SONICLEVEL-POBBLEBONK APP FOR THE ICAD 2023 SONIC TILT COMPETITION

Stephen Barrass

Sonic Information Design
sonification.com
Canberra, Australia
stephen.barrass@sonification.com

ABSTRACT

The SonicLevel-PobbleBonk App sounds like a congregation of frogs in a pond. You navigate around the pond by tilting the spirit level. Different frog-calls come from each quadrant and become more distinctly different as you approach the centre. This allows you to tell which way to go as you get close to level. When you reach the level spot in the middle the frogs stop calling and the pond goes quiet.

1. LINK TO APK FILE

The SonicLevel-PobbleBonk App builds on the Tiltification App [1] using code from the open source project Sonic Tilt.

The SonicLevel-PobbleBonk App can be downloaded onto your mobile phone from `https://drive.google.com/file/d/1fA3xIF-C2hvG2NEa3W-CBv6KErwXEwRx/view?usp=share_link`.

2. INTRODUCTION

Trying to level a 2D bubble is a steering task where the visual position of the bubble tells you which direction to tilt to head for the centre. If the bubble is to the right then tilt left, and vice versa. If the bubble is too high then tilt in the opposite direction. When the bubble is in the centre you are at the 2D level position.
The bubble helps you to answer different questions that occur in different stages of the task.
1) How far am I from level at the moment? (close, medium, far).
2) Which way do I need to tilt to make it more level? (left, right, up, down)
3) Is it level yet? (Yes/No).

3. YOUR SONIFICATION

The idea for this sonification is that you should be able to tell your location in the coordinate space from an absolute judgement of the sound. Mapping the coordinates to pitch won't work because most people cannot judge absolute pitch. Providing a reference pitch at the 0 point of each axis could help but you also need to know which pitch corresponds with which axis. This lead me to try a

Figure 1: *Pobblebonk Frog*

sequence of 3 pitches X-0-Y where the x coordinate is mapped to pitch X, the origin to reference pitch 0, and the y coordinate to pitch Y. This sequence of tones is similar to the Van Noorden Gallop which is a repeating triplet of tones ABA- that has been used extensively in psychoacoustic experiments [2]. Changing the auditory difference between A and B, and the time - between triplets produces different galloping rhythms depending on how the tones group and segregate into auditory streams [3]. This psychoacoustic probe has been extended to a sequence ABC- in experiments on more complex streaming between auditory factors [4]. The Theory of Auditory Scene Analysis can provide a general scientific basis for designing "stream-based" Sonifications founded on predictable psychoacoustic effects [4].

I adapted the Van Noorden Gallop to the spirit level sonification by mapping the X coordinate to the frequency of A, a reference tone for the origin to B and the Y coordinate to the frequency of C to produce the triplet X0Y-. The gallop speeds up as you move towards the centre. Both the X and Y frequencies pass through the reference frequency 0 at the origin as they go from low to high along each axis. If both X and Y are close to 0 all 3 tones stream together into a triple gallop. If either X or Y are close to 0 you hear a double gallop as one or other of the variable tones groups with the reference. As X and Y move farther from the 0 you no longer hear a galloping rhythm because the tones all segregate.

The theory of Auditory Streaming provides a predictable psychoacoustic basis for the sonification design. However in practice there were some task-based issues. Although you can readily hear that you are close to level from the galloping sound, the closer you get the less you can hear which way to tilt to get to the exact centre. I needed to hear distinctly different directions to fine tune the final tilt adjustments. This lead me to flip the coordinate mapping to produce a maximum change in frequency as you cross from - to + on each axis. The result is that each quadrant of the coordinate space has a distinct rhythmic signature that becomes more apparent the closer you are to the origin. You can hear a change in the rhythm when you cross between quadrants from -X to +X, or -Y to +Y as distinctly different rhythms. The maximum difference from the reference frequency was adjusted and tested to make sure that the 3 tones stream to form a gallop even at the fastest presentation rate and maximum frequency differences. The sonification is silenced at the level position. The various galloping rhythms sound like frog calls so I named the App after the PobbleBonk frog which is local to my area.

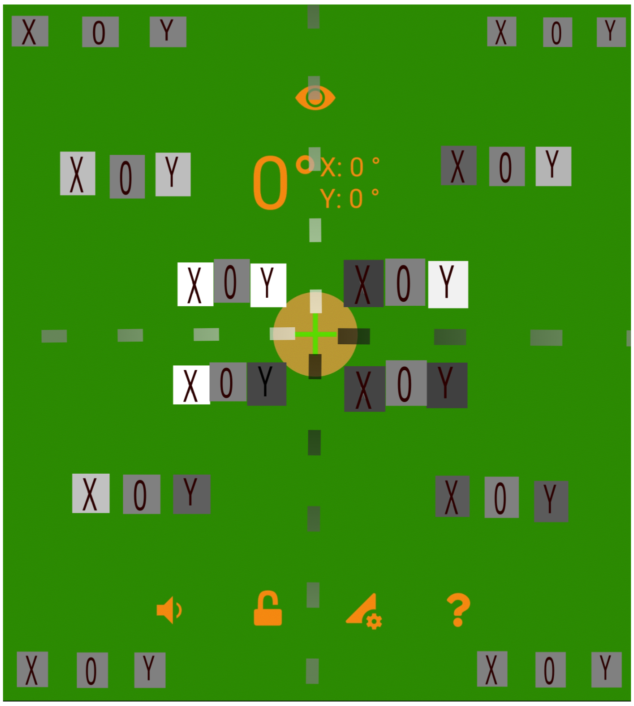

Figure 2: *Sonic Information Design.*

4. IMPLEMENTATION

The implementation in PD consists of three band-pass noises organised in the sequence X0Y-, where the central frequency of the X and Y noisebands is controlled by the X,Y tilt angles. The Reference 0 is a noise centred at 666 Hz. The coordinate axes are inversely mapped so the -X axis begins with -1 mapped to the Reference frequency, and -0 to -Max frequency. On the +X side +0 maps to +Max frequency and +1 to the Reference. The -Y axis maps -1 to the Reference and -0 to -Max. On the +Y side +0 maps to +Max and +1 to the Reference. The mapping from coordinate to band-pass centre frequency is shown as a mapping to greyscale lightness in the Sonic Information Design Diagram below. The distinctive frog-calls in each quadrant are shown by differently shaded patterns in the diagram.

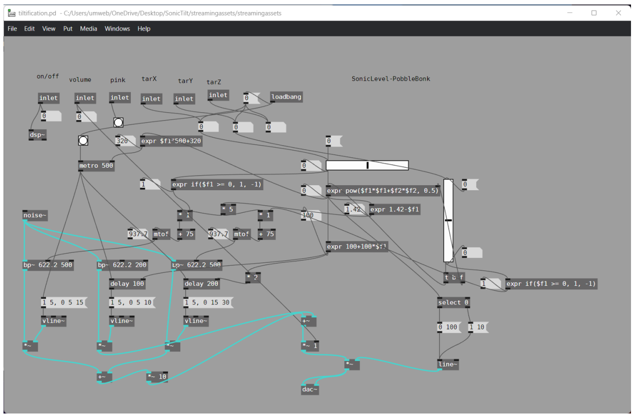

Figure 3: *PD Patch*

A video of the SonicLevel-PobbleBonk App can be found at `https://youtu.be/UUVYpw7FA6M`.

5. EVALUATION

I did a rudimentary evaluation by timing how long it took to level the phone by hand in 10 trials using the Visual, Sonic, and Visual+Sonic modes.

	Visual	Sonic	Visual+Sonic
Mean	14.9	20.9	9.6
StdErr	2.1	2.5	0.9

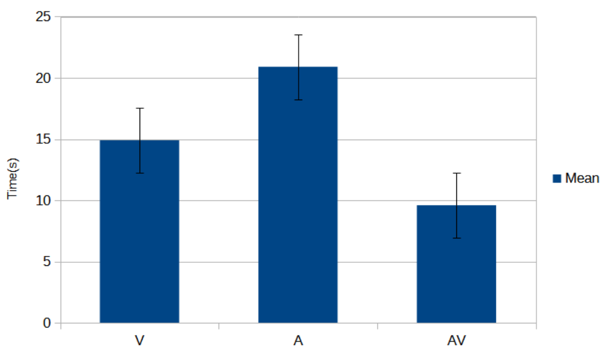

Figure 4: *Time to Level over 10 trials in Visual, Sonic and Visual+Sonic modes*

These results from a small number of trials by me alone cannot be taken too seriously, but the process helped me to pay attention to, and reflect on, the relationship between the task and the sonic information I could hear while doing it. My performance in the Sonic mode was 40% slower than the Visual mode (20.9 s vs 14.9 s), while the combined mode was 35% faster than the Visual mode

(9.6 s vs. 14.8 s). Performance in the Visual+Sonic mode was much more consistent than the Visual or Sonic modes alone.

The thing that took the most time in every mode was the fine tuning from very close to exactly level, which required small manual adjustments and precise hand control. In the Sonic mode I knew that it was exactly level when the sound stopped, but I often passed through this point and had to readjust because it was too late to stop moving by the time I had mentally registered the silence. Perhaps an auditory cue that you are very close but not quite level could further improve hand-ear coordination. In the Visual+Sonic mode I noticed that the graphical feedback on the screen did not show 0 when the sound went silent. This seems to indicate a technical discrepancy between the Graphical User Interface and the PD Patch in processing the data from the tilt sensor.

6. ACKNOWLEDGMENT

Big thanks to Tim Ziemer for all the time and effort required to organise the Sonic Tilt Competition, and to his students for building the App which provides a learning tool and software framework for sonification researchers who would like to make Killer sonification Apps for the masses.

7. REFERENCES

[1] 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

[2] L.P.A.S. van Noorden (1975). "Temporal coherence in the perception of tone sequences," doctoral dissertation, Eindhoven University of Technology, Eindhoven, The Netherlands.

[3] A.S. Bregman (1990). "The Auditory Scene," in Auditory Scene Analysis. The Perceptual Organization of Sound (MIT Press, Cambridge, MA), pp. 1–45.

[4] S. Thomassen and A. Bendixen (2017) Subjective Perceptual Organization of a Complex Auditory Scene. J Acoust Soc Am 1 January 2017; 141 (1): 265–276. https://doi.org/10.1121/1.4973806

[5] S. Barrass (2009) Developing the Practice and Theory of Stream-based Sonifications, SCAN Journal of Media Arts Culture, Vol 6, Number 2, September 2009, Maquarie University, ISSN: 1449-1818.http://scan.net.au/scan/journal/print.php?journal_id=135&j_id=17