Noise Responsive Systems: How do those change the infrastructure of the Institution?

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Abstract

Sound studies are incorporating signal analysis, rhythmanalysis, physics, engineering and computation. According to Shannon and Weaver, signal analysis is the principle to understand all processes in information theory. This process follows the schema: sing – storage – transmission. Signal emission is produced in communication systems, computing and noise responsive environments. Rhythm is a characteristic of signal emission, and its detection and transmission is studied for example through the experimentation with electromagnetic devices. As a result, noise is produced. Noise is defined in Norbert Weiner as a non-desired message. However, content and context, support and message in noise responsive systems cohabit in the electronic continuum generated by signals to be deciphered.

Noise Responsive Systems

In this paper, I will present different artists and projects that work with signal processing, for example, soundscapes, cyber-sound, neuro-noise, biomusic and responsive environments that will clarify and give a possible solution for research practice based projects and the curatorial development of exhibitions in museums and institutions.

Sonic Landscapes

In sound practice, there is an extensive development of techniques that are related to the environment or the public space surrounding us. Soundscapes and experimentation with electromagnetic emissions are happening in this multi-mediated and natural area.

Once using eavesdropping techniques, the transmission of a signal is captured using hacking strategies in d.i.y computing machines. What this technique is doing is deciphering the electromagnetic wave emissions through the analysis of the pulse that is produced by the wave. So pulse is a rhythm of emission that configures the signal to transmit a message. Usually, in eavesdropping, noise interferes with the signal and need to be corrected. The signal is always noisy, a noise signal.

Moreover, working with soundscapes and the natural space there are some examples of artists working with the transmission of signals. Peter Ablinger demonstrates how the acoustic dimension is experienced through the use of loudspeakers, microphones or DSP digital signal processors. Another one is the case of Audible Eco-systems, work made by the artist Agostino di Scipio. In these cases, the audio work synthesizes the room, the network and the feedback with the performance. Sound sources and resonances of acoustic space, so-called noise, implement the relation machine, human, and environment. The principle of interaction becomes a unique part of the generative work. The results are noise amplified rooms, saturated sounds, discontinued and restarted pieces.

Another example of artists transferring signals into noise is Psychogeophysics, a group that borrows techniques from EVP/itc (electronic voice phenomena and instrumental transcommunication), classical psychogeography, thoughtography, amateur radio astronomy, archaeological geophysics, tempest analysis and environmental steganography. These techniques include excitation, intervention and performance, domains and frequencies (earth or skin resistance or impedance measurement), low and high-frequency electromagnetic radiation detection and all frequencies of sound signal detection. In most of the electromagnetic experiments, a phenomenon such as noise appears in all audio signals received from the exterior, through electronic components and circuits. As a result, the criticism towards the commodification of the devices understands that the output signal proceeds from a noise, which is embedded in the aesthetic context of the infosphere emissions representing the technological genocide. [1]

The three examples could be classified as sound generating signals for environmental data and in so doing they operate the capture of sound in the atmosphere. However, noise is a constant political weapon in outer space to detect the radiation of established devices, which are damaging the ecosystems.

Going further, up to the magnetosphere, the Department of Physics and Astronomy, at the University of Iowa, developed the Plasma Wave Instrument (PWI) to measure the plasma waves in Earth’s Polar Regions in between frequencies of 01 Hz to 800 Hz. Although most of the sounds are in the acoustic frequency range, they are not audible to the human ear. These sounds are produced by processing the original wave data, in the same way, that radio stations process signals. The PWI detected a different range of sounds and was powered on 1997. Working with a wideband receiver (WBR), the data processing is done through the multi-channel analyzer and the signal processing by the five receivers system. Static electric field and magnetometers are used, too. Receivers and antennas are used to design the plasma waves, altogether with software. Microprocessors are also part of the electronic circuit. The input signals with the utilization of a compressor are transformed into data values, processed logarithmically. There are also noise filters and noise generators that work together with the sinewave's output and the wave's amplitude captured. Also, memory storage is used to keep data and sensors, and signals are also part of the PWI. In the results of the captured waves can be appreciated a very profound background noise, despite its modulation through filters. Engineered apparatus, such as PWI, obtain and notify the presence of signals transduced into sound.

More examples of capturing signals from outer space, in this case from the ionosphere, is The Inspire Project, a project presented by NASA, as a physics ionosphere radio experiment with VLF signals receivers' device. The NASA Inspire Project offers a printed board for a D.i.Y. soldering kit.

Cyber-sound

Signalling is an operation present in almost all the circuits that pretend communication. According to Lefebvre and Miyazaki, the signal functions, such as an expansive electromagnetic wave, could be analysed according to rhythmanalysis. Conditions of amplification, modulation, resonance, coupling, oscillation and feedback could be extracted from the signalling process. This process in communication devices is also reframed in systems theory. [2]

Following the studies, there are different non-linear systems. A system with no time series could form pure signals types of corrupting noise. For example, in stochastic systems where could be found an error under differential time conditions. The stochastic systems have randomly distributed errors. Deterministic systems have a mistake that remains stable and regular. Investigating the failure in between two states is deduced that randomness increases the dimension of the wave. In non-linear deterministic systems, external fluctuations produce severe permanent distortions. Noise amplified has non-linear dynamic properties. Non-linear feedback systems are produced by interactions between non-linear deterministic and noise (feedback noise is used as a media language in responsive systems).Others examples are DNA, brain dynamics, computing, quantum physics and electrical engineering. Finally, complex adaptive systems are fundamental to understand the natural non-linear structures based on the interval of external forces.

Other systems used in the signalling process are cyber-physical systems (CPS) which are becoming a promising research field to integrate the computing components, the physical processes and the communication networks. The primary challenge in designing CPS is to understand the effect of physical factors on the communication. It is proposed a mathematical model to present the relations between the performance and the controller area network (CAN) and some physical factors, such as the temperature, the impedance value and the electromagnetic interference. On CPS systems, a noise occur and is obtained insight the bit-error rate of these physical factors. It gives an approach to fundamental insights into the impact of the physical factors on communication. Cyber-physical systems are in charge of the control of physical processes characterized by dynamics or movement. This control must comply with timing constraints to capture changes in the system. CPS system cases of studies are generative software, interactive installations and neural signal.

Neuro-noise

In 1929, Hans Berger discovered the alpha rhythm, a fundamental rhythmic brain signal that could be used as a mental remote control, through electroencephalographic (EGG) data operated through open source software. In this field of research, the functional cortical areas are determining control behaviour and physical actions. Spontaneous electrical signals have also been found in the cortical origins. Signals generated by cerebral cortex in the brain are translated into data and digital information and then used as a source for sound generation, producing, for example, feedback loops. The result is electro encephalo-music, a sort of spontaneous music, created by cortical signals producing sounds. In a feedback loop circuit, bits of cortical material are processed into sound. Between the behaviour and the recorded, remains a relative state.

In neurosciences studies, neural signals receivers are commonly using CMOS technology. Low-noise biopotential recording circuits are a CMOS microsystem that provides an excellent method for the reduction of noise in a low-frequency signal processing. The simple circuit structure can be a widespread application for neural signal recording. The circuit consists of a close-loop bio-amplifier and significantly suppresses low-frequency noise and focuses in the bio-potential signal, in a range from 10 Hz to 10 kHz. Another example, the ultra-low-power neural recording microsystem for an implantable brain-machine interface, is an implantable CMOS microsystem for the detection of neural spike signals from complex brain neural potentials that achieves the characteristics of ultra-low-power and high-precision.

Neuro-noise and neuro-feedback are used in neuroscience system altogether with hearing, psychology, physics or engineering and are articulating sounds that response to stimulus or signals sends to the brain. These electrical signals are transmitted to auditory nerves. They are called brain alteration techniques. In addition to that, it mentions particular attention the works by Jonathan Kemp, *Experimental communication system*, and Ryan Jordan, *Hylozoistic neural computation*.

Bio-music

A part of neuro-noise signalling technologies, there are biopotentials, which use skin sensors in information processing. Electrical signals generated are detected as an information source. Psycho-galvanic skin reflex and skin resistance sensors are biopotentials. Signals generated by involuntary muscular contraction are captured and processed. The biological feedback sensory stimulation amplifies electrical signals. Biopotentials attached to the body or in its proximity convert these responsive signals into aural, visual or electrical phenomena. Biopotentials signals are as well myoelectric signals. A central feature of myoelectric signals that is essential to further developments is its amplitude. The amplitude of a myoelectric signal is thought to represent the contraction force of the respective muscle. Some myoelectric signals are used in the control of the hand prosthesis, and its sonifications are a possible application. Some phenomena can affect the transduction, such radical interference in information transmission, unintelligible rendered sound, completely disavowed sound or misled sound by incorrect data. Incorrect data transmission is supporting awareness theory in media ecology and media archaeology studies that declare the fatal technique's embrace. Random decisions or combinatorial rules differentiate among control societies governed by prediction systems and unpredicted systems developing other uses of technology and devices. [3]

Marco Donnarumma, *Music for Flesh II* is a seamless mediation between human biophysical potential and algorithmic composition. By enabling a computer to sense and interact with the muscular potential of human tissues, the work approaches the biological body as a means for computational artistry. The artist is highlighted as a bio-music composer. Here, the algorithmic composition executes the biophysical signals.

Intermedia Interactive Immersive Environments

Finally, the last type of work studied here is interactive systems that are developed as responsive environments. The non-verbal signals in media communication will be used to compose a different range of sound installations that typically are directed by interactive response and immersion into the environment. Here, interactive installations appear under different procedures, where the sound responds to light or installations where the sound responds to the movement. Those use transducers such accelerometers and others sensors. Moreover, an interactive installation where sound responds to light could use sensors, solar cells, lasers harps, flashing lights, lamps, strobe lights or any light source with luminous flows modifications. Light sensors transmit the bright impulses and variations to a data-processing program or electronic circuit. Accelerometers such the minibees are considered transducers. A transducer is a device that converts a signal to one form of energy to another form of energy. While the term transducer commonly implies the use of a sensor/detector, any device that converts energy can be considered a transducer: antennas, piezoelectrical crystal, hydrophone, light emitting diodes, cathode ray tube (CRT). Receivers and transmitters are also used in responsive environments and interactive installation. Others are sensors, actuators and interfaces that are configured for a personal computer. Intermedia, interactive, immersive environments play a crucial role in D.i.Y. The circuits are vulnerable to noise, but the further developments reach to calibrate more accurate results. [4]

To finalize, I would like to introduce another type of sound installation, though not being immersive, it uses parameters of responsiveness. 'Signal To Noise' is an installation by LAb[au], immersing the spectator in patterns of sonic motion produced by 512 recycled mechanical split-flaps. It uses the expression 'signal-to-noise', which is a measure used to quantify how much a signal has been lost to noise; it is a ratio of useful to un-useful information in a data exchange. The circular installation invites the visitor to plunge into a kinetic composition in the midst of the eternal calculation process of an auto-poetic machine. The split-flaps are constantly spinning on a variable speed/rhythm which is dependent upon on the underlying algorithm, analyzing in the maze of information the appearance of a word-equals-meaning. It is an interesting hybrid of digital and analogue technology based on mechanics, visual and sonic characteristics. The signal is the silence and the noise being the one of the split-flaps communicates the ratio of useful information to false or irrelevant data in a conversation or a data exchange. The split-flaps are always spinning but on a variable speed/rhythm depending on the processing limitations of the underlying algorithm, analyzing in the maze of information. The LAb[au] installation can be entirely embedded in Frances Dyson's theories of information, processes of data, and economies in an environmental system mediated by noise. The criticism points to a technology-based computer control systems to support the so-called collective intelligence system. Algorithms and robots guided by this techno-culture based in finance and automatic statistics produce an excess, which does not stop being a corrupted noise. [5]

Conclusion

For closing the paper, I mention here that the divergences in signal noise ratio are more notified in experimental devices in environmental surroundings, because of space acoustics. Also, neuro-noise circuits are also more vulnerable as are non-linear systems, affected by brain dynamics and external conditions, such as time, air, and movement.

Furthermore, the concept of signal-to-noise responsive system proceeds from noise responsive systems, where actuators emit signals and circuits response to it. These could be frequency amplifiers and receivers, mentioned in this paper, but also, all of those that treat the different ratio of noise and signal as a noise signal because noise is part of the signal, and communications channels emit noise, and signals mimic (where possible) disturbances, and statistically, so signals emit noise. Hence, interference is part of the message and data. Friedrich Kittler writes about the materiality of communication systems and focuses on how noise is a fundamental element in understanding communication technologies and systems of information. Kittler scrutinizes the statistical formalization of communication by mathematician Claude Shannon who argues that communication is in the presence of noise; that noise is alongside the information/signal. Kittler discusses Shannon's argument that sets out to show that the maximum communication of information turns into a statistical improbability because the information becomes very hard to separate from noise. Engineers might equate information with the signal, but Kittler includes noise in his notion of information and proposes an inseparable cross-linking of signal and noise, and of noise and matter. [6]

According to Claude Shannon, the communication theory analyzes noise disturbances in the communication channel. The schematic diagram of general communication systems based on semiotic and computing machine shows different parts: information (message or sequences of messages); transmitter (changes the signals into a signal, for example, sound into electrical voltage); a channel (issued to transmit the signal from the transmitter to the receiver); the receiver (which informs the inverse operation of the transmitter, reconstructing the message from the signal). Encoding and encryption techniques are used in transmission. Vocoders, TV and frequency modulation use transmitters, too. Communication systems are an essential part of communication theory and computing machines. In these processes, deduction resulted is conditioned to unexpected, stochastic and randomness. Even there are a finite number of possible states in the system; there is a set of transition probabilities. It brings to study ergodic processes in communication theory like in complex dynamic systems, formed by indefinite components, which make them uncertain. The result deducted will be reasonably probable or also called relative entropy. [7]

To answer my initial question, about how the noise responsive systems reshape the frame of the institutional bodies, here I contend that these practices are embedded in a major framework, denominated the curatorial lab. This concept considers the production of own devices in hack labs. Resulting D.i.Y. devices as well as own build apparatus, constructs a fierce criticism towards the deviation of the mainstream edified thought. The political aesthetics of noise must transform the functions of art and music in the contemporary society, which is threatened by ecological disaster, electronic waste disposal, and the financial crisis. Moreover, the practices of a curatorial lab innovate in exhibition making and, also, in research practice based. In so doing, the key element of this new tendency changes dynamics in museums and galleries, as well as universities, reinforcing a connection between them.

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