TRIPOD SOUND LEVEL — A SPIRIT LEVEL SONIFICATION BASED ON THE SONIC TILT APP

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ABSTRACT

Sometimes, when aligning a telescope, a video camera, or other devices, a tripod is used. Tripods are stable and never wobble. The presented sonification helps users adjust leg lengths to level a tripod.

1. LINK TO APK FILE

The Tripod Sound Level APK can be found under: `https://github.com/Tiltification/sonic-tilt/tree/tripod/build/app/outputs/flutter-apk`

2. INTRODUCTION

Tripods are often used to hold devices that need to stand rigidly. Tripods do not wobble. Sometimes, such devices need to be leveled to ensure a perfect azimuth rotation along the horizon and a perfect altitude rotation perpendicular to the horizon.

Photo and video cameras are often mounted on a tripod. A perfectly leveled tripod is a prerequisite for a perfectly horizontal picture, as well as for the performance of self-calibrating video cameras [1].

In amateur astronomy [2], telescopes are often mounted on a tripod using an equatorial mount. Equatorial mounts hold and align the telescope. They are used to align the telescope with the rotation axis of the earth. However, a prerequisite for an efficient polar alignment of an equatorial mount is, that the tripod below is perfectly leveled.

In archaeology, tripods are used to align electronic distance measuring devices [3, entries “Tripod” and “Electronic Distance Measuring Devices”]. Again, such a device is screwed to a tripod. Usually, devices are installed on the tripod with a 1/4" or 3/8" screw.

Especially in the case of astronomy, leveling a tripod is not straightforward, as it takes place at night in the dark. Conventional spirit levels are hardly visible. An advanced approach to level a tripod is to utilize a smartphone holder for a 1/4" or 3/8" screw and attach it to the tripod. A spirit level app, like Tiltification [4], can serve the purpose of leveling the tripod. Here, the benefit of auditory display over visual display is that sound minimizes light pollution.

However, the psychoacoustic sonification [5] implemented in Tiltification is not dedicated to tripods. Tripod Sound Level, as presented in this paper, informs users which leg to adjust in order to level a tripod. The proposed app can also be used to apply the tripod logic in any other context. reducing the number of alignment axes from 4 to 3 and thus simplifying the process of leveling.

3. THE TRIPOD SONIFICATION

Figure 1 explains the tripod sonification symbolically.

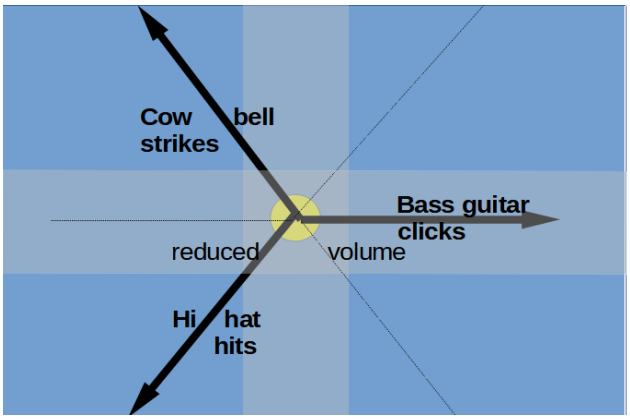

Figure 1: *Tripod sonification. The main orientation sound is a bass guitar sample. The bass sound is aligned to the x-axis of the diagram. The other two orientation sounds are a hi-hat and a cowbell sample being played repetitively. Reaching the “almost leveled” region triggers a tow tone confirmation sound and mutes repetitive orientation sounds app. Near the axes (gray regions) the sound pressure level of the sonification is reduced.*

Conceptually, I consider the spirit level a tripod. A tripod has one leg every $120°$. The x- (pitch-) and y- (roll-) coordinates transmitted by the app are converted into polar coordinates with a radius r and an angle ϕ. Here, the *radius* is the absolute tilt angle, independent of the tilt direction. The angle ϕ on the other hand is the angle towards which the device is tilted in relation to the reference axis.

One tripod leg serves as a reference leg. The reference leg is aligned with the positive x-axis, i.e., it has an angle of $0°$. Con-

sequently, the other legs point at angles 120° and -120°. The positive y-axis corresponds to an angle of 90°, the negative y-axis corresponds to an angle of -90°, the negative x-axis to an angle of $\pm 180^\circ$.

Every leg is associated with a musical instrument. The reference leg is associated with a bass guitar, the other legs, with a cowbell and a hi-hat. Such a categorical timbre-mapping has been suggested before, as timbre is categorical rather than continuous [6]. Associating information with musical instruments may make the sound more pleasant and appealing — a critique that was raised against the original Tiltification app [7].

The radius is represented by the Inter-Onset-Interval (IOI). The IOI is a common mapping strategy [8]. It is probably the most (if not the only) familiar sonification strategy people know, mostly from car parking assistants. One of its benefits is its intuitive nature. The lower the IOI, the more hectic the sound becomes, raising awareness and calling for action. On the other hand, everybody feels relief when a stressful sound disappears.

The IOI is nonlinear function of radius r as defined in Eq. 1 and plotted in Fig. 2:

$$\mathrm{IOI} = (1.61 - \arctan(50r)) \times 900 \tag{1}$$

When leveled almost perfectly, a two tone confirmation sound

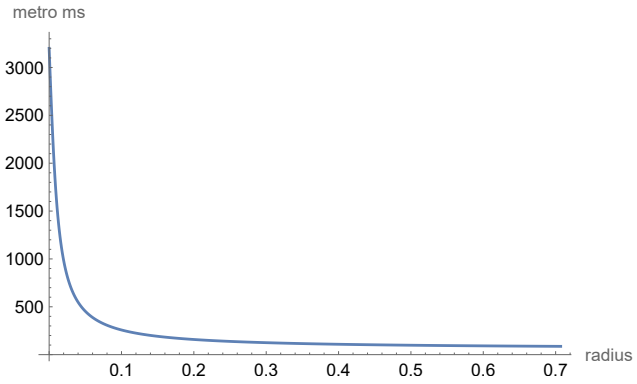

Figure 2: *Inter Onset Interval (IOI) as a function of radius (r).*

will be played once, and the phone is muted. In Fig. 1, his "safe zone" [9] is represented by the small disk in the center. However, when the tilt angle leaves this safe zone of 1.5°, a regular pulse is triggered. The IOI of this pulse is a nonlinear function of the radius, as defined in Eq. 1. The larger the angle, the shorter the IOIs becomes, i.e., the faster the tempo of the regular pulse. The IOI starts at 1000 ms, i.e., 60 bpm. Due to the nonlinear decrease, the IOI becomes audibly shorter even at small tilt angles. At larger angles (roughly above 10°), the IOI does not decrease much more when the angle increases. However, this is not a typical region for a spirit level, anyway.

The selection of the instrument that is regularly triggered is a function of the angle ϕ. See Fig. 1. An electric bass guitar sound means that the leg on the right-hand side has to be adjusted (=shortened). We can call it the reference leg, as it is aligned with the x-axis. A cowbell sound means that the next leg (counterclockwise) has to be adjusted. A hi-hat sample means that the third leg needs to be adjusted.

If the App is used on without a physical tripod and the smartphone is being hold in the usual vertical mode with its lower side directed to the user, the tilt angle amount of the phone's lower side is represented by increasing x-values causing a high repetition frequency of the bass guitar sound.

When the user hears the bass-guitar sound, the lower part (pointing towards the user) of the smartphone has to be lifted. Now that we get closer to the balance situation and the repetition frequency of the bass-guitar sample will decrease until either the confirmation sound is displayed (=balance situation) or the until the repetitive hi-hat or the cowbell sound is being played.

When the hi-hat sound is displayed, the upper left corner of the smartphone has to be lifted to proceed to the balance point. When the cowbell sound is displayed, the upper right corner has to be lifted. If this is carried out slow enough, the balance point will be reached easily and a two tone confirmation sound will be displayed. As long as the smartphone stays balanced, it will remain silent. As soon as the tilt angle of the smartphone increases to more than the tolerance angle of 1.5°, then — depending on the direction of the tilt angle — one of the repetitive voices will appear again.

Although the tolerance angle has been programmed as 1.3°, the balance situation is sometimes kept while the visual display already shows 2°. This means that depending on the actual angle, at least a 1.5° is being processed as "still in balance".

Whenever one of the smartphone's rectangular axes (x or y) are close to a horizontal situation (see gray region in Figure 1), the sound pressure level is reduced. This makes the sound quieter, and thus, more calm. According to the literature, tempo and energy affect the perceived arousal of sounds [10, chap. 2.5] [11] and give a feedback, that the balance situation is near.

In noisy surroundings, the low frequencies of the bass guitar might not be very significant, and the bass guitar will be similar to a click-sound, that nevertheless can easily be distinguished from the other sounds. When using headphones, the bass frequencies of the bass guitar are clearly audible and give the reference leg a warm timbre.

4. REFERENCES

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