The Potential Navigation of Verysonic: a selection of "harmonic" events translated for acoustic projection

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SUCH THAT verysonic, "true" sonic, may be considered any acoustic event which exists in a modality optimally adjusted for human perception. Any acoustic event, which naturally propagates in waves, has the potential to navigate in a modality which may be both heard, and felt as vibration. So that human senses be tuned to perceive the vibrations of all possible acoustics in any media, it is necessary to translate the original acoustic path into the verysonic. This translation must admit a broad range of factors within its processes such that frequency, temperature, pressure, phase, velocity, amplitude, and medium of propagation be considered. Where the original acoustic path has perceptual relevance, as in its generation by sea mammals, etc., translation to the verysonic must enable unique transfer functions for these conflations of sensory input.

Acoustic events which are of special interest for their potential navigation in the verysonic should include sources which originate from under the surface of the ocean. Underwater acoustic events are particularly rich in variety and frequency range. Though often barely audible above the background noise and low in amplitude, it is desirable to translate a broad range of underwater events for examination. It is similarly necessary to consider the specific nature of how subsurface sources typically propagate in their original media with respect to human perception. Further, perceptual relevance specific to cetaceans, and the comparing of these perceived acoustics to humans, necessarily figure a complex component of sources for potential navigation in verysonic.

First, second, and third modal vibrations of violin top plates under hologram interferometry, left to right, at 80, 147 and 222 Hz.

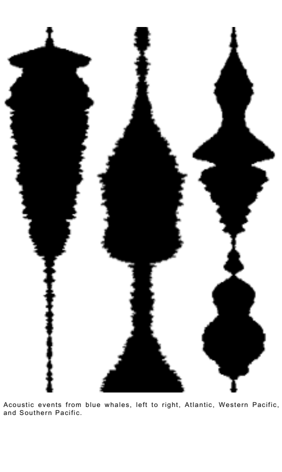
Ocean-Transferred Sources

String instrument acoustic sources, particularly for their production of rich harmonics are additionally desirable as source acoustic for verysonic. Both for their modal navigation in verysonic of alternate media, and for their specific potential subsea navigation, bowed string sources may be translated into verysonic from within sonically non-resonant media. Both as in-air propagation and as subsea virtually generated verysonic, reverberational string sources should provide particularly unique wave characteristics.

Horns, and other exponential resonating acoustic chambers should also be examined in multiple different media for translation. The sound colours of instruments and chambers of lesser harmonics may permit better examination of sensory/perceptual extremes and propagation limits. Percussive instruments are not part of this examination, however, percussive acoustic events from natural sources (earthquakes, thunder, volcanism, etc.) should be included, especially for their propagation features.

Phonetic Sources

An additionally valid source for verysonic translation are speech components. In the admission of human speech into the sources to be examined by verysonic translation, the perceptual function of language must also be addressed. In the same way that the perceptual functions of communications between cetaceans alters through translation into verysonic, velocity and dampening effects, strongly alter source phonetics. Similarly, a great number of sonic sources may not be comprehensible or are not enabled for human ears. It is likely that the translation of these collected harmonic events would be made imperceptible, both through frequency mapping and shifting, etc., and in the application of modifications upon waves in situ, as part of translation to the verysonic.



Acoustic events from blue whales, left to right, Atlantic, Western Pacific, and Southern Pacific.

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Additional Sonic

Examples of acoustic events, related to seismic tremors which would be suitable for verysonic (percussive) translation, are the subsea soundings of shallow microearthquakes (magnitude 1 or less). These soundings are typically collected from mid-ocean sonobuoys and exhibit acoustic properties very similar to thunder in air, with the ambient signal noise very close to the sound of heavy rain.

Blue whale acoustic events are of special interest for their strong periodicity, and infra-sound communication waves. Their dominant frequency range is between 15 and 27 Hz. Most common blue whale calls are made up of tonal bursts, having strong associated harmonics. Blue whales receiving these calls do so with complex sensory modalities. Typical isovaleroyl-rich tissues in their lower jaw "tune" incoming sound. For information how these calls propagate, see Appendix I: *Deep Sound Channel*. Echolocation clicks of toothed whales, for the location of objects, and communication whistles, may also be translated to verysonic.

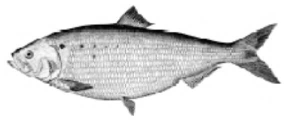
Microacoustic events occur in extreme low amplitude. They are predominantly percussive events, but may provide rich variants in verysonic. Microacoustic sources may be mistaken for infrasonic or ultra-sonic events which are perceived to be low in amplitude. Microacoustic events richly occur in the plants. Seed pod dehiscence, bamboo growth, and the opening of blossoms are typical examples.

Verysonic in Alternate Media

Call of the koil bird in glass; bowerbird song in streamwater; sunflower dehiscence in resin; cornflower blossoming in milk; black and red kites in cedarbark; jungle crow in mango juice; bharal (the Himalayan blue sheep) in snow; Ox bells in brick.

Methods of Translation

That the spectra of sound in human experience be present for acoustic environments which are normally unable, verysonic translation modes would attempt to adapt all acoustic events for the human perceptual range of experiences. Unique verysonic transfer functions specific to each acoustic source event would provide the optimum translation.



The hearing thresholds of a clupeid, the American shad (Alosa sapidissima), range over 0.2 to 180 kHz. American shad have greatest sensitivity from 0.2 to 0.8 kHz in the sonic range and from 25 to 130 kHz in the ultra-sonic range.

Frequency

Propagating sound waves consist of alternating compressions and rarefactions detected as changes in sound pressure. The rate at which this occurs determines the frequency of these propagating waves, and human ears are most sensitive between 500 and 4000Hz, which corresponds almost exactly to the frequencies of speech. (The auditory canal can resonate and amplify sounds between 2000 to 5500Hz by up to ten times.) Therefore, for acoustic translation of "speech" communication to verysonic, the target range for humans is necessarily between 500 and 4000 Hz. Similarly, although there are not complete records extant for all cetaceans, it is assumed that whales, for example, can hear the range of sounds they produce. Since blue whales are most sensitive to sound pressure between 15 and 27Hz (entire range is 12 to 390Hz), the unique *verysonic transfer function* (vtf) specific to each blue whale acoustic source event within this range would be mapped to the most sensitive frequency range for humans, 500 to 4000Hz. However, were the acoustic event for translation to have originated from volcanism, for example, or some other event which was not a mode of "communication", then for its acoustic translation to verysonic, the target range would necessarily be mapped to between 20Hz and 20kHz. In this way, since the ultrasonic echolocation clicks of toothed whales and dolphins are a phenomenological modality, and are neither considered communication, they may be mapped with a vtf to the high sonic range for humans, say around 10 to 15kHz.

American Shad

Since the American shad has its greatest sensitivity for "speech" from 0.2 to 0.8 kHz, the vtf maps the frequencies of these acoustic events to the human communication band, between 500 and 4000Hz.

It must, of course, be noted that all of the frequency adjustments made within the frequency component of the vtf (vtf_{freq}) are concurrently subject to a syncretized attention to all other vtf operators (temperature, pressure, amplitude, etc.). An additional component of the vtf_{freq} is a compensatory function for the human perception of pitch disproportionate with intervals between pitch. If the acoustic source increases in equal steps, the human listener will perceive each interval as diminishing with each higher step in pitch. The compensatory vtf will attempt to enable verysonic wherever possible.

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Wavelength

For one cycle of the acoustic event source wave, the distance it travels within the medium (air, sea, glass, etc.) is its wavelength. As both frequency and wavelength are interdependent, they are both effected by the medium within which the wave propagates. Nominally, the speed of sound in water is 1372 m/s, and is more than four times faster than in air, where sound travels at 344 m/s. It may easily be seen that low frequency sources may travel much more quickly in water than high frequency sources in air. A 15Hz wave in water has a wavelength of 91m, whereas a 15Hz wave in air has a wavelength of 23m. As propagation is a function of both wavelength and frequency, the vtf for wavelength performs no operation, but recognizes that it is a component of the vtf for frequency.

Amplitude

The low amplitude of microacoustic events must engage a large verysonic translation/amplification for human perception, and may be additionally up-shifted in frequency out of the extreme percussive of the infra-sonic. Subsea bivalve activity is a good example of a microacoustic source from ocean acoustic events. Where 0dB is the normal threshold of hearing, microacoustic events occur below this nominal level. vtf_{ampl} operates to amplify acoustic events to approximately 60db (normal conversation levels).

Temperature and Pressure

Increased pressure and increased temperature cause sound waves to increase in speed. Both vtf_{temp} and vtf_{pres} operate to counteract the effects of temperature and pressure on acoustic source velocity. The pressure transfer function is additionally applied to air-to-water and water-to-air conversions, where sound sources from air typically shifted 26 dB in water. See Appendix I: *Conversion of dB from Air to Water.*

Wave Phase

Where multiple listeners experience a single acoustic source, each will experience that source at a slightly different locations within its wavelength. This positioning relative to other parts of the wave is known as *phase*. There is no verysonic translation enabled for phase displacement.

Medium of Propagation and Velocity

The characteristic impedance of various media is the factor which determines how sound sources will propagate through it. This impedance is determined by the relationship between density and pressure. Water, for example, has an impedance that is 3600 times that of air. This factor has both a propagational effect on the source acoustic wave, and determines at what speed the waves will travel. Typical velocities in m/s are:

rubber	*54*	*water*	*1372*
carbon dioxide	*258*	*steel*	*5000*
air	*344*	*glass*	*3658 - 6000*
lead	*1219*	*concrete*	*3,048*
hardwood	*4267*	*softwood*	*3353*

All media effect the source acoustic event as it follows its "wavefront". As this wavefront expands, its energy is spread over a larger and larger area, until it completely dissipates within the medium. vtf_{media} accounts for these impedance dissipation and propagational effects.

The Potential Verysonic

Of those acoustic events which are to be examined for their potential navigation in a modality optimally adjusted for human perception, the following verysonic transfer function relationship is then true for the original acoustic paths translated into verysonic:

$$vtf_{final} = vtf_{freq} + vtf_{ampl} + vtf_{temp} + vtf_{pres} + vtf_{media}$$

Verysonic Path

Final modality predictions for the verysonic are extremely varied and offer new ways of perceptual examination for the broad range of acoustic source events. The verysonic transfer functions are highly adaptive and should adjust well to any source modality, for any target media. The verysonic path has several advantages over common perception. Its transfer functions may enable rare events which humans may not directly experience. I t also compensates for extreme dissipations of high impedance media, permits tonal readings in ranges sensitive to humans, and appropriately localizes mammal communicative frequencies. Perhaps the most difficult verysonic transfer function adaptation is where vtf_{media} is of an unpredictable or unstable nature. Yet, having applied vtf_{final} to a specific source, verysonic will result. It will be present in such an acoustic state that perceptually, both cognitively and synergistically, an optimum modality will be presented. Any acoustic event, which by nature, propagates in waves, has this navigation potential. The verysonic presents a modality of sound experience which is a true compendium of all sonic.

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Appendix I

Sound Pressure Level and Sound Intensity Level

The sound levels to which most mammals are sensitive extend over many orders of magnitude and, for this reason, it is convenient to use a logarithmic scale when measuring sound. Both Sound Pressure Level (SPL) and Sound Intensity Level (SIL) are measured in decibels (dB) and are usually expressed as ratios of a measured and a reference level:

Sound Pressure Level (dB) = 20 log (p/pref)
where pref is the reference pressure
Sound Intensity Level (dB) = 10 log (I/Iref)
where Iref is the reference intensity

The decibel is ten times the log of the ratio of two intensities, and twenty times the log of the ratio of two pressures. Units for both SPL and SIL are dB relative to the reference intensity (often abbreviated as dB re 1µPa or dB//1µPa). The commonly used reference pressure level in underwater acoustics is 1 µPa while 20 µPa (which is roughly the human hearing threshold at 1000 Hz) is used as the reference level in air. The reference intensity in water is:

Iref = p2 ref / (Dwater cwater) = 6.7 x 10-19 W/m2
where reference pressure in water (pref) is 1µPa rms,
and the density of water (Dwater) is about 1000kg/m3,
and the speed of sound in water (cwater) is about 1500 m/s

In addition to the reference level, the distance from the source for that reference level must also be cited; typically the units of SIL are dB relative to the reference intensity at 1 meter (e.g. 20 dB re 1µPa @ 1m). In practice, itis easier to measure sound pressure than sound intensity, so that pressure is measured, and intensity is inferred. Within the same medium:

I ∝ p2
therefore
SIL(dB) = 10 log (I/Ir)
= 10 log (p2 water / p2 ref-water) = 20 log (pwater/1µPa)

Conversion of dB from air to water

In air, the sound pressure level is referenced to 20 µPa, while in water the sound pressure level is referenced to 1 µPa. Given the above equation for dB's, the conversion factor for dB air for water is:

dB = 20 log (pwater/1µPa) = 20 log (20) = + 26 dB

Therefore a pressure comparison between air and water differs by 26 dB. The characteristic impedance of water is about 3600 times that of air; the conversion factor for a sound intensity in air vs water is 36 dB.

10 log (3600) = 36 dB 36+26 = 62 dB

Note that all of these conversions simply relate underwater sounds to those in air. How an animal perceives or reacts to an underwater sound may be very different from it's reaction to airborne sounds. While there are no established audiograms for the hearing range of many whales, for example, it is generally assumed that animals can hear the ranges of sounds that they produce.

Signal to Noise Ratio

Finally, whether or not a particular acoustic signal can be detected in the ocean is a factor of the level of the signal of interest relative to the background noise level of the ocean, or ambient noise. This is normally expressed as a "signal to noise ratio" (SNR), where any value greater than 1 implies that the signal is detectable above the noise, while a number below 1 implies that the signal is "buried" in the noise. For rough calculations of SNR, ambient noise level (NL) is subtracted from the sound intensity level:

SNR = SIL - NL

Deep Sound Channel

A "channel" is present in the deep ocean, within which acoustic energy can travel long distances. This channeling of sound occurs because there is a minimum sound speed in the ocean caused by changes in the water density. Ocean water density is affected by water temperature, pressure (depth), and salinity. As temperature decreases, the speed of sound decreases; as pressure increases, the speed of sound increases. The minimum sound speed at the channel depth is the result of higher temperatures toward the surface of the ocean and higher pressures toward the bottom of the ocean. At low and middle latitudes, the deep sound channel depth is between 600-1200 m. Sound waves can become "trapped" in the deep sound channel and propagate long distances.

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