PATENT COOPERATION TREATY

From the RECEIVING OFFICE

To:	**PCT**
RICHARD G.A. BONE VLP LAW GROUP LLP 555 BRYANT STREET SUITE 820 PALO ALTO, CALIFORNIA 94301	COMMUNICATION IN CASES FOR WHICH NO OTHER FORM IS APPLICABLE
Confirmation No: 5215	Date of mailing *(day/month/year)* 17 May 2017
Applicant's or agent's file reference 2006-003WO1	**REPLY DUE** See paragraph 1 below
International application No. PCT/US2017/016756	International filing date *(day/month/year)* 06 Feb 2017
Applicant NEW RESONANCE, LLC	

1. ☐ REPLY DUE within ______ months/days from the above date of mailing

   ☐ NO REPLY DUE, however, see below ________________________

   ☒ IMPORTANT COMMUNICATION

   ☐ INFORMATION ONLY

2. COMMUNICATION:

Applicant's 13 APR 2017 communication forwarding proposed replacement drawing sheets nos. 1/16-16/16 and proposed replacement sheets nos. 9, 42, 45, 46, 47, 68 and 69 has been received.

The proposed replacement sheets include changes made therein which render them ineligible for entry under PCT Rule 26. Specifically:

Figs. 1 and 10A-10D: text deleted.
Figs. 8A-8B and 10A-10D: text added.
Figures 8 and 10 renumbered.
Sheets nos. 9, 42, 45-47, 68 and 69 of the description: text altered.

At this point in international processing, such changes may be entered only if the appropriate authority, in this case the ISA, considers the changes to be the rectification of obvious mistakes. See PCT Rule 91. The USPTO is not the ISA for the present international application and therefore, cannot make such a ruling.

If applicants want to pursue making these changes, applicants should send a copy of the proposed replacement drawing sheets to the European International Searching Authority (ISA/EP) together with a request for rectification of obvious mistakes. See PCT Rule 91.1(b)(ii). The United States Receiving Office (RO/US) has placed these sheets in the Home Copy but has not and will not forward them to the ISA/EP.

Accordingly, proposed replacement drawing sheets nos. 1/16, 8/16, 9/16 and 11/16-14/16 and proposed replacement sheets nos. 9, 42, 45-47, 68 and 69 of the description are REFUSED. It is noted that the RO/US has approved the remaining drawing sheets for entry as substitute sheets.

Name and mailing address of the receiving Office	Authorized officer
Mail Stop PCT, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450	Jeremy Fleming
Facsimile No. 571-273-8300	Telephone No. 571-272-3284

Attorney Docket No.: 2006-003WO1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
AS INTERNATIONAL RECEIVING OFFICE

Applicant	: New Resonance, LLC	Customer No.	: **86012**
Int'l. App. No.	: **PCT/US2017/016756**	Confirmation No.	: 5215
Int'l. Filing Date	: 06 Feb. 2017	Priority Date	: 5 Feb. 2016

Title: MAPPING CHARACTERISTICS OF MUSIC INTO A VISUAL DISPLAY

RESPONSE TO INVITATION TO CORRECT DEFECTS
IN THE INTERNATIONAL APPLICATION

Mail Stop: PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

ATTENTION: George Poindexter, Authorized Officer

Dear Sir:

This communication is in response to the *Invitation to Correct Defects in the International Application* ("Invitation") mailed by the U.S. Receiving Office of the PCT on 13 February 2017 in the above referenced international application.

As specified in Annex A of the Invitation, the following defects are found in the international application as filed:

1) the drawings do not admit of direct reproduction, and contain numbers, letters and reference lines lacking simplicity and clarity.

Applicant submits herewith 16 replacement drawing sheets showing the Figures of the international application to replace the originally filed drawing sheets. In the replacement drawings, original FIG. 8 has been re-presented as FIGs. 8a and 8b, on two separate sheets, and original FIG. 10 has been re-presented as FIGs. 10a – 10d on four separate sheets.

1355137_1

CERTIFICATE OF TRANSMISSION BY EFS-WEB FILING

I hereby certify that this paper was filed with the U.S. Patent and Trademark Office using the EFS-WEB system on this date: ____April 13, 2017_______

________/Richard G. A. Bone/________
Richard G. A. Bone, Reg. No. 56,637

Applicant also submits 7 replacement sheets of the specification of the application containing portions of text updated to reference figure panels, as renumbered in the replacement drawing sheets.

Applicant believes that this response and accompanying drawings places the above-referenced international application in order for publication and that no additional fees are due at this time.

Furthermore, the response is timely, being submitted no later than two (2) months from the mailing date of the Invitation.

If the Receiving Office requires any additional information or documents, please contact the undersigned at the telephone number indicated below.

Respectfully submitted,

Date: April 13, 2017

/Richard G. A. Bone/

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[0030] FIG. 2 is a flow chart illustrating Stage 1 of the present process in which a music source file is stepwise converted to a time stream of Pitch-Amplitude-LIV (PAL) tables.

[0031] FIG. 3 illustrates how the time offsets of successive music samples relate to time resolution and recognition of the onset of a note.

[0032] FIG. 4 provides a representative format for a PAL table.

[0033] FIG. 5 expands that step in FIG. 2 regarding the detection and characterization of new notes and hits in a given time segment, as well as the updating of prior determinations.

[0034] FIG. 6 illustrates the process steps involved in each decision diamond of FIG. 5.

[0035] FIG. 7 is a flow chart illustrating how accumulated data, external updating, and machine learning support the operations of FIG. 5.

[0036] FIGs. 8a and 8b show a flow chart illustrating Stage 2 of the present process, in which a time stream of PAL tables are converted to a time stream of psychoacoustic attribute files (PAFs).

[0037] FIG. 9 provides a representative format for a PAF, generated for each time segment by Stage 2.

[0038] FIGs. 10a – 10d provide a representative format of a visual display generated by the invention.

[0039] FIG. 11 presents the relationship between six aspects of implementation and mapping selection.

[0040] FIG. 12 shows a schematic computer implementation.

[0041] Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0042] The instant technology is directed to the visualization of music, such as the translation, or mapping, of music into a corresponding visual form that can be displayed on

Stage 2

[0157] The second stage of the method is illustrated in FIGs. 8a, 8b. The purpose of the second stage is to take the output of Stage 1, i.e., a time stream of PAL tables 123, and convert it to a time stream of psychoacoustic attribute files, PAFs, 214. The format of a representative PAF is presented in FIG. 9.

[0158] In overview, Stage 2 analyzes the time stream of PALs to extract all the remaining cues to be used by the system, all cues other than pitch, amplitude and LIV. The input time stream of PALs can originate within the device (as 123), or from a different device separately acquired by the listener (as 125) such as a separately acquired MIDI file, or a Stage 1 output from a different system. Stage 2 is comprised of five levels, as follows:

Stage 2, level 1

[0159] The first level of Stage 2 calculates across-all-note, within-TSX, metrics, of which there can be the following four, among others: 201: summing the amplitudes of all notes in a particular TSX to give a total TSX amplitude or volume; 202: calculating one or more chordal structures from frequency ratios; 203: assigning an individual affect score (i.e., an affect score for one TSX) based on factors such as pitch, tempo, key (*i.e.*, major or minor) and instrumentation; and 204: assigning an individual tension score (i.e., a tension score for one TSX) based on several factors, including such as chord inversions and chord progressions, intervals, relationships between melody and harmony lines, relationships between multiple melody lines, relationships between current notes and the tonic, and volume. Each of the foregoing metrics is calculated for a single time segment TSX (*cf.* FIGs. 8a, 8b). The methods herein are not limited to those four metrics.

[0160] Processing in level 1 of stage 2 thus provides summed amplitudes, calculated chord structures, affect scores, ambience scores, and tension scores for each TSX analyzed. Other calculations in Stage 2, *i.e.*, the calculations for levels 2 through 4, involve analysis of not only the current TSX but also a plurality of preceding TSXs. The number of preceding TSXs analyzed depends on the particular metric provided, as will be further described.

Stage 2, Level 5

[0167] In level 5 of stage 2, pitch intervals between notes are determined by: (1) the ratio of the two frequencies associated with two pitches of any two simultaneously played notes; (2) separately, for each note in a TSX, the note's pitch interval relationship to the last ended associated note. The data from this level is used to calculate several audio cues: chords, intervals, note sequences and transitional notes.

[0168] The information from all five levels of stage 2 is loaded into a current PAF, and updates previous PAFs as necessary, as indicated at the bottom of FIG. 8b. The numbers in FIG. 8b, i.e. “40 current notes, … 40 previous notes,” are for example only, and in fact represent the upper limit of what would normally be called for.

[0169] A representative PAF format is presented in FIG. 9. The interval relationship of a note to each simultaneously sounded note and to the last ending note, calculated in level 5 of stage 2, is indicated in the lower part of the table. Both the representative PAL table format of FIG. 4 and the representative PAF format of FIG. 9 are general in nature, so that they can support a variety of perceptually conformal mapping systems. The numbers in Fig. 9 are also exemplary only. The number “20” for notes in FIG. 4 is also for example only; the numbering of FIG. 4 is not inconsistent with the numbering in FIGs. 8a, 8b, and 9, but is not since FIG. 4 assumes a maximum of 20 notes at the same pitch.

[0170] The result of the calculations and determinations of stage 2 is a psychoacoustic attribute file that contains a full characterization of all psychoacoustic cues for the musical piece, in time order TSX by TSX. That is, each TSX segment has, at this point, an associated PAF. The PAFs for the entire musical piece are sequentially loaded, in real time, into a PAF sequence buffer.

[0171] The output of stage 2, *i.e.*, the time stream 214 of PAFs, can be input directly into a stage 3 that is integrated into a single system containing both stage 2 and stage 3, or it may be provided as a separate output 215 to a consumer to be used in connection with a user-selected, separately acquired stage 3.

Stage 3

[0172] In stage 3, the PAF time stream 214 obtained as the output of stage 2 is converted into a visual display. That time stream can originate within the device (as 214) or from a different device separately acquired by the consumer (as 216). Stage 3, then, is where the mapping discussed previously occurs, taking the time sequence of PAFs and turning it into a signal to be fed into a visual display. As discussed earlier, different mappings may be applied for different types of music (e.g., different genres, voice versus instrumental, and the like) and for different types of displays (e.g., small screens versus JumboTrons, etc.). The selected audio-to-visual mapping algorithm is indicated at 303 in FIG. 1. As FIG. 1 also indicates, that mapping can be selected by an algorithm as indicated at 301 or that selection can be manually overridden by the user through a control device, as indicated at 302, e.g., if the user prefers a different mapping or different level of abstraction. A user can, for instance, use a remote control device to control not only mappings, but also the number of melody and harmony lines separately displayed, the amount of time displayed, time streaming options (right-to-left, right and left to center, center to right and left, etc.), and other aspects of the visualization. A representative perceptually conformal mapping system is described elsewhere herein, and alternatives to and variations of that mapping system will be apparent to those of ordinary skill in the art and/or can be arrived at using minimal experimentation.

[0173] FIG. 1 presents all three stages of the method, starting with the music source file and ending with the output of Stage 3 that is sent to the visual display. FIG. 1 also illustrates a particular aspect of updating, namely, that the updating of previous PALs (123) and updating of previous PAFs (214) have the effect of updating the visual cues in previous TSXs on the display (see also FIGs. 10a–10d). That is, as the visual cues in earlier TSXs time-stream across the display (in FIGs. 10a–10d, from right to left), those cues may be updated and so change. This feature mimics human music perception and takes into account the processing of the auditory information over time. For example, that part of the music that is the melody takes some seconds or fraction of a second to be recognized as such. The recognition applies to the melody sequence from its beginning. The same process applies to recognizing an instrument as, for example, a viola.

[0174] The operations of Stages 1, 2, and 3 are performed by a device having any one of a variety of configurations. For instance, the device can be a digital signal processing circuit inside in a consumer entertainment device or packaged in a separate housing. It can also be implemented in music processing devices for music producers and concert producers.

[0175] FIGs. 10a – 10d schematically illustrate a representative display showing possible visual cues accompanying a segment of music; this example of a display shows how the visual cues described previously can be displayed. The circled numbers in FIGs. 10a – 10d correspond to the cue numbering elsewhere herein (see Appendix A, for example).

[0176] The system can store information associated with a piece of music it processes, such that the music is stored along with the set of audio cues identified. Over time, the stored information can grow, e.g. at a market-wide scale, and ultimately be used as reference library that the system can query to find a particular piece of music or type of music. For instance, a consumer may wish to find a piece of music in a particular key with a particular affect played by a particular instrument, and can query the stored information in order to identify such a piece of music.

Applications

[0177] The method has several applications that do not depend on the real-time performance of a full implementation of all of the operations described herein. The system can be modified in one or more ways to reduce its overall computational burden, so that it may be made available to a variety of end users with different needs and/or expectations. Such modifications include, without limitation: capability of operating in real time, *i.e.*, capability of processing as music is presented; operation at different levels of time resolution; sophistication of mapping; level of detail in voice/singer identification (*e.g.*, female, generically, versus specific individual such as Taylor Swift or Marilyn Horne); level of detail in instrument identification (e.g., string instrument versus viola); sophistication of melody-harmony recognition; and sophistication of options offered to the user on a control device.

[0178] The various types of user can be placed in three categories: individual consumers; concerts; and commercial music producers. These applications are also (then time streamed as described above), sized ("stretched") to match its time duration, placed vertically according to its Pitch, with brightness or size according to its Amplitude, with shapes, lines, borders, patterns, textures, colors, sizes and time fluctuations to depict other cues associated with the Note. A Note without tonal Pitch, e.g. percussive hit, may be assigned to a separate region on the display.

Audio Cue 2. Time Extent of a Note, Strum, Chord, or any other audio cue with a time of appearance and disappearance

[0256] Metric: Position on the display along a dimension depicting time, that dimension can be binary (current vs. past time) or two-stage (current time then past time streaming in some direction), or continuous time streaming from current to past time. In any case with time streaming, that past time will be depicted on a metric spatially linear, or non-linear compressed with more time per spatial extent as the time streaming approaches a disappearance point. A linear metric can be a ratio metric, with the zero point defined as the appearance point, or in displays with a current column, as in FIGs. 10a – 10d, as the boundary between the current column and the time streaming part of the display.

[0257] Visual Cue Vocabulary: Any audio cue that has a Time Extent, i.e. a time of appearance then disappearance, can be depicted as appearing and disappearing along a visual dimension depicting time. For example, a Note can appear at an appearance point, points, line or lines, then visually extend in a time streaming pattern to a disappearance point, points, line or lines. For example: A Note can appear at the right edge of the display, then time stream to the left to disappear at the left edge. Visual cues not associated with an individual Note, *e.g.*, Affect (Cue 17), can be depicted either in a time relation with the Notes to which it is associated, e.g. matching (in time) its associated Notes in a time streaming pattern but separated from those Notes, or that audio cue can be represented by a visual cue, e.g. a colored area or bar, that appears and disappears in time, in a way not linked to a time streaming pattern in the visual display. The two-stage case mentioned in the metric discussion is presented in FIGs. 10a–10d, with a current column representing the currently playing Notes, then a time streaming pattern off to its left. In that type of display, the Time Extent of a Note is indicated by both its existence in the current column and in the time streaming part of the display to the (in this case) left. Note that in cases where the time streaming pattern is non-linear in time, e.g. where that pattern is compressed in time per spatial extent as the time streaming approaches the disappearance point, points, line or lines, the spatial extent of a Note is not linear with its Time Extent.

Audio Cue 3. Pitch.

[0258] The Pitch of a Note is perceived based on its frequency. The Pitch of a group of Notes, such as a guitar Strum, is associated with the Pitches of its component Notes.

[0259] Metric: Ordinal, anywhere from monotonic to logarithmic in frequency. Generally, logarithmic metric on frequency is desirable in that Pitch is perceived on a logarithmic scale with frequency. That is, an octave interval is always a factor of two in frequency, with each other musical interval corresponding to a certain ratio of frequencies. That logarithmic metric means, then, that for cases where Pitch is mapped on to a spatial dimension on the display, any given musical interval is mapped on to a given distance on the display. For example, an octave will always correspond to X inches on the display, a major fifth will correspond to 7/12*X inches (if well tempered) on the display, etc. That said, it can be effective to adjust that logarithmic scale over the range of Pitches, e.g. to compress that scale in terms of interval per inch as Pitch moves up, or alternatively to compress that scale as Pitch moves down.

[0260] Visual Cue Vocabulary: Pitch can be mapped onto any axis of the display or line on the display. One mapping of Pitch would be to the vertical position on the display, with Notes without tonal Pitch, e.g. percussive hits, assigned to a special region of the display. However, Pitch may also be mapped to one or more other visual cues on List (a) Version 5, the ordinal version.

Audio Cue 4. Amplitude of a Note

[0261] The perceived Amplitude of a Note is a logarithmic function of physical amplitude of that Note.

[0262] Metric: All ordinal metrics can apply to this cue: Monotonic, non-linear, linear, ratio or logarithmic in physical amplitude, though note as described further herein that some adjustments to the metric can be desirable. Aside from those adjustments, a logarithmic metric on physical amplitude is desirable in that Amplitude is perceived on a logarithmic scale with physical amplitude.

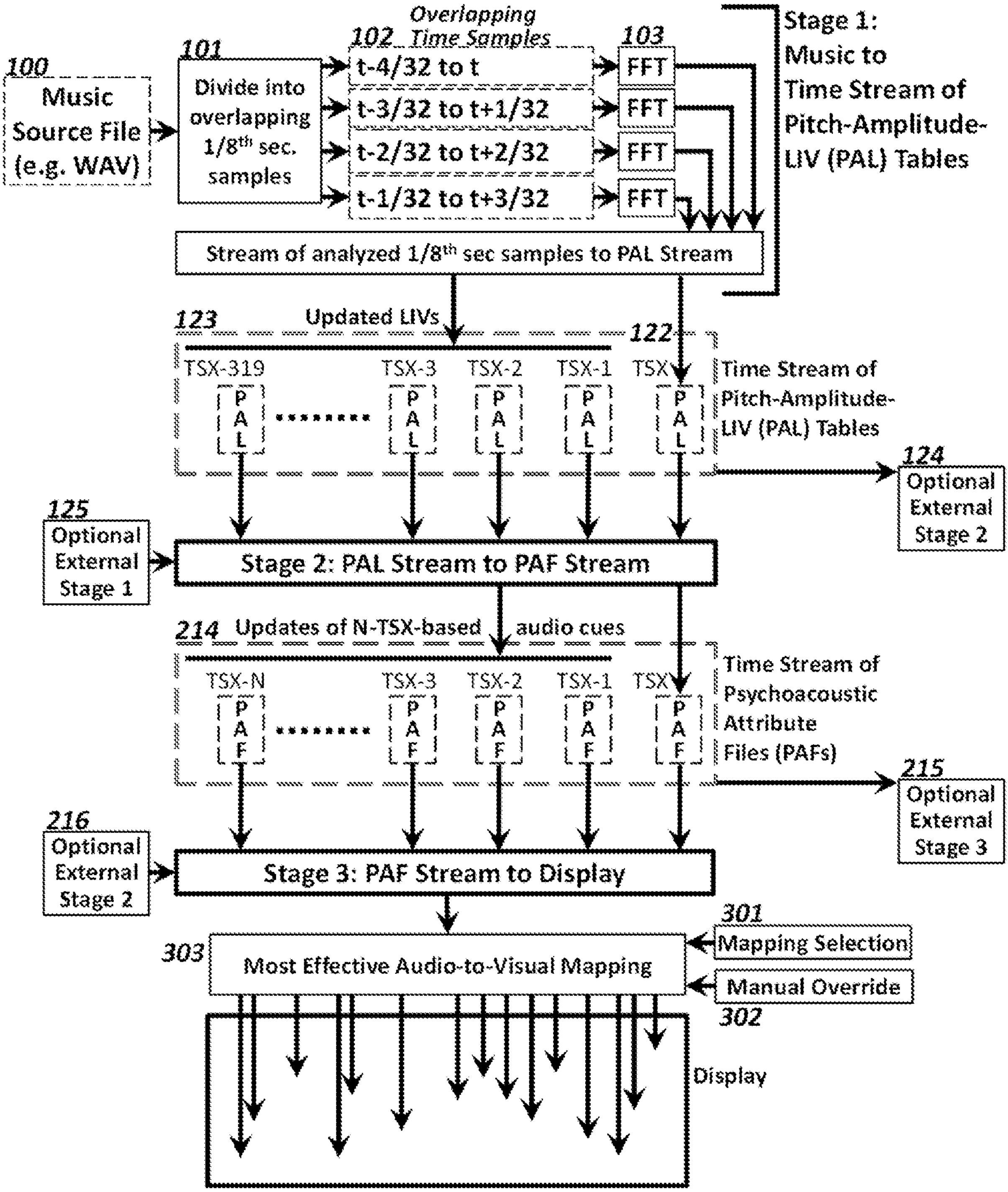
100
Music Source File (e.g. WAV)
101
Divide into overlapping 1/8th sec. samples
102
Overlapping Time Samples
t-4/32 to t
t-3/32 to t+1/32
t-2/32 to t+2/32
t-1/32 to t+3/32
103
FFT
FFT
FFT
FFT
Stage 1: Music to Time Stream of Pitch-Amplitude-LIV (PAL) Tables
Stream of analyzed 1/8th sec samples to PAL Stream
123
Updated LIVs
122
TSX-319
TSX-3
TSX-2
TSX-1
TSX
PAL
Time Stream of Pitch-Amplitude-LIV (PAL) Tables
124
Optional External Stage 2
125
Optional External Stage 1
Stage 2: PAL Stream to PAF Stream
214
Updates of N-TSX-based audio cues
TSX-N
TSX-3
TSX-2
TSX-1
TSX
PAF
Time Stream of Psychoacoustic Attribute Files (PAFs)
215
Optional External Stage 3
216
Optional External Stage 2
Stage 3: PAF Stream to Display
301
Mapping Selection
303
Most Effective Audio-to-Visual Mapping
Manual Override
302
Display

FIG. 1

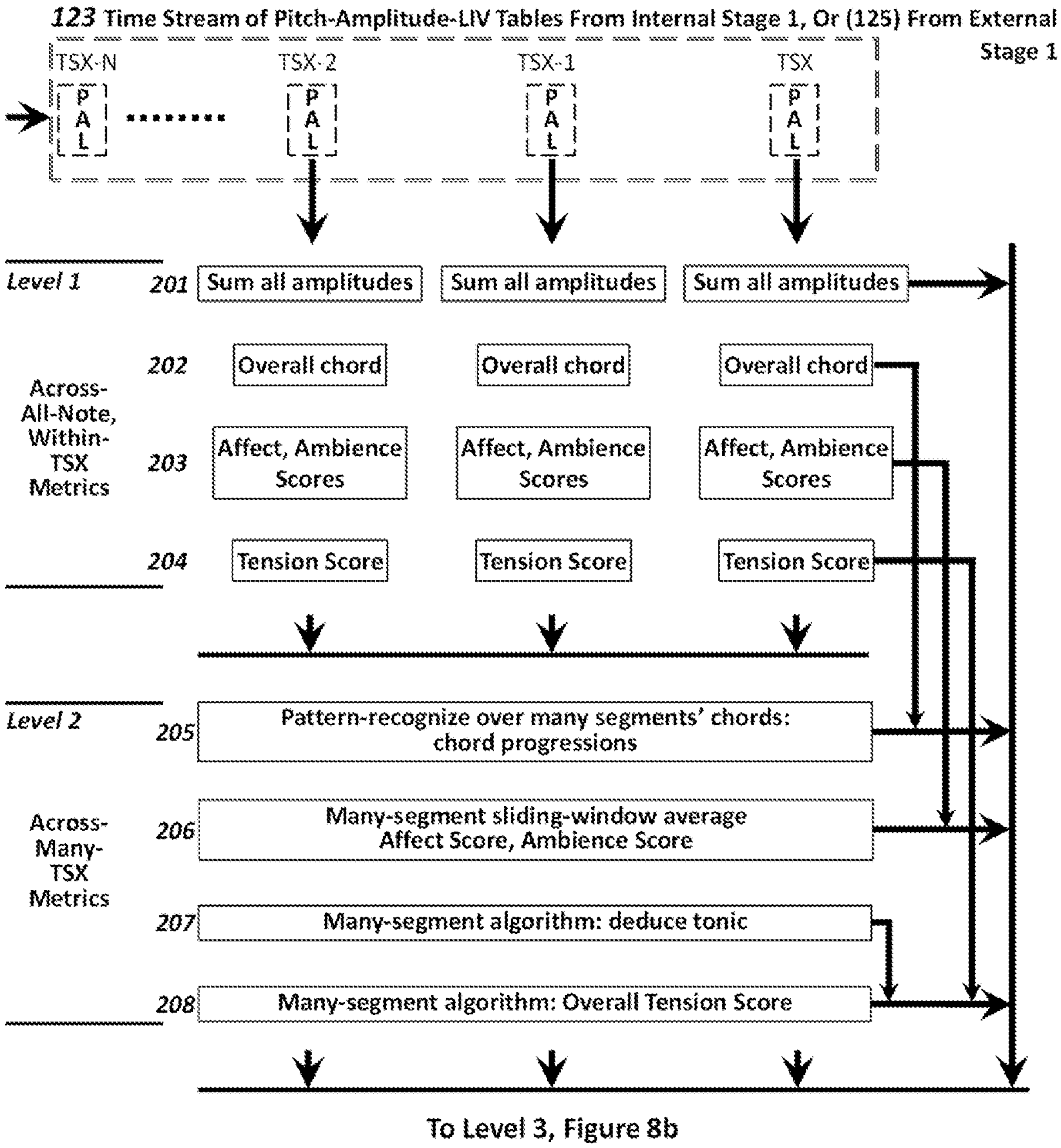
123 Time Stream of Pitch-Amplitude-LIV Tables From Internal Stage 1, Or (125) From External Stage 1
TSX-N
TSX-2
TSX-1
TSX
P A L
Level 1
201
Sum all amplitudes
202
Overall chord
Across-All-Note, Within-TSX Metrics
203
Affect, Ambience Scores
204
Tension Score
Level 2
205
Pattern-recognize over many segments' chords: chord progressions
Across-Many-TSX Metrics
206
Many-segment sliding-window average Affect Score, Ambience Score
207
Many-segment algorithm: deduce tonic
208
Many-segment algorithm: Overall Tension Score
To Level 3, Figure 8b

FIG. 8a

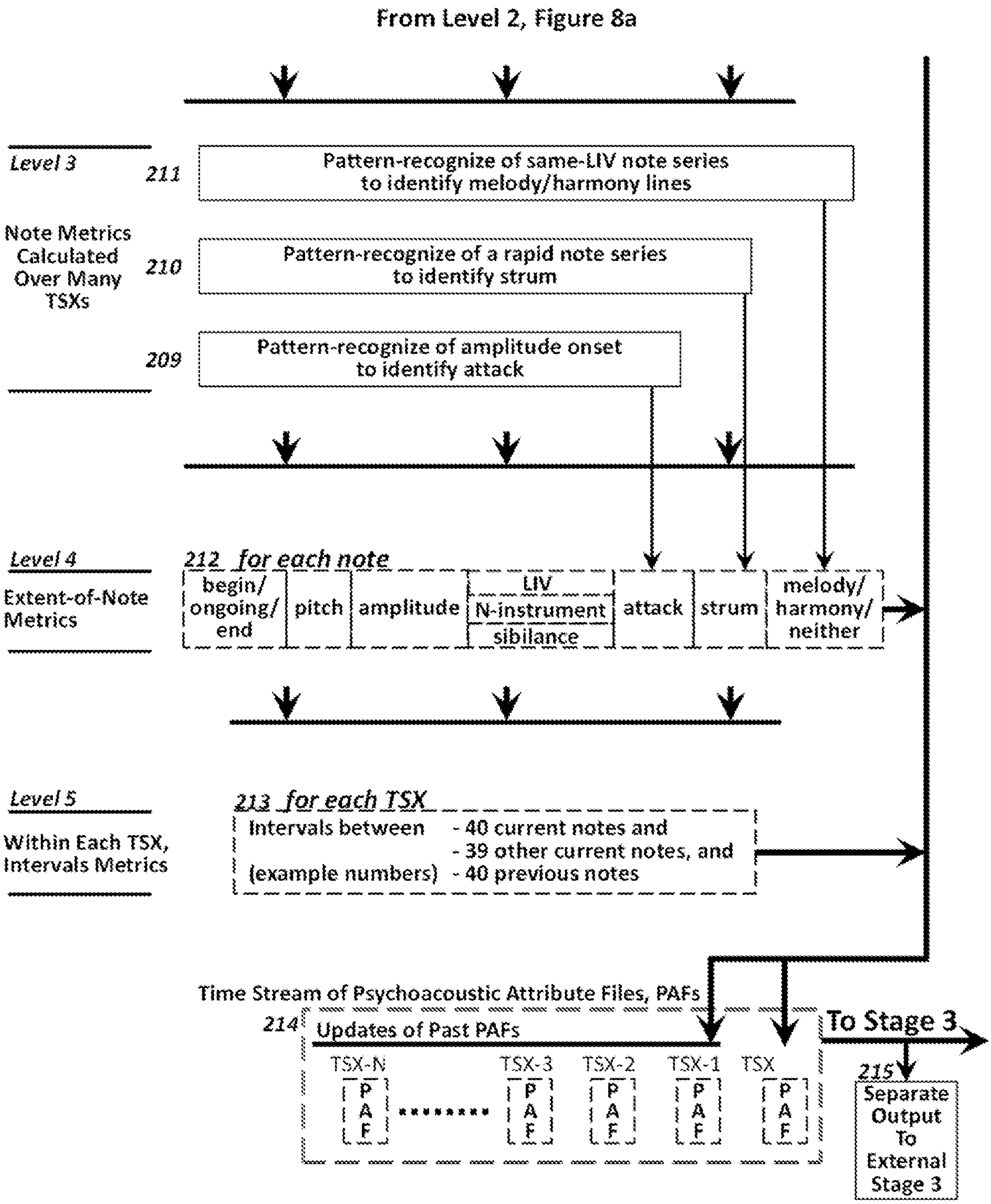
From Level 2, Figure 8a
Level 3
Note Metrics Calculated Over Many TSXs
211
Pattern-recognize of same-LIV note series to identify melody/harmony lines
210
Pattern-recognize of a rapid note series to identify strum
209
Pattern-recognize of amplitude onset to identify attack
Level 4
Extent-of-Note Metrics
212 for each note
begin/ ongoing/ end
pitch
amplitude
LIV
N-instrument
sibilance
attack
strum
melody/ harmony/ neither
Level 5
Within Each TSX, Intervals Metrics
213 for each TSX
Intervals between
(example numbers)
- 40 current notes and
- 39 other current notes, and
- 40 previous notes
Time Stream of Psychoacoustic Attribute Files, PAFs
214
Updates of Past PAFs
TSX-N
TSX-3
TSX-2
TSX-1
TSX
P A F
To Stage 3
215
Separate Output To External Stage 3

FIG. 8b

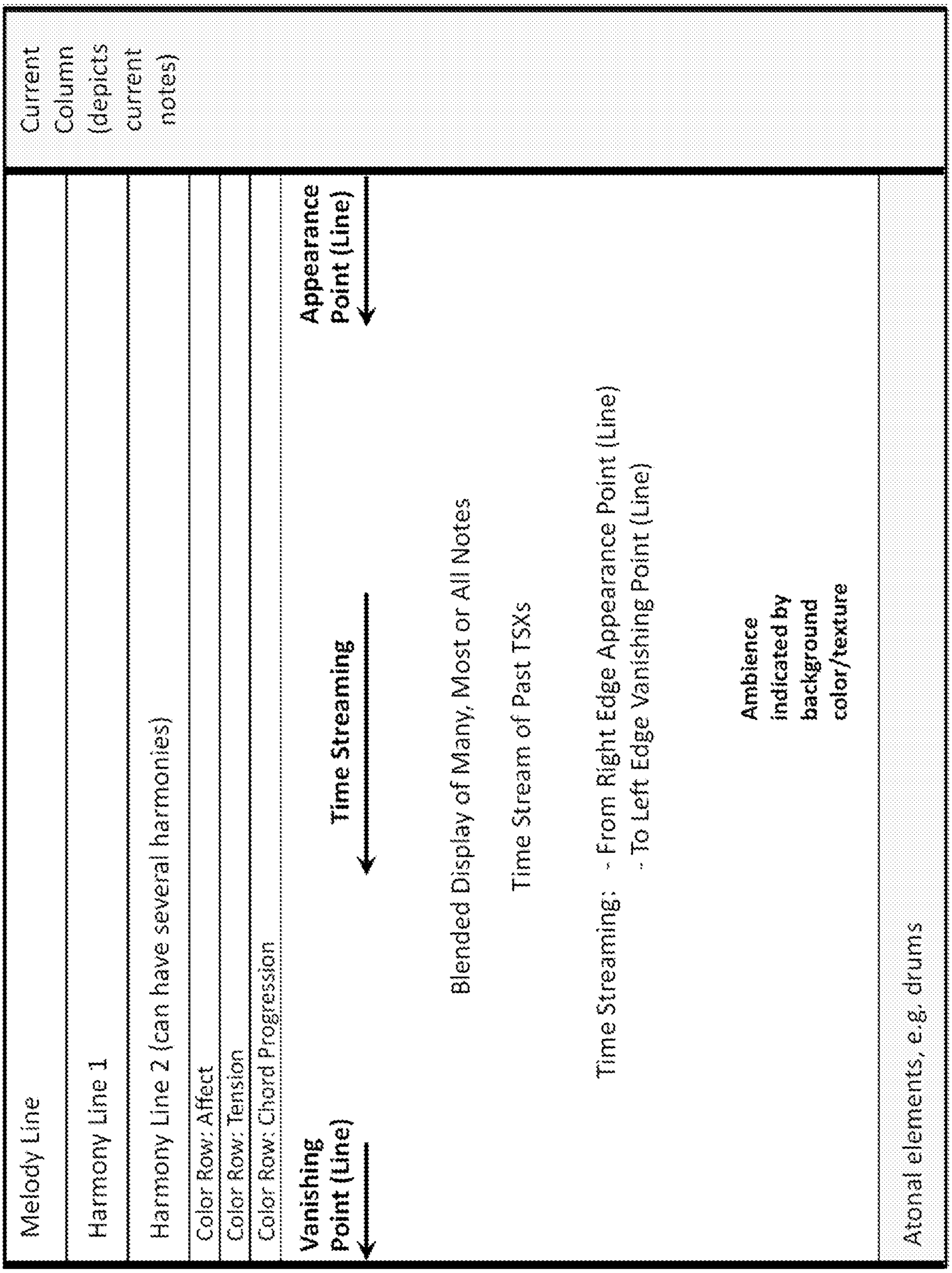
Melody Line
Harmony Line 1
Harmony Line 2 (can have several harmonies)
Color Row: Affect
Color Row: Tension
Color Row: Chord Progression
Vanishing Point (Line)
Time Streaming
Appearance Point (Line)
Blended Display of Many, Most or All Notes
Time Stream of Past TSXs
Time Streaming: - From Right Edge Appearance Point (Line)
- To Left Edge Vanishing Point (Line)
Ambience indicated by background color/texture
Atonal elements, e.g. drums
Current Column (depicts current notes)

FIG. 10a

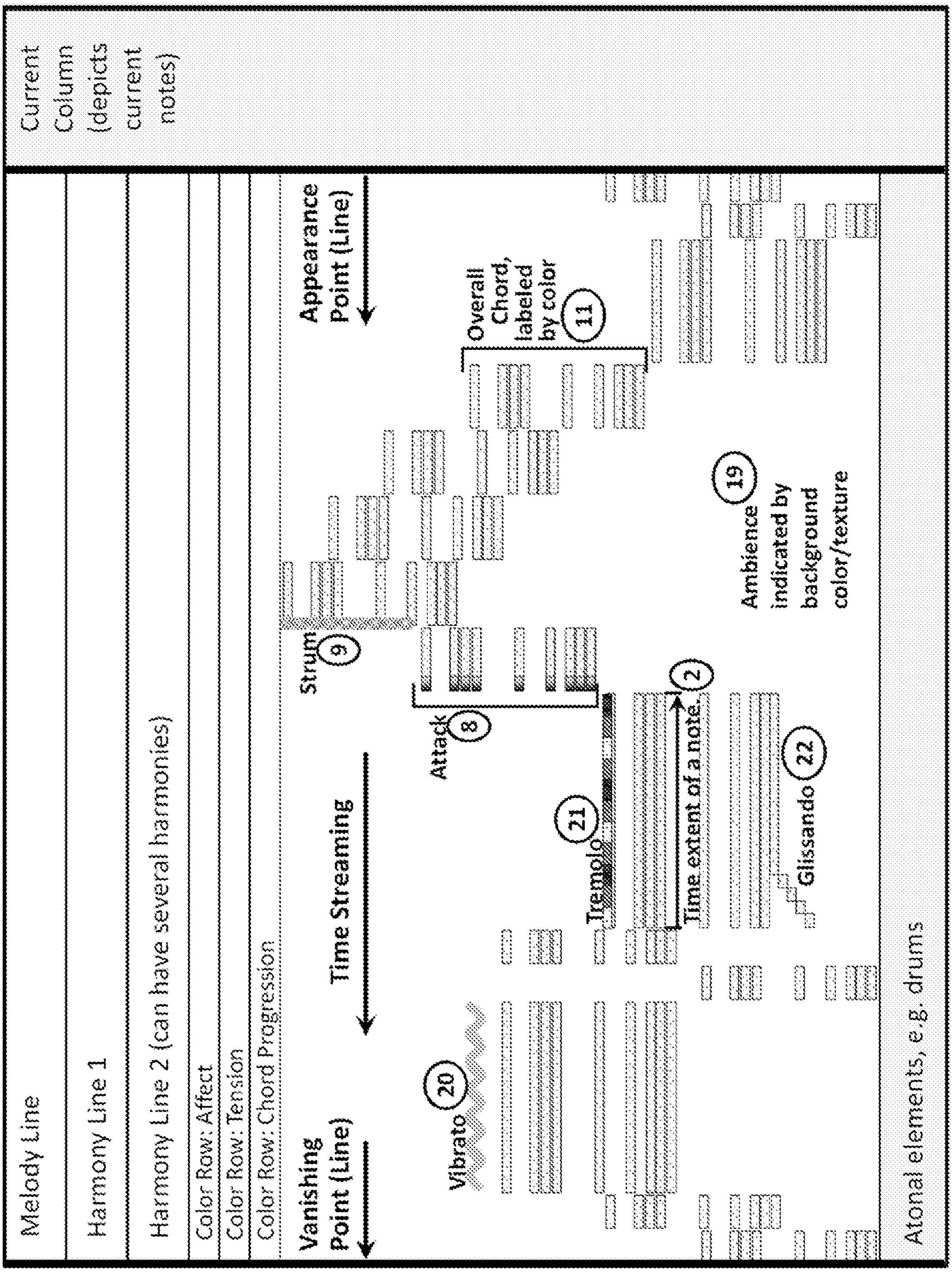
Current Column (depicts current notes)
Melody Line
Harmony Line 1
Harmony Line 2 (can have several harmonies)
Color Row: Affect
Color Row: Tension
Color Row: Chord Progression
Vanishing Point (Line)
Appearance Point (Line)
Time Streaming
Vibrato
20
Tremolo
21
Time extent of a note.
2
Glissando
22
Attack
8
Strum
9
Overall Chord, labeled by color
11
Ambience indicated by background color/texture
19
Atonal elements, e.g. drums

FIG. 10b

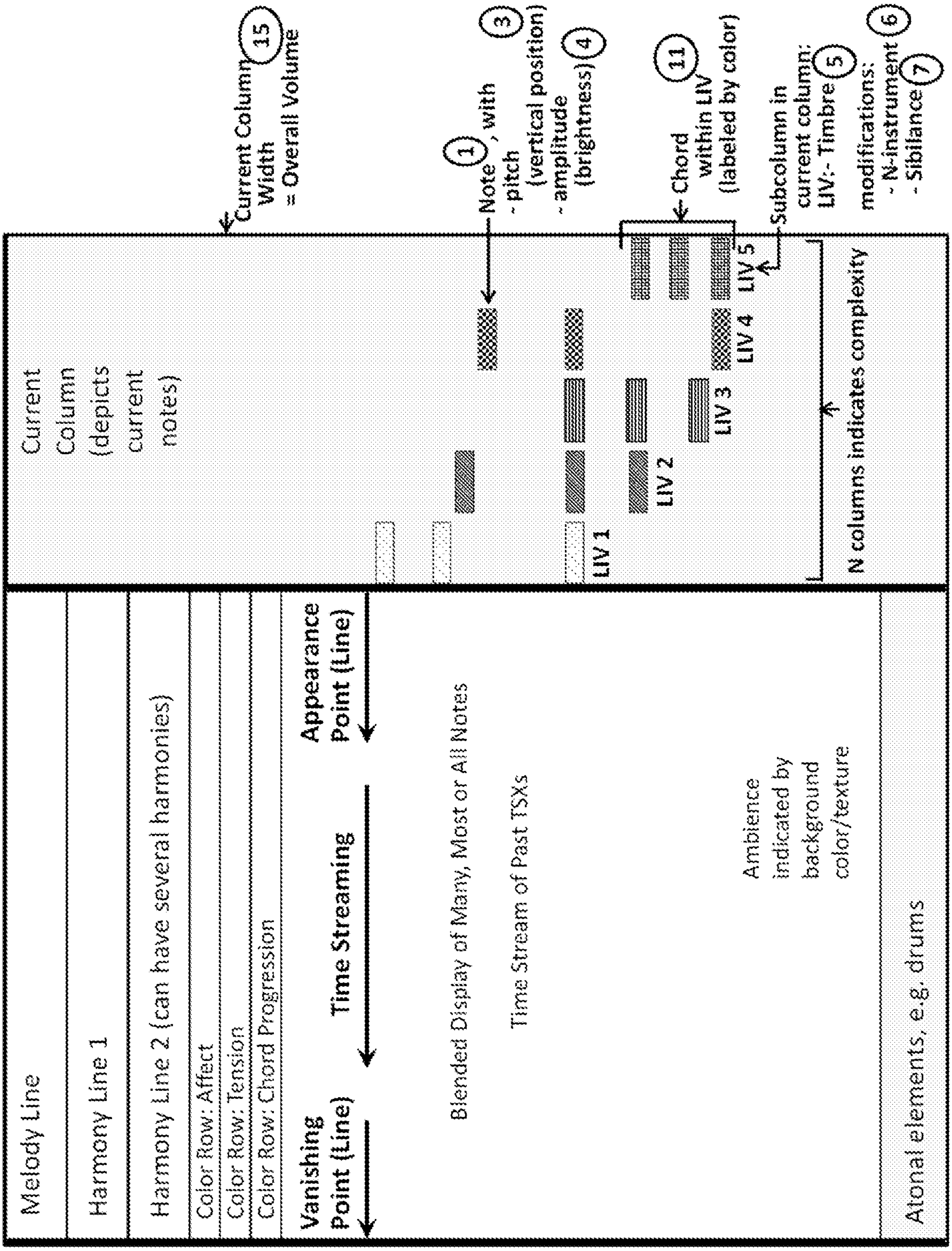
Melody Line
Harmony Line 1
Harmony Line 2 (can have several harmonies)
Color Row: Affect
Color Row: Tension
Color Row: Chord Progression
Vanishing Point (Line)
Time Streaming
Appearance Point (Line)
Blended Display of Many, Most or All Notes
Time Stream of Past TSXs
Ambience indicated by background color/texture
Atonal elements, e.g. drums
Current Column (depicts current notes)
LIV 1
LIV 2
LIV 3
LIV 4
LIV 5
N columns indicates complexity
Current Column Width = Overall Volume
15
Note 1, with - pitch (vertical position) 3 - amplitude (brightness) 4
Chord 11 within LIV (labeled by color)
Subcolumn in current column: LIV:- Timbre 5 modifications: - N-instrument 6 - Sibilance 7

FIG. 10c

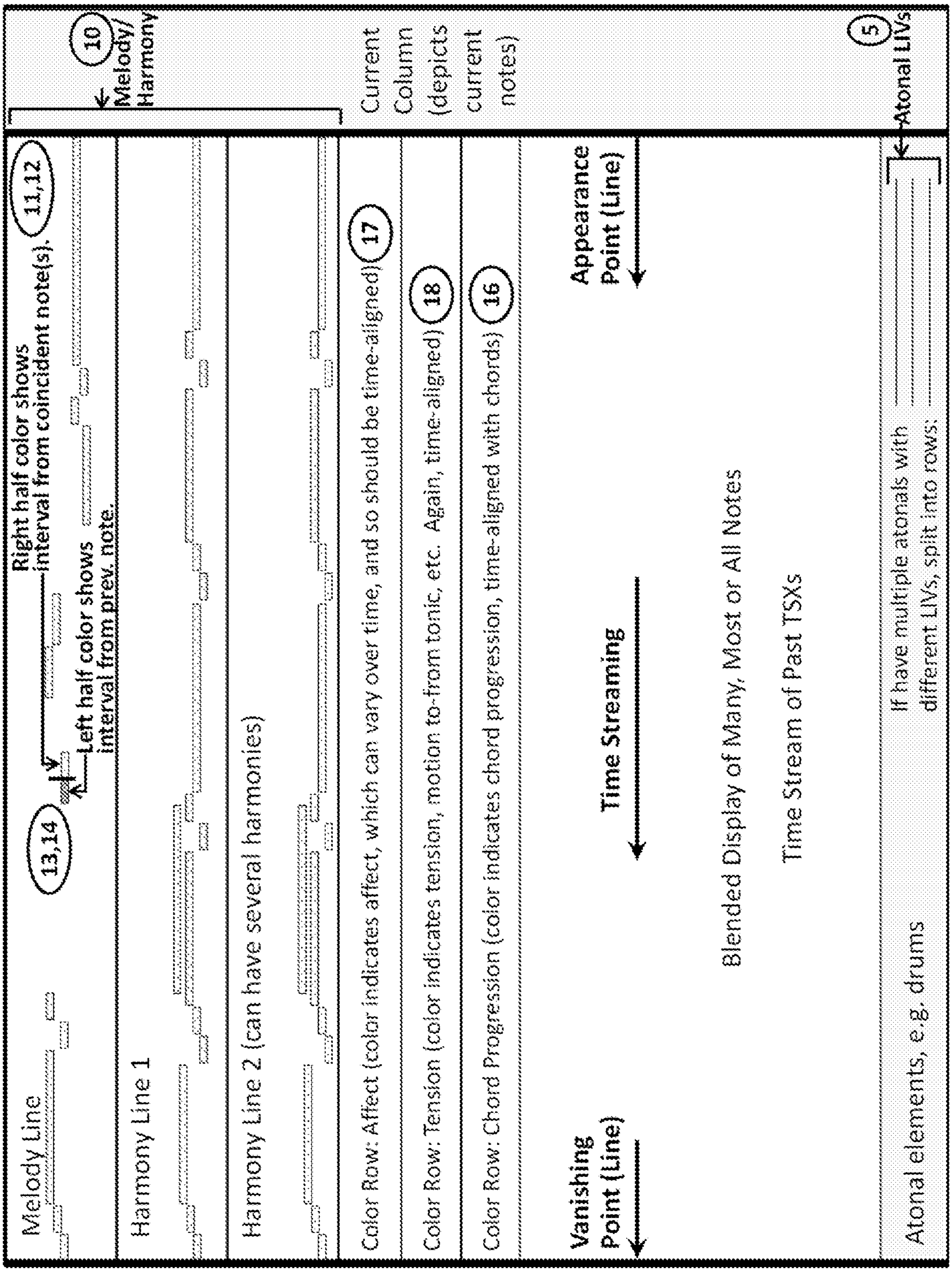
Melody Line
13,14
Left half color shows interval from prev. note.
Right half color shows interval from coincident note(s).
11,12
10
Melody/ Harmony
Harmony Line 1
Harmony Line 2 (can have several harmonies)
Color Row: Affect (color indicates affect, which can vary over time, and so should be time-aligned)
17
Current Column (depicts current notes)
Color Row: Tension (color indicates tension, motion to-from tonic, etc. Again, time-aligned)
18
Color Row: Chord Progression (color indicates chord progression, time-aligned with chords)
16
Vanishing Point (Line)
Time Streaming
Appearance Point (Line)
Blended Display of Many, Most or All Notes
Time Stream of Past TSXs
Atonal elements, e.g. drums
If have multiple atonals with different LIVs, spit into rows:
5
Atonal LIVs

FIG. 10d