CHORD LEVEL — A MUSICAL SPIRIT LEVEL APP

Julien Bohnsack

University of Hamburg
Institute of Systematic Musicology
Hamburg, Germany
julien.bohnsack@studium.uni-hamburg.de

ABSTRACT

People enjoy music and use their smartphones for music listening. Chord Level makes music a tool, enabling users to use their smartphone as a spirit level.

1. LINK TO APK FILE

The APK file of Chord Level can be found under `https://github.com/Tiltification/sonic-tilt/tree/chordlevel/build/app/outputs/flutter-apk`.

2. INTRODUCTION

The psychoacoustic sonification [1] in the original Tiltification app [2] has been criticized as sounding unpleasant [3]. An obvious solution for a more appealing sound, and thus a higher acceptance, is music. The major chord results out of the natural harmonics. Octave, fifth and third are the first three partial notes. Therefore, but not only our ears are educated to the sound of that harmonic. A dissonance perceived as disturbance. Its note needs to resolve into the tonic chord itself. Thus, a natural but although an educated suction effect to that major chord is given. We apply that effect to our chord level application to sonify a harmonic level where $y\angle \approx 0°$. Rising velocity can be interpreted as tension or stress. That and the position of the major chord are further indicators for the position in the spatial field.

3. CHORD LEVEL SONIFICATION

Firstly, the two spatial dimensions are divided into different regions as illustrated in Fig. 1. Closer to the center, the fields are smaller, so you get fine-grained feedback.

Whenever a new field is entered, an arpeggio is triggered. You can consider the arpeggio an *earcon* [4].

The x-angle is divided in two directions: positive (blue) and negative (green). Likewise, the y-angle is divided into two: positive (red) and negative (orange).

The arpeggio for fields on the right is illustrated in Fig. 2. It is a triad in root position, starting with the prime, going over the third to the fifth. The tempo of the arpeggio is a linear function of the x-angle, as the perception of duration is linear [5]. A fourth note informa about the y-angle. The pitch of the last note is a continuous, nonlinear function of the y-angle:

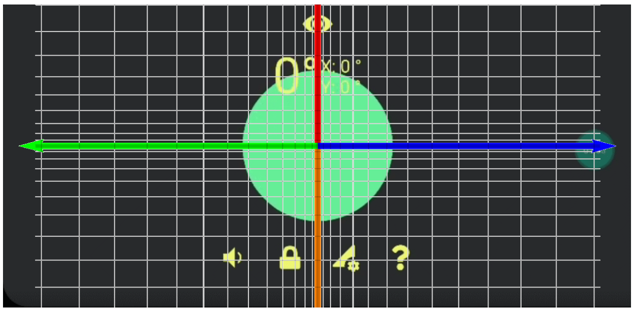

Figure 1: *The two-dimensional space is divided into rectangular fields. Whenever a new field is entered, a new 4-note arpeggio is played. The x-angle determines the tempo of the arpeggio. The y-angle determines the pitch of the last note.*

$$f(y) = \begin{cases} 150y - e^{(-7y+1)} + 391.277 \text{ , if } y > 0 \\ 150y - e^{(1+7y\times(-1))} + 391.995 \text{ , if } \leq 0 \end{cases} \quad (1)$$

When y is 0, the fifth is played once more. For positive y-values, the pitch goes up (red arrow). For negative values, it goes down (orange arrow). You only need to compare the last two notes to understand whether you have to tilt the phone towards or away from you.

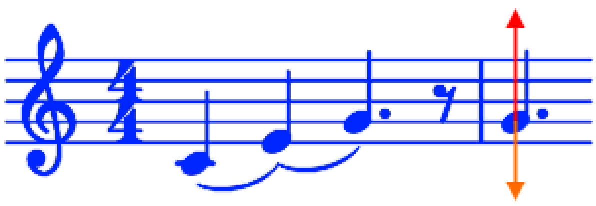

Figure 2: *Arpeggio for fields on the right (positive x-angles). The melody moves upwards. The tempo is a function of the x-angle. The pitch of the last note is a function of the y-angle.*

The arpeggio for fields on the left is illustrated in Fig. 3. It is the same triad in root position, but starting with the fifth, going over the third to the prime. Again, the tempo of the arpeggio is a linear function of the x-angle. The function for the y-angle stays the same, so you have to compare the first and the last note of the arpeggio.

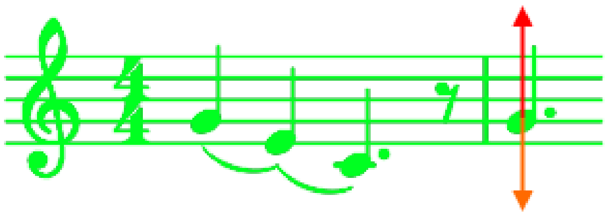

Figure 3: *Arpeggio for fields on the left (negative x-angles). The melody moves downwards. The tempo is a function of the x-angle. The pitch of the last note is a function of the y-angle.*

The y-angle manipulates the pitch continuously, so you may hear changes while the note is being played. Such a strategy has been referred to as *scalable earcon* [6].

4. IMPLEMENTATION

A simple FM-synthesis [7], is used to produce harmonic complex tones with some partials. This ensures that even low pitches are clearly audible through the smartphone tweeter. While raising the arpeggio tempo, the notes get shorter.

You know that you have successfully leveled your phone when you hear a short, harmonic, pizzicato-like chord. Whenever the chord sounds inharmonic, the y angle has to be adjusted. When you hear an arpeggio instead of a chord, you have to adjust the x-angle. Note that Chord Level only works for slow tasks, like leveling a table or a caravan. Fast, extreme motions produce random-sounding patterns.

5. REFERENCES

[1] T. Ziemer, D. Black, and H. Schultheis, "Psychoacoustic sonification design for navigation in surgical interventions," *Proceedings of Meetings on Acoustics*, vol. 30, 2017. [Online]. Available: http://asa.scitation.org/doi/abs/10.1121/2.0000557

[2] M. Asendorf, M. Kienzle, R. Ringe, F. Ahmadi, D. Bhowmik, J. Chen, K. Huynh, S. Kleinert, J. Kruesilp, Y. Lee, X. Wang, W. Luo, N. Jadid, A. Awadin, V. Raval, E. Schade, H. Jaman, K. Sharma, C. Weber, H. Winkler, and T. Ziemer, "Tiltification — an accessible app to popularize sonification," in *Proc. 26th International Conference on Auditory Display (ICAD2021)*, Virtual Conference, June 2021, pp. 184–191. [Online]. Available: https://doi.org/10.21785/icad2021.025

[3] T. Ziemer and N. M. Jadid, "Recommendations to develop, distribute and market sonification apps," in *The 27th International Conference on Auditory Display (ICAD 2022)*, Virtual Conference, June 2022. [Online]. Available: https://doi.org/10.21785/icad2022.003

[4] D. McGookin and S. Brewster, "Earcons," in *The Sonification Handbook*, T. Hermann, J. G. Neuhoff, and A. Hunt, Eds. Berlin: COST & Logos, 2011, ch. 14, pp. 339–361. [Online]. Available: https://sonification.de/handbook/chapters/

[5] T. Ziemer and H. Schultheis, "A psychoacoustic auditory display for navigation," in *24th International Conference on Auditory Displays (ICAD2018)*, Houghton, MI, June 2018, pp. 136–144. [Online]. Available: http://doi.org/10.21785/icad2018.007

[6] M. Watson, "Scalable earcons: Bridging the gap between intermittent and continuous auditory displays," in *12th International Conference on Auditory Display*, London, Jun 2006. [Online]. Available: http://hdl.handle.net/1853/50645

[7] J. Chowning and D. Bristow, *FM Theory & Applications. By Musicians for Musicians*. Tokyo: Yamaha Music Foundation, 1986.