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NOISE AND INTERFERENCE IN TRANSMISSION OF SPEECH SIGNALS IN THE COROPORATE NETWORK

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In signal processing, noise is a general term for unwanted (and, in general, unknown) modifications that a signal may suffer during capture, storage, transmission, processing, or conversion.
Sometimes, it can also mean signals that are random (unpredictable) and carry no useful information; even if they are not interfering with other signals or may have been introduced intentionally, as in comfort noise.
Noise reduction, the recovery of the original signal from the noise-corrupted one, is a very common goal in the design of signal processing systems, especially filters. The mathematical limits for noise removal are set by information theory, namely the Nyquist–Shannon sampling theorem.
Noise may arise in signals of interest to various scientific and technical fields, often with specific features:
Noise is unwanted sound considered unpleasant, loud or disruptive to hearing. From a physics standpoint, noise is indistinguishable from desired sound, as both are vibrations through a medium, such as air or water. The difference arises when the brain receives and perceives a sound.
Acoustic noise is any sound in the acoustic domain, either deliberate (e.g., music or speech) or unintended. In contrast, noise in electronics may not be audible to the human ear and may require instruments for detection.

Background noise or ambient noise is any sound other than the sound being monitored (primary sound). Background noise is a form of noise pollution or interference. Background noise is an important concept in setting noise levels.
Background noises include environmental noises such as water waves, traffic noise, alarms, extraneous speech, bioacoustics noise from animals, and electrical noise from devices such as refrigerators, air conditioning, power supplies, and motors. The prevention or reduction of background noise is important in the field of active noise control. It is an important consideration with the use of ultrasound (e.g. for medical diagnosis or imaging), sonar, and sound reproduction.
Comfort noise (or comfort tone) is synthetic background noise used in radio and wireless communications to fill the artificial silence in a transmission resulting from voice activity detection or from the audio clarity of modern digital lines.

Some modern telephone systems (such as wireless and VoIP) use voice activity detection (VAD), a form of squelching where low volume levels are ignored by the transmitting device. In digital audio transmissions, this saves bandwidth of the communications channel by transmitting nothing when the source volume is under a certain threshold, leaving only louder sounds (such as the speaker's voice) to be sent. However, improvements in background noise reduction technologies can occasionally result in the complete removal of all noise. Although maximizing call quality is of primary importance, exhaustive removal of noise may not properly simulate the typical behaviour of terminals on the PSTN system.
The result of receiving total silence, especially for a prolonged period, has a number of unwanted effects on the listener, including the following:
- the listener may believe that the transmission has been lost, and therefore hang up prematurely;
- the speech may sound "choppy" (see noise gate) and difficult to understand;
- the sudden change in sound level can be jarring to the listener.

To counteract these effects, comfort noise is added, usually on the receiving end in wireless or VoIP systems, to fill in the silent portions of transmissions with artificial noise. The noise generated is at a low but audible volume level, and can vary based on the average volume level of received signals to minimize jarring transitions.

Electromagnetically induced acoustic noise (and vibration), electromagnetically excited acoustic noise, or more commonly called coil whine, is audible sound directly produced by materials vibrating under the excitation of electromagnetic forces. Some samples of this noise include the mains hum, hum of transformers, the whine of some rotating electric machines, or the thrill of fluorescent lamps. The hissing of high voltage transmission lines is because of corona discharge, not magnetism.
The phenomenon is additionally called audible magnetic noise, electromagnetic acoustic noise, lamination vibration or electromagnetically-induced acoustic noise, or more rarely, electrical noise, or "coil noise",

looking on the application. The term electromagnetic noise is usually avoided because the term is employed within the field of electromagnetic compatibility, managing radio frequencies. The term electrical noise describes electrical perturbations occurring in electronic circuits, not sound. For the latter use, the terms electromagnetic vibrations or magnetic vibrations, that specialize in the structural phenomenon are less ambiguous.

Acoustic noise and vibrations due to electromagnetic forces can be seen as the reciprocal of microphonics, which describes how a mechanical vibration or acoustic noise can induce an undesired electrical perturbation [1].

In telecommunications, an interference is that which modifies a signal in a disruptive manner, as it travels along a communication channel between its source and receiver. The term is often used to refer to the addition of unwanted signals to a useful signal.

Noise is a form of interference but not all interference is noise.

A solution to interference problems in wireless communication networks is interference alignment, which was crystallized by Syed Ali Jafar at the University of California, Irvine. A specialized application was previously studied by Yitzhak Birk and Tomer Kol for an index coding problem in 1998. For interference management in wireless communication, interference alignment was originally introduced by Mohammad Ali Maddah-Ali, Abolfazl S. Motahari, and Amir Keyvan Khandani, at the University of Waterloo, for communication over wireless X channels. Interference alignment was eventually established as a general principle by Jafar and Viveck R. Cadambe in 2008, when they introduced "a mechanism to align an arbitrarily large number of interferers, leading to the surprising conclusion that wireless networks are not essentially interference limited." This led to the adoption of interference alignment in the design of wireless networks.

In many cases noise found on a signal in a circuit is unwanted. There are many different noise reduction techniques that can reduce the noise picked up by a circuit.

Faraday cage – A Faraday cage enclosing a circuit can be used to isolate the circuit from external noise sources. A faraday cage cannot address noise sources that originate in the circuit itself or those carried in on its inputs, including the power supply.

Capacitive coupling – Capacitive coupling allows an AC signal from one part of the circuit to be picked up in another part through the interaction of electric fields. Where coupling is unintended, the effects can be addressed through improved circuit layout and grounding.

Ground loops – When grounding a circuit, it is important to avoid ground loops. Ground loops occur when there is a voltage difference between two ground connections. A good way to fix this is to bring all the ground wires to the same potential in a ground bus.

Shielding cables – A shielded cable can be thought of as a Faraday cage for wiring and can protect the wires from unwanted noise in a sensitive circuit. The shield must be grounded to be effective. Grounding the shield at only one end can avoid a ground loop on the shield.

Twisted pair wiring – Twisting wires in a circuit will reduce electromagnetic noise. Twisting the wires decreases the loop size in which a magnetic field can run through to produce a current between the wires. Small loops may exist between wires twisted together, but the magnetic field going through these loops induces a current flowing in opposite directions in alternate loops on each wire and so there is no net noise current.

Notch filters – Notch filters or band-rejection filters are useful for eliminating a specific noise frequency. For example, power lines within a building run at 50 or 60 Hz line frequency. A sensitive circuit will pick up this frequency as noise. A notch filter tuned to the line frequency can remove the noise.

The noise level in an electronic system is typically measured as an electrical power N in watts or dBm, a root mean square (RMS) voltage (identical to the noise standard deviation) in volts, dBμV or a mean squared error (MSE) in volts squared. Examples of electrical noise-level measurement units are dBu, dBm0, dBrn, dBrnC, and dBrn(f1 − f2), dBrn(144-line). Noise may also be characterized by its probability distribution and noise spectral density N0(f) in watts per hertz.

A noise signal is typically considered as a linear addition to a useful information signal. Typical signal quality measures involving noise are signal-to-noise ratio (SNR or S/N), signal-to-quantization noise ratio (SQNR) in analogue-to-digital conversion and compression, peak signal-to-noise ratio (PSNR) in image and video coding and noise figure in cascaded amplifiers. In a carrier-modulated passband analogue communication system, a certain carrier-to-noise ratio (CNR) at the radio receiver input would result in a certain signal-to-noise ratio in the detected message signal. In a digital communications system, a certain Eb/N0 (normalized signal-to-noise ratio) would result in a certain bit error rate. Telecommunication systems strive to increase the ratio of signal level to noise level in order to effectively transfer data. Noise in telecommunication systems is a product of both internal and external sources to the system.

Noise is a random process, characterized by stochastic properties such as its variance, distribution, and spectral density. The spectral distribution of noise can vary with frequency, so its power density is measured in Watts per hertz (W/Hz). Since the power in a resistive element is proportional to the square of the voltage across it, noise voltage (density) can be described by taking the square root of the noise power density, resulting in volts per root hertz. Integrated circuit devices, such as operational amplifiers commonly quote equivalent input noise level in these terms (at room temperature).