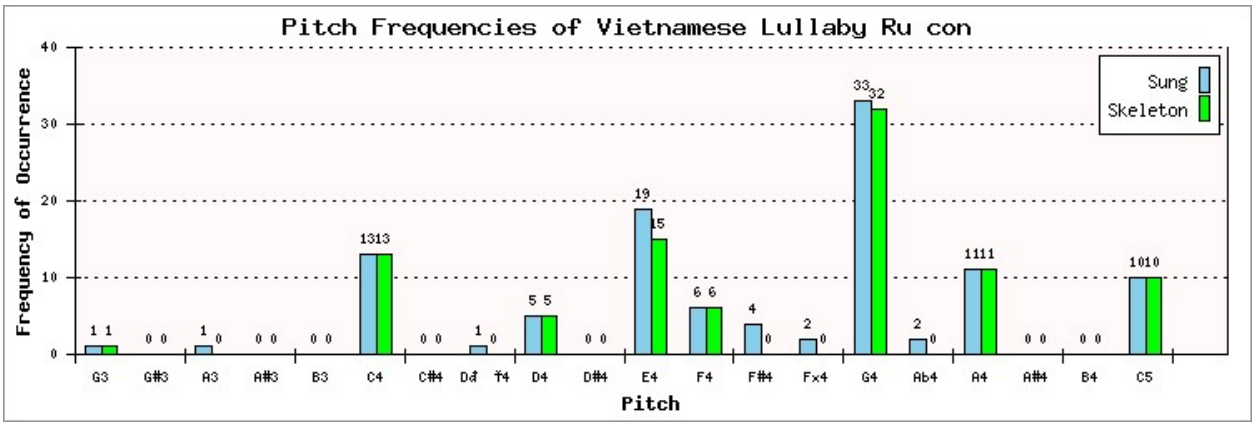

Figure 3. Frequencies of occurrence of pitches in *Ru con*.

Ru con, 108 pitches (or music notes) long, is comprised of 13 distinct pitches, with B's absent. There are two microtones, F♯+25*c* and D♭-25*c*. Frequencies of occurrence of these 13 pitches show the dominant presence of G, C, E, F and A as evidenced by their frequencies of occurrence, shown in parentheses: pitch class G (34) with G^4 (33) and G^3 (1), pitch class C (23) with C^4 (13) and C^5 (10), pitch E^4 (19) and pitch class A (12) with A^3 (1) and A^4 (11). Pitch D^4 (5) only appeared in the last two phrases. The skeletal version consists of 93 pitches and maintains the same properties as the performing version. The skeletal pitch classes are C, D, E, F, G and A.

c. The note and scale determination in the lullaby

This *hexatonic* song of C, D, E, F, G and A has a strong *pentatonic* and southern *điệu* property:

- The first 11 phrases of *Ru con* contain no Ds or Bs—resulting in the interplay of G, A, C, E and F, with *vibrato* on G and C—that seems to suggest a southern *điệu* "modal system" in *hơi oán* "mourning air";
- The last 2 phrases, pitch D appears, but without Fs or Bs, while still with strong *vibrato* on G and C—resulting in the interplay of C, D, E, G and A, suggesting perhaps the southern *điệu*, *hơi khách*.

These observations lend additional help to determine the choice of pitches for the skeletal music version, the manner of tuning the *đàn tranh* for this song, the change of air while playing, and the arrangement of different ensemble voices, or style bindings in free improvisations.

4. Key notes in context *(knic)* analyzing

Key notes in context, or ***knic***, is an algorithm used to discover the internal pitch regularities in a music piece. The ***knic*** patterns below show the tendencies of a pitch immediately followed by other specific pitches. Thus, ***knic***[x_1 x_2... x_n …] represents the frequencies of occurrence of a string of n adjacent pitches, where $2 \leq n \leq 8$, 2 is the shortest string, and 8 is the longest string. A pitch, after being delivered, tends to suggest other specific pitches of a music piece. A ***knic***, thus, in this paper, is a function fed by identifiable pitches (in *cents*) from the pitch contour of a performed music piece and giving frequencies of occurrence of two, three, four, five, etc. adjacent pitches. In this demonstration, we fed the performed version of *Ru con*, to ***knic***.

If a song is a skeletal piece, void of lyrics, written in tempered music notes, broken into phrases, while keeping the entire duration of the music piece intact, then ***knic*** shows its regular internal patterns of pitches in its simplest form. If ***knic***'s of a skeletal version and ***knic***'s of its performed version are similar, we say the skeletal version keeps the patterns of adjacent pitches intact.

a. ***knic*****[x_1 x_2]** of two adjacent pitches in *Ru con*

We call a di-pitch a string of two adjacent pitches in this discussion of *Ru con*. The skeletal version, in this case, covers 93 pitches out of the performed version of 108. The results show:

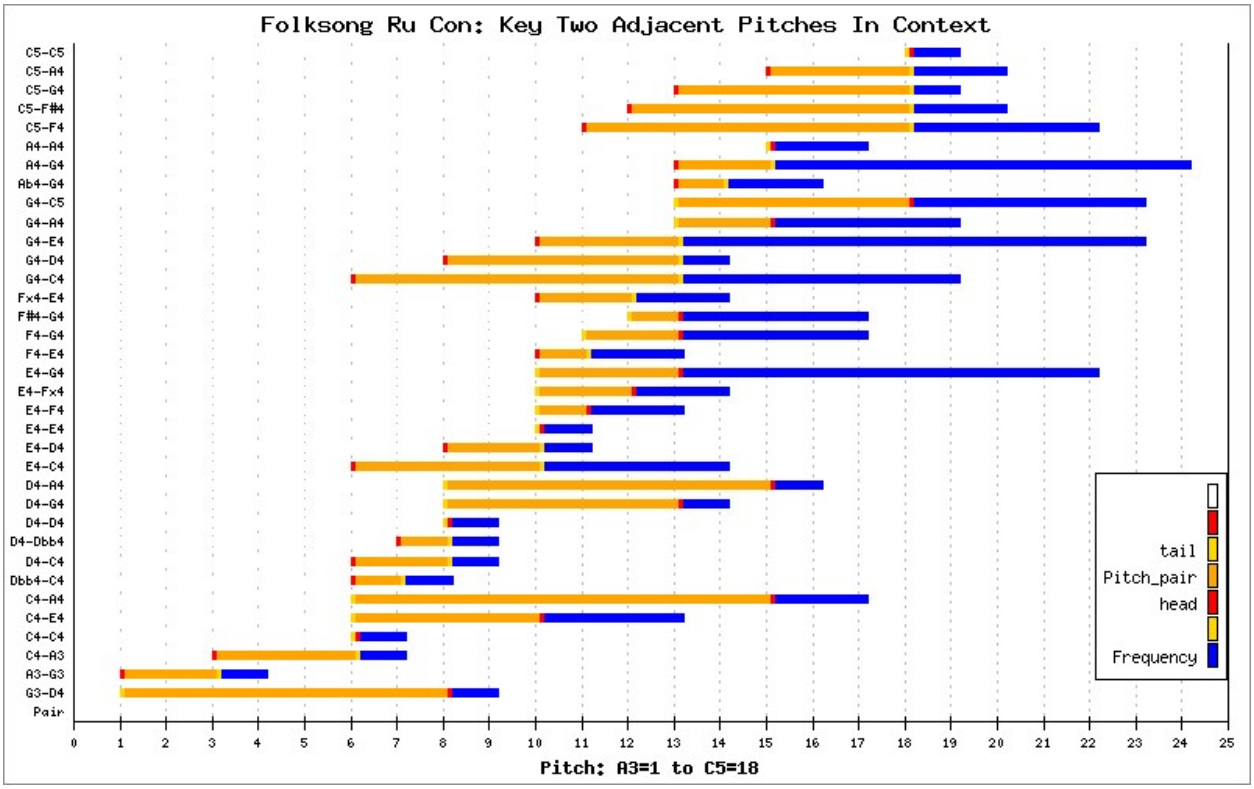

Figure 4. Di-pitch patterns in the performed version of *Ru con.*

i. ***knic*** of di-pitches in performed version, 35 patterns, total 96 di-pitches;
ii. ***knic*** of di-pitches, counted in pitch classes, 30 patterns, total 96 di-pitches;
iii. ***knic*** of di-pitches in skeletal version, 27 patterns, total 81 di-pitches.

For example, ***knic***[G C] = 11 means that a pitch class G immediately followed by pitch class C occurs 11 times in the performed version of *Ru con*. A graph of 35 di-pitches is shown with their frequencies of occurrences in Figure 4.

The data on ***knic*** for di-pitches show that there is not much difference between the performing version and the pitch class version, because the song really stays in one octave, i.e. from C^4 to C^5, except for two pitches, A^3 and G^3. The dominance of di-pitch patterns pools around G^4, i.e. ***knic***[G^4 C] = 11 (but ***knic***[C^5 G^4] = 1), and ***knic***[G^4 E^4] = 10 is almost the same as ***knic***[E^4 G^4] = 9, and ***knic***[A^4 G^4] = 9 while ***knic***[G^4 A^4] = 4. Movements between G and E total 19, between G and A total 13, and between G and C total 12, are all dominant. The ***knic***'s among G A C E pairs is 44 out of the entire piece of 96 di-pitches, which is about half of the song. This observation using ***knic***'s helps the students to learn improvisations with the song *Ru con*.

b. ***knic*****[x_1 x_2 x_3]**, frequency of occurrence of three adjacent pitches in *Ru con*

We call a tri-pitch a string of three adjacent pitches in this discussion. The number of tri-pitch patterns in *Ru con* remains the same as with di-pitch patterns, which is 35. The data shows:

i. ***knic*** of tri-pitches in performed version, 44 tri-pitch patterns, total 82 tri-pitches;
ii. ***knic*** of tri-pitches in pitch classes, 42 tri-pitch patterns, total 82 tri-pitches;
iii. ***knic*** of tri-pitches in skeletal version, 35 tri-pitch patterns, total 66 tri-pitches.

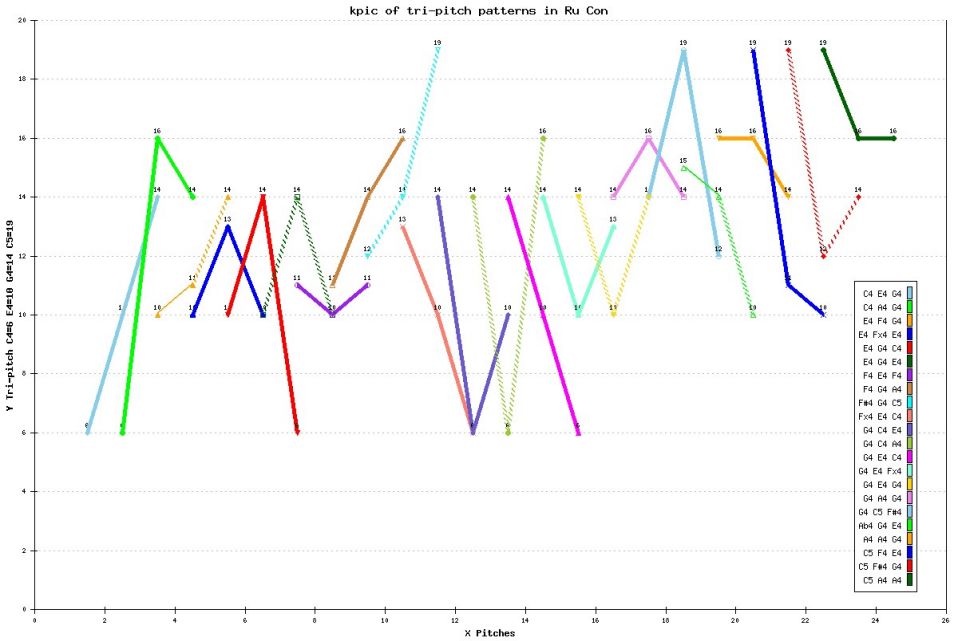

Figure 5. Tri-pitch patterns in the performed version of *Ru con.*

knic of tri-pitches higher than 3, among the performed version, or the version counted by pitch classes, and its skeletal version seems to agree with tri-pitches, C^4-E^4-G^4, C^4-A^4-G^4, E^4-G^4-C^4, E^4-G^4-E^4, F^4-G^4-A^4, $F\#^4$-G^4-C^5, G^4-E^4-C^4, G^4-C^4-A^4, G^4-E^4-G^4 and G^4-A^4-G^4, and C^5-G^4-C^5 in the skeletal version.

c. ***knic*[x_1 x_2 x_3 x_4]**, frequency of occurrence of four adjacent pitches in *Ru con*

We call a tetra-pitch a string of four adjacent pitches in this discussion. The number of tetra-pitch patterns in *Ru con* is significantly higher than that of tri-pitch patterns of 35. The data shows:

i. ***knic*** of tetra-pitches in performed version, 47 patterns, total 70 tetra-pitches;
ii. ***knic*** of tetra-pitches in pitch classes, 45 patterns, total 69 tetra-pitches;
iii. ***knic*** of tetra-pitches in skeletal version, 37 patterns, total 54 tetra-pitches.

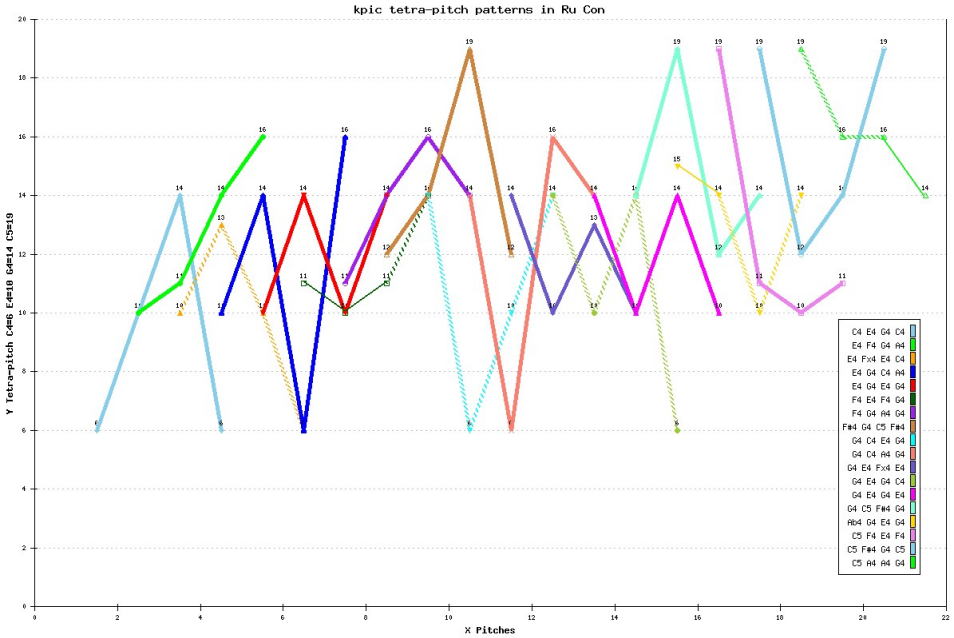

Figure 6. Tetra-pitch patterns in the performed version of *Ru con.*

The following ***knic*** patterns, above 3, show C^4-E^4-G^4-C^4, E^4-G^4-E^4-G^4, F^4-G^4-A^4-G^4, G^4-E^4-G^4-E^4. There is not much difference between the performed version, the performed version counted by pitch classes, and the skeletal version.

d. ***knic*[x_1 x_2 x_3 x_4 x_5]**, frequency of occurrence of five adjacent pitches in *Ru con*

We call a penta-pitch a string of five adjacent pitches in this discussion. The number of penta-pitch patterns in *Ru con* is lower than that of tetra-pitch patterns. The data shows:

i. ***knic*** of penta-pitches in performed version, 43 patterns, total 56 penta-pitches;
ii. ***knic*** of penta-pitches in pitch classes, 43 patterns, total 56 penta-pitches;
iii. ***knic*** of penta-pitches in skeletal version, 34 patterns, total 43 penta-pitches.

Most of the penta-pitch patterns occur only once, a few twice, which suggest repeats. There is not much difference between the performed version, the pitch class version, and the skeletal version.

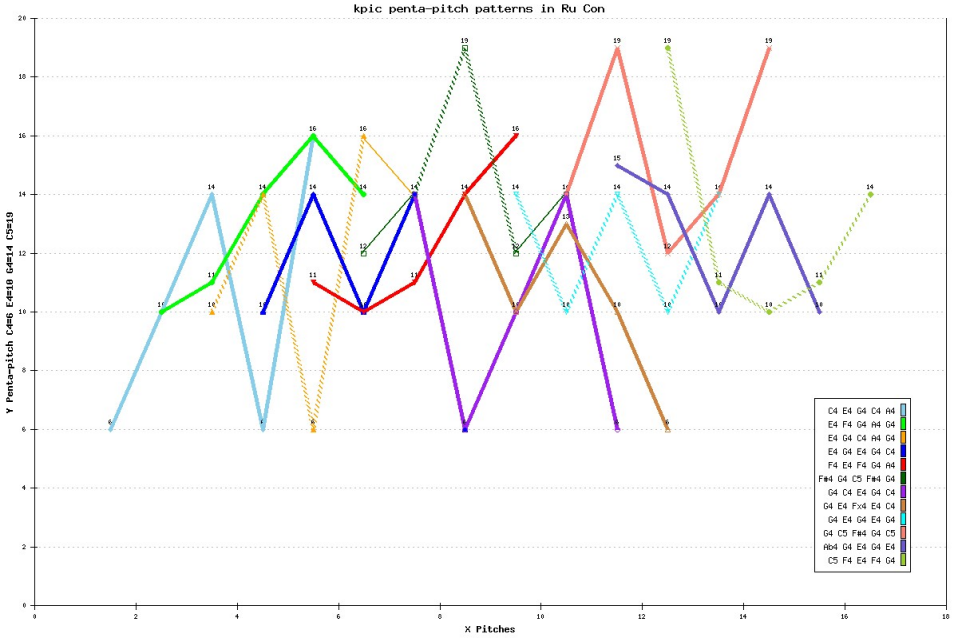

Figure 7. Penta-pitch patterns in the performed version of *Ru con.*

We note in general that ***knic***[x_1 x_2... x_n], $2 \leq n \leq 8$ for *Ru con*, exhausts all possible strings of adjacent pitches when n starts to be equal to the number of pitches of the shortest phrases (3 in the skeletal version, 5 in the sung version of *Ru con*) and reaches those of the longest phrases (7 in *Ru con*). Patterns of di-pitches and tri-pitches are strongest with G^4: all 11 tri-pitch patterns involve G^4.

The fact that ***knic*** results are found to be similar in the skeletal version and the performed version of *Ru con* tells us that the skeletal version seems to retain meaningful melodic nuances of the performed version. Of course, this is only an initial exercise. More research is required, but the results of the experiments with PIC graph and ***knic*** on *Ru con* are encouraging.

CONCLUSION

The MTVIET song analysis method attempts to formulate reliable means to aid teachers of Vietnamese traditional and folk music, while attending to the needed *finesse* of Vietnamese music. In this paper, we have developed the pitch/intensity contour graph, or the PIC graph, using a peak frequency spectrogram generated by *Sonic Visualisation*, superimposed by a music staff and assigned identifiable pitches with note heads. From the enriched PIC graph, we then cut the performed version of the music piece into phrases, define its corresponding skeletal version, and fed both versions to *key notes in context* algorithm, or ***knic***, to discover the recurrent pitch patterns in the piece. In this paper, we apply these procedures to *Ru con miền Nam*, a lullaby from southern Vietnam, sung by Ms. Bích Tuyền, and obtained from Youtube.

The enriched PIC graph tells us that *Ru con miền Nam* consists of 108 distinct pitches, broken

into 13 phrases in the pentatonic *điệu nam* southern "modal system" (evidenced by a strong *rung vibrato* on G and a weak *vibrato* on C). The skeletal version displays evidence of *hơi oán* "mourning air" in the first 11 phrases (scale C E F G A) modulating to *hơi khách* "northern air" (scale C D E G A) in the last two-phrase cadence. The ***knic*** analysis of *Ru con* confirms the dominant role of pitch classes G and C on the entire piece with a strong presence of E and A.

The pitch contour graph clearly shows a series of microtones in this piece, marked as F♯+25*c* and D♭-25*c* related to the modal *vibrato* of G and C. We suspect that these microtones are mode-dependent and could represent the characteristic feel of Vietnamese music. The PIC graph also shows the behavior of Vietnamese linguistic tones on the melody throughout the piece. For example, the influence of linguistic tones is evidenced in the first note of the PIC graph of *Ru con*, C^5, sung for a duration of 2.6*sec*. The voice seems to stay at tone *ngang* "high level" for *gio* "ash" but spikes abruptly towards the end to D^5 for 0.20*sec*, turning tone *ngang* into tone *sắc* "high rising" to form *gió* "breeze." In addition, there are strong vibrations of the voice over the pitches, G^4 and C^5. These two behaviors require future in-depth research with a much larger data set including their accompanying PIC graphs and *key notes in context* analyses.

Finally, the PIC graph brings music researchers closer to the raw data. Although the weaknesses of using spectrograms for music study, remarked upon in many scientific forums are duly noted, it does give us measurable information about silence (rests), pitch and rest durations, and intensity of each pitch, etc. which potentially show the metrical structure as well as the rhythmic patterns of a piece. We shall leave these important subjects for future research.

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