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Klouzal et al.

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(54) METHOD AND APPARATUS FOR ENTRAINING SIGNALS

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G05B 15/02	(2006.01)

(Continued)

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CPC ***G06F 3/015*** (2013.01); ***A61B 5/7225*** (2013.01); ***G02F 1/225*** (2013.01); ***G05B 15/02*** (2013.01);
(Continued)

(58) **Field of Classification Search**
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(Continued)

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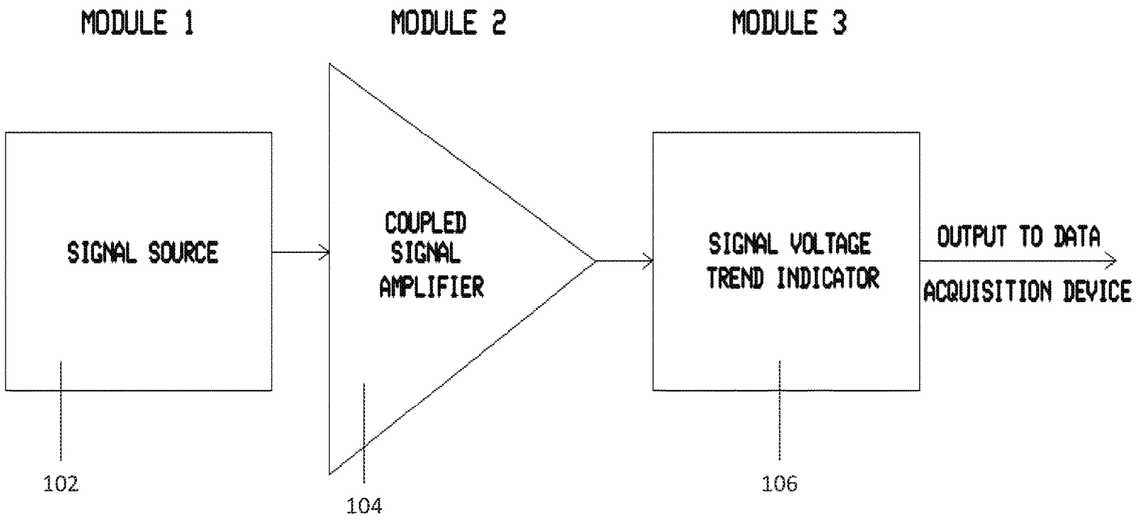
(57) **ABSTRACT**

Methods and apparatus configured to allow for users to intentionally interface with an external signal are provided. The methods and apparatus incorporate a randomly-generated electronic signal the behavior of which may be influenced to provide a control output. The methods and apparatus provide a temporal coherence measure influenced by a user that improves the ability to discriminate between intentionality and non-intentionality, and allow for the control of switching, communication, feedback and mechanical movement.

22 Claims, 8 Drawing Sheets



(51) **Int. Cl.**

H03K 5/003	(2006.01)
G02F 1/225	(2006.01)
A61B 5/00	(2006.01)
A61B 5/30	(2021.01)
A61B 5/245	(2021.01)
A61B 5/246	(2021.01)
A61B 5/291	(2021.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
CPC A61B 5/291; A61B 5/30; A61B 5/7257; A61B 2560/0223; A61B 2562/0214
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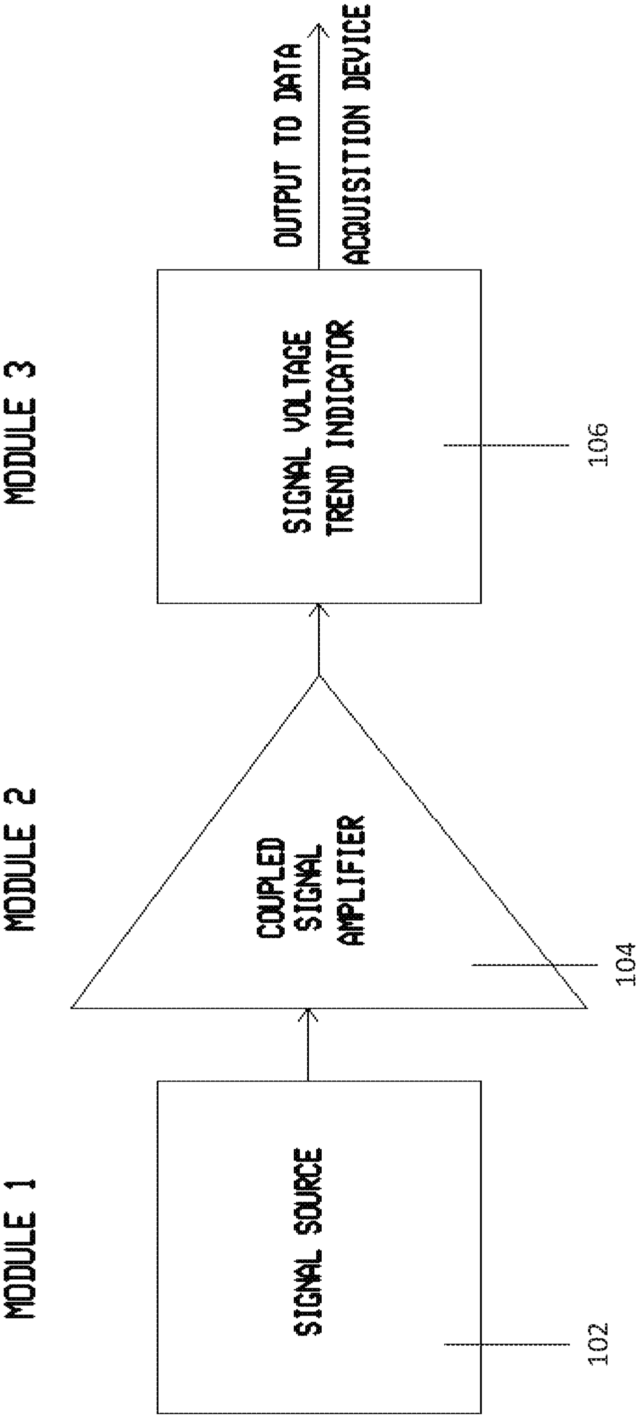

MODULE 1
SIGNAL SOURCE
102
MODULE 2
COUPLED SIGNAL AMPLIFIER
104
MODULE 3
SIGNAL VOLTAGE TREND INDICATOR
106
OUTPUT TO DATA ACQUISITION DEVICE

FIG. 1

FIG. 2

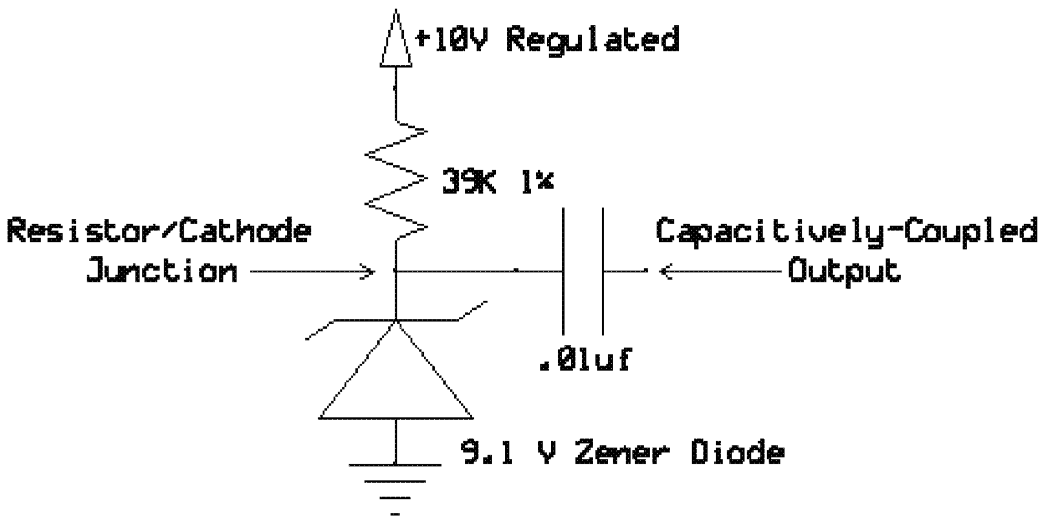

+10V Regulated
39K 1%
Resistor/Cathode Junction
Capacitively-Coupled Output
.01uf
9.1 V Zener Diode

FIG. 3

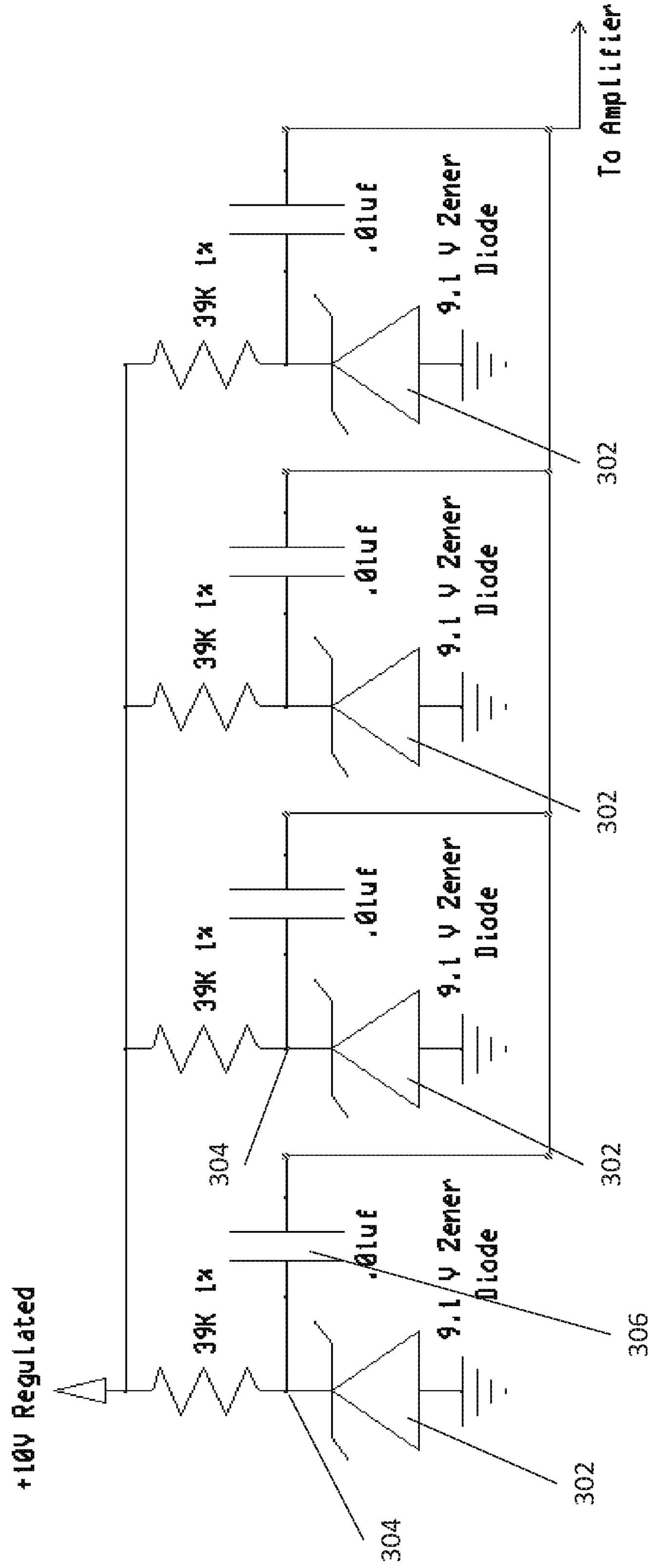

+10V Regulated
304
39K 1%
.01uf
9.1 V Zener Diode
306
302
304
39K 1%
.01uf
9.1 V Zener Diode
302
39K 1%
.01uf
9.1 V Zener Diode
302
39K 1%
.01uf
9.1 V Zener Diode
302
To Amplifier

FIG. 4

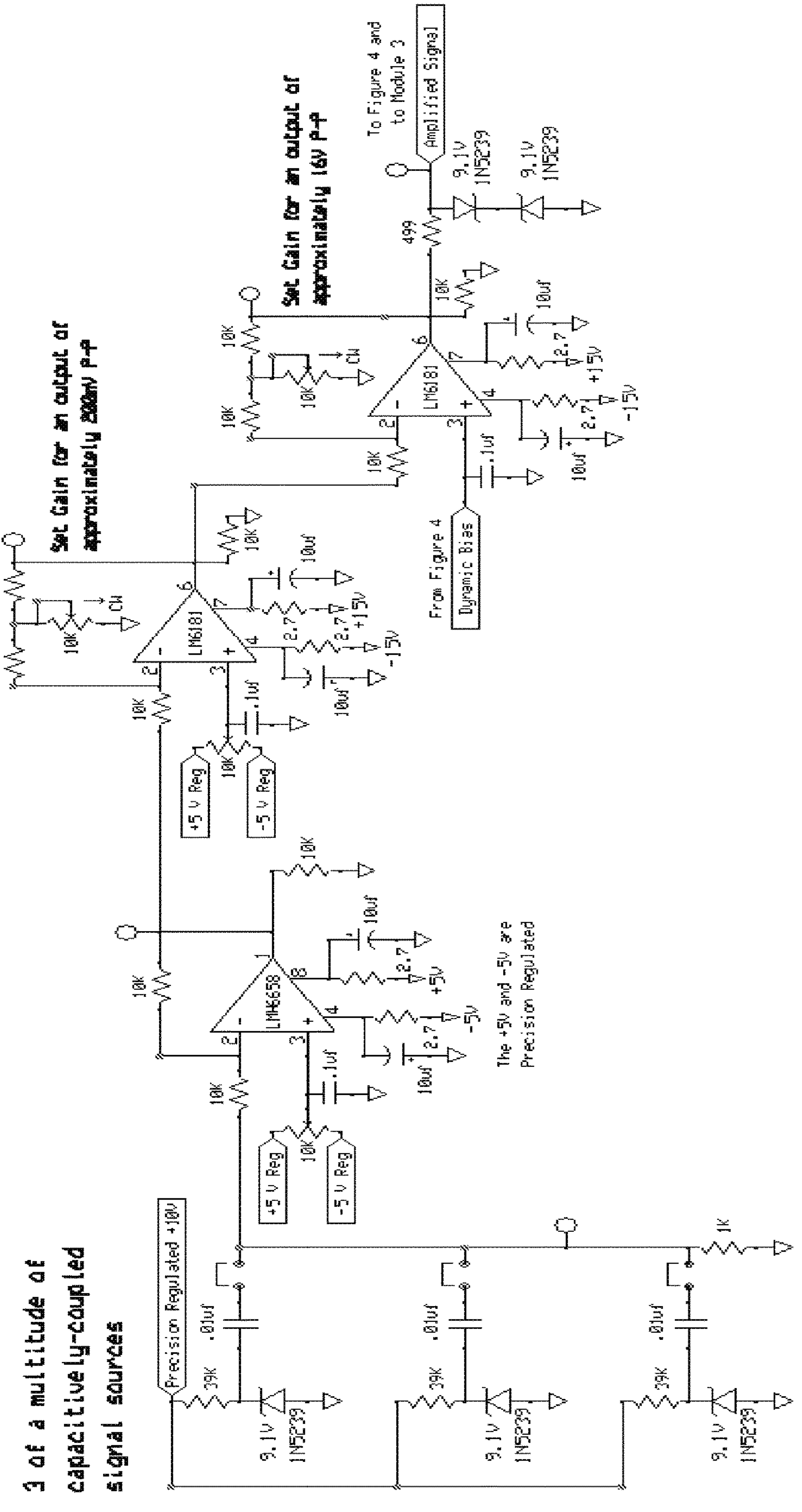
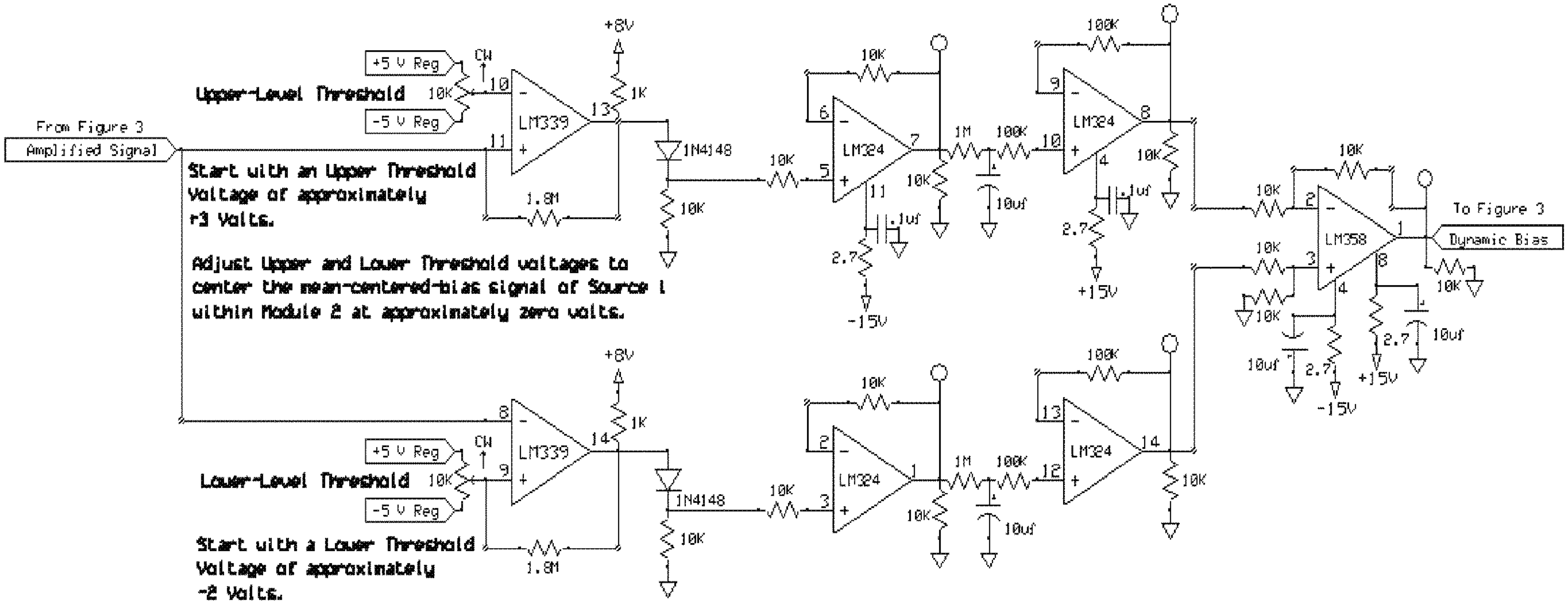

3 of a multitude of capacitively-coupled signal sources

FIG. 5



Upper-Level Threshold

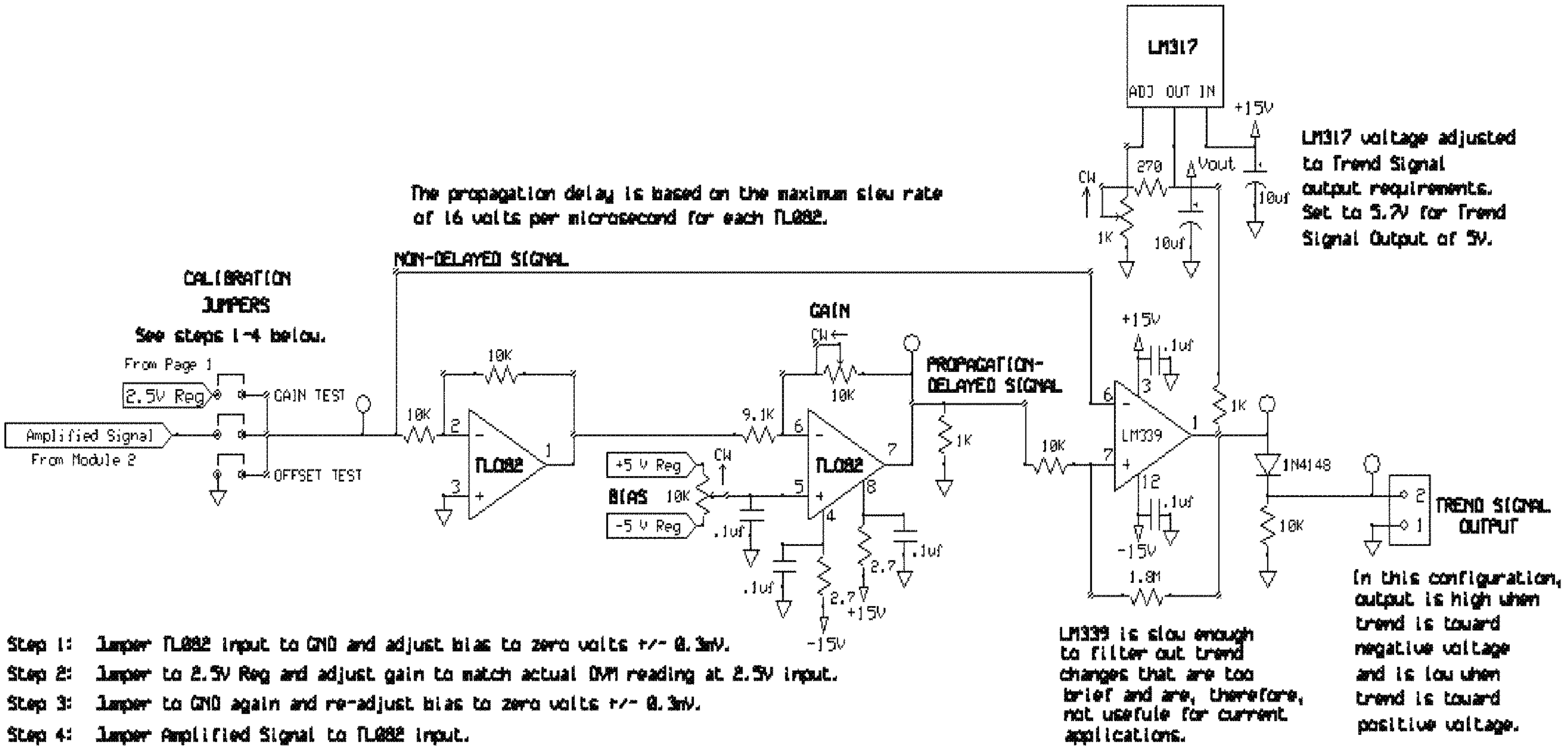
Start with an Upper Threshold Voltage of approximately +3 Volts.

Adjust Upper and Lower Threshold voltages to center the mean-centered-bias signal of Source 1 within Module 2 at approximately zero volts.

Lower-Level Threshold

Start with a Lower Threshold Voltage of approximately -2 Volts.

FIG. 6



The propagation delay is based on the maximum slew rate of 16 volts per microsecond for each TL082.

LM317 voltage adjusted to Trend Signal output requirements. Set to 5.7V for Trend Signal Output of 5V.

LM339 is slow enough to filter out trend changes that are too brief and are, therefore, not usefule for current applications.

In this configuration, output is high when trend is toward negative voltage and is low when trend is toward positive voltage.

Step 1: Jumper TL082 input to GND and adjust bias to zero volts +/- 0.3mV.
Step 2: Jumper to 2.5V Reg and adjust gain to match actual DVM reading at 2.5V input.
Step 3: Jumper to GND again and re-adjust bias to zero volts +/- 0.3mV.
Step 4: Jumper Amplified Signal to TL082 input.

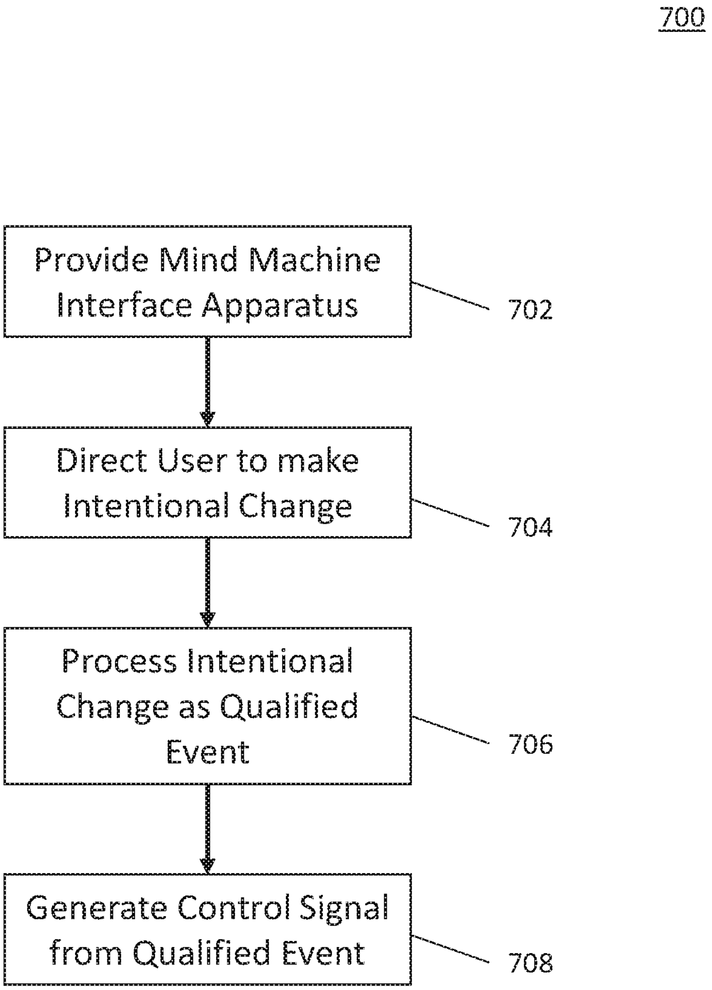

700
Provide Mind Machine Interface Apparatus
702
Direct User to make Intentional Change
704
Process Intentional Change as Qualified Event
706
Generate Control Signal from Qualified Event
708

FIG. 7

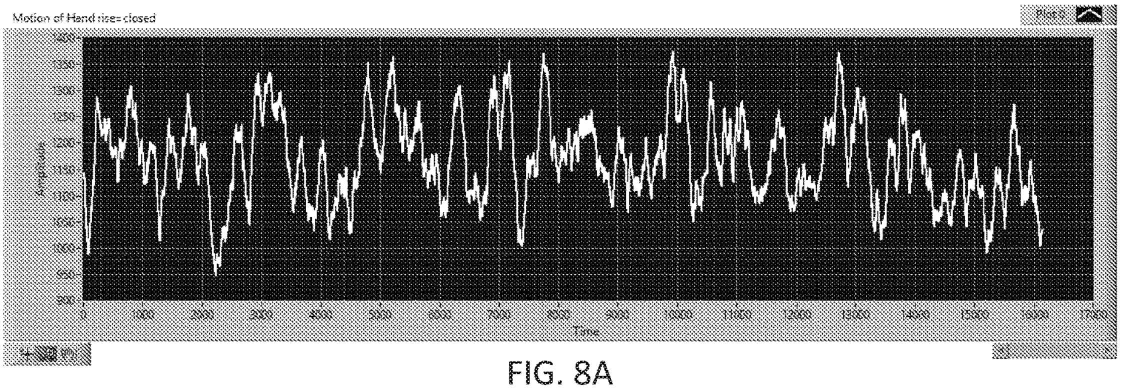

Motion of Hand rise= closed
Plot 0
Amplitude
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
Time

FIG. 8A

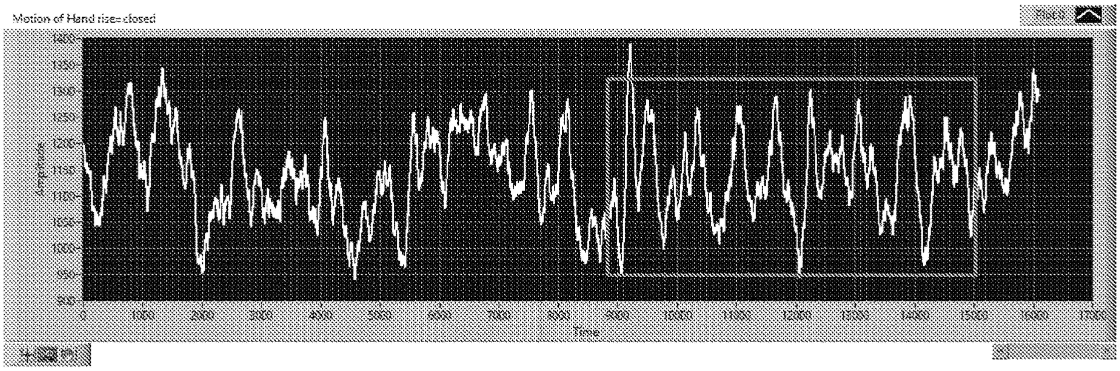

Motion of Hand rise= closed
Plot 0
Amplitude
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
Time

FIG. 8B

METHOD AND APPARATUS FOR ENTRAINING SIGNALS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application Ser. No. 62/512,671, filed May 30, 2017, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The current invention is directed to devices that detect the influence of external signals (e.g., mental intention changes) in the entrainment characteristics of a single signal source resulting from coupled multiple randomly-generated signals. The detected changes in coherence as measured by rate of change, and other electrical characteristics, are output as discrete measures of the entrained signals (e.g., mental intention), and systems are provided to control, for example, switching, communication, feedback, intention-influenced performance metric, and mechanical movement.

BACKGROUND OF THE INVENTION

Mind-machine interfaces seek to allow control of an object using thoughts and/or impulses stemming from thoughts. A number of research groups have disclosed methods and apparatus for detecting the influence of the mind on a physical construct. Some attempts to construct a mind-machine interface include using contacts placed on the head of an individual to detect changes in brain-impulse signals. In additional methods and apparatuses, the influence of the mind on a randomly-generated signal has been observed by processing a random digital number output by various methods. Examples of such methods and systems may be found, for example, in U.S. Patent Publication No. 2013/0036078; and U.S. Pat. Nos. 9,858,041; 8,423,297; RE44,097; U.S. Pat. Nos. 6,324,558; 6,763,364; and 6,762,605, the disclosures of each of which are incorporated herein by reference.

SUMMARY OF THE INVENTION

Many embodiments are directed to methods and apparatus configured to allow for very small amplitude signals such as those produced by human thought to influence the behavior of a randomly-generated electronic signal that can then be processed to provide a controlled output.

In various embodiments, the methods and apparatus describe an external intentionality interface apparatus, which includes a plurality of sub-atomic-based random signal sources, a coupling circuit in signal communication with the plurality of sub-atomic-based random signal sources, configured to combine the randomly-generated signals from the plurality of sub-atomic-based signal sources into a coupled randomly-generated signal capable of being entrained by an external intentionality signal, a signal amplifier in signal communication with the coupling circuit to amplify the coupled randomly-generated signal, a dynamic bias circuit to maintain a means-centered bias of the coupled randomly-generated signal, and a signal voltage trend indicator in signal communication with the signal amplifier and configured to detect the voltage difference between a non-delayed signal and a propagation-delayed signal, and to produce a trend output signal indicative of the voltage difference, where the digitally-processed trend output signal is provided at a first logic state where the trend is toward a negative voltage and a second logic state where the trend is toward a positive voltage, and wherein the trend output signal provides an indication of the presence of an external intentionality signal entrained within the coupled randomly-generated signal, each intention-entrained signal being a qualified event.

In a further embodiment of the methods and apparatus, the plurality of sub-atomic-based random signal sources comprise reverse-biased Zener diodes configured to produce multiple random signals at their respective breakdown voltage knees.

In another embodiment, of the methods and apparatus, the sub-atomic-based random signal sources comprise at least two Zener diodes.

In a still further embodiment of the methods and apparatus, the sub-atomic-based random signal sources comprise a laser photonic source.

In still another embodiment, the methods and apparatus include a photonic crystal waveguide interferometer configured to detect a greater phase state coherence and convert this phase state into a variable electrical signal.

In a yet further embodiment of the methods and apparatus, the plurality of randomly-generated signals are capacitively coupled.

In yet another embodiment of the methods and apparatus, the dynamic bias circuit is analog.

In a further embodiment of the methods and apparatus again, the output from the signal voltage trend indicator is a high or low logic state that is subsequently digitally processed using derivative calculations.

In another embodiment of the methods and apparatus again, the output signal from the signal voltage trend indicator is a high or low logic state that is output as a series of packets of discrete digitized frequency data, and the methods and apparatus further include a period-clock counting apparatus, where the period-clock counting apparatus normalizes the digitized frequency data as proportional values between adjacent digitized frequency values within each packet, generates a coherence score for the series of packets by summing the normalized digitized frequency data within each packet, determines the trend of the series of packets by determining changes in the coherence score between each packet in the series of packets, identifies frequency components of the trend by running FFT sampling for 10 seconds at 0.023 seconds per sample, sums the frequency components of the trend having a greatest percent difference between intention-entrained signals and signals that are not intention-entrained signals, and outputs the summed frequency components as a controlling signal.

In a further additional embodiment of the methods and apparatus, the presence of a qualified event in the digitally-processed trend output signal is utilized as a control signal for a device in signal communication therewith.

In another additional embodiment, the methods and apparatus further include a circuit feedback loop, where the circuit feedback loop is configured to determine at least one of the amount of qualified events and the temporal density of qualified events and automatically adjust the DC bias of the single randomly-generated signal generated from the coupled randomly-generated signals to set the central frequency of a set of higher and lower bandpass filters.

In a still yet further embodiment, the methods and apparatus include a plurality of nodes of multiple randomly-generated signals disposed in proximity to each other node and configured to entrain each other node such that the nodes act collectively to accomplish a programmed directive, via goal directed programming and feedback control processing of a set of filter module settings.

In still yet another embodiment, a method for entraining signals from a user in a randomly-generated signal to generate a control signal for controlling an external device includes providing an external intentionality interface apparatus to the user, and directing the user to make an intentional change to a state of an observable stimulus configured to be representative of the trend output signal.

In a still further embodiment again, a method for entraining signals from a user further includes processing the intentional change as a qualified event, and generating a control signal from the qualified event.

In still another embodiment again of the method for entraining signals from a user, the control signal directs the operation of an external device in signal communication with the mind-machine interface apparatus.

In a still further additional embodiment of the method for entraining signals from a user, the mind-machine interface apparatus further comprises an external device in signal communication with the mind-machine interface apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

The description will be more fully understood with reference to the following figures, which are presented as exemplary embodiments of the invention and should not be construed as a complete recitation of the scope of the invention, wherein:

FIG. **1** provides a schematic diagram of a signal interface system in accordance with embodiments.

FIG. **2** provides a circuit diagram of a single randomly-generated signal source in accordance with embodiments.

FIG. **3** provides a circuit diagram of a plurality of randomly-generated signal sources capacitively coupled together in accordance with embodiments.

FIG. **4** provides a circuit diagram of a signal amplifier in accordance with embodiments.

FIG. **5** provides a circuit diagram of a dynamic bias circuit in accordance with embodiments.

FIG. **6** provides a circuit diagram of a signal trend indicator in accordance with embodiments.

FIG. **7** provides a flow diagram of a method of entraining intentional signals in a randomly-generated signal in accordance with embodiments.

FIG. **8**A illustrates a non-intentional wave form pattern in accordance with embodiments.

FIG. **8**B demonstrates an intentional signal wave form pattern in accordance with embodiments.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to the data and description, methods and apparatus configured to allow signals produced from mental thoughts to interface with a device generated signal are provided. In many such embodiments, the methods and apparatus incorporate a randomly-generated electronic signal the behavior of which may be influenced by an external signal to provide a control output. In various such embodiments, the methods and apparatus provide a temporal coherence measure influenced by an external signal (e.g., mental intention) that improves the ability to discriminate between an ambient state (e.g., where there is no external intentionality or mental signal) and an intentional state (e.g., where an eternal intentionality or mental signal is present). In some such embodiments, the methods and apparatus allow for the use of such of switching, communication, feedback, intention-influenced performance metric, and mechanical movement.

Embodiments of the invention allow for the integration and control of an external device to perform a designated task for which a user is required to respond. Embodiments allow for user influence and non-contact control of an external device determined by the sensitivity of the randomly-generated signals. In various embodiments, the sensitivity may be enhanced using a large plurality of randomly-generated signal sources. Embodiments allow for the output control of all forms of communication including self-feedback of all available organisms' perceptics. Embodiments allow for one or more users to influence the device to control external devices and feedback systems. Finally, some embodiments provide functionality whereby one device with two or more nodes of multiple randomly-generated signals in proximity to each other may entrain one another and via goal-directed programing and feedback control processing, act collectively to accomplish a programmed directive.

Entrainment is a natural phenomenon both in electronics, whereby two or more coupled asynchronous oscillating signals with differing periods and/or phases will tend to synchronize, and in biology, whereby two or more asynchronous biological organisms, systems or tissues with differing periods and/or phases will tend to synchronize similar biological characteristics. Biologic entrainment examples include the synchronization of the hand clapping of a crowd, of fireflies flashing, of consensus of thought, and of circadian rhythm. (See, e.g., Fusaroli, R., et. al., Timescales of Massive Human Entrainment, PLOS One, April 2015; Gill, S. P., Entrainment and Musicality in the Human System Interface, AI & Soc., 2007, 21, 567-605; Gonze, D., et. al., Stochastic Models of Circadian Oscillations: Emergence of a Biological Rhythm, International Journal of Quantum Chemistry, 2004, 98(2), 228-238; Letiche, H., Self-Organization, Action Theory, and Entrainment: Reflections Inspired by Alicia Juarreno's Dynamics in Action, Emergence: Complexity and Organization, April 2000, 58; Liu, F., et. al., Improvements and Applications of Entrainment Control for Nonlinear Dynamical Systems, Chaos, 2008, 18, 4, 43120; and Pantaleone, J., Synchronization of Metronomes, American Journal of Physics, 2002, 70, 10, 991-992, the disclosures of which are incorporated herein by reference.) This phenomenon has been known to drive a random system to a more coherent and synchronous state.

Some random generators, including the ones used in the present art, generate a random signal at the atomic or sub-atomic level. In turn, quantum theory provides the theoretical foundation and supports an explanation as to why a user (e.g., via mental intention) can, in theory, affect specific types of randomly-generated signals. (See, e.g., Erol, M., Quantum Entanglement, Fundamentals and Relations with Consciousness/Mind, NeuroQuantology, September 2010, 8(3), 390-402; Gargiulo, G., Mind, Meaning and Quantum Physics: Models for Understanding the Dynamic Unconscious, Psychoanalytic Review, February 2010, 97, 1, 91-106; and Har, S. D., Mind and Tachyons: How Tachyon Changes Quantum Potential and Brain Creates Mind, NeuroQuantology, June-11, 9, 2, 255-270, the disclosures of which are incorporated herein by reference.) Specifically, several researchers have established that the mind operates at a quantum level. (See, e.g., Wolf, F. A., Towards a Quantum Field Theory of Mind, NeuroQuantology, September 2011, 9, 3, 442-458; Georgiev, D., No-Go Theorem for Stapp's Quantum Zeno Model of Mind-Brain Interaction, NeuroQuantology, June-15, 13, 2, 179-189; Shimizu, T. & Ishikawa, M., Quantum Walk Founds Over Dispersion of Field RNG Output: Mind Over Matter Through Quantum Processes, NeuroQuantology, December 2015, 13, 4, 408-412; and Libet, B., Conscious Mind as a Field, Journal of Theoretical Biology, 1996, 178, 223-224, the disclosures of which are incorporated herein by reference.) Researchers have gone further to support the quantum-mind interaction by proposing that the mind generates a quantum field that can influence the quantum aspects of mechanical systems. (See, e.g., Hari. S. D., Mind and Tachyons: Quantum Interactive Dualism-Libet's Causal Anomalies, NeuroQuantology, June-14, 12, 2, 247-261; and Musha, T. & Sugiyama, T., Possibility to Realize the Brain-Computer Interface from the Quantum Brain Model Based On Superluminal Particles, Journal of Quantum Information Science, December 2011, 111-118, the disclosures of which are incorporated herein by reference.) Although there are opposing opinions as to whether the quantum interaction of an organism is generated from mind or the brain, the distinction is irrelevant to the operation of embodiments of the device that require only the generation of such interaction.

Embodiments of methods and apparatus provide an interface capable of entraining a user's intention (e.g., via mental signals) to influence randomly-generated signals such that they can be processed, discriminated and then output to fulfill the objective of user's intention. In many embodiments, methods and apparatus use multiple randomly-generated signals that, when coupled together, produce a higher state of synchronization (e.g., coherence) of the single random coupled signal. More specifically, the apparatus and methods utilize the entrainment of multiple randomly-generated signals, that when coupled together as a single random-generated signal, can manifest changes in entrainment characteristics when acted on by an external signal (e.g., a user's mental intention). This single random signal is then processed to detect the amount of synchronization (e.g., coherence) that is in a non-influenced (ambient) and influenced (intentional) state. Embodiments of the methods and apparatus also include a temporal processed measure of the coherence change in entrainment beyond an ambient state. Examples of measures of changes in entrainment coherence by a user include, but are not limited to, the control of switching, communication, feedback, and movement.

Embodiments of Interface Devices

Turning to the figures, as shown in FIG. **1**, the methods and apparatus utilize a three module system. In a first "signal source" Module **1** (**102**), a plurality of random signals are generated and capacitively coupled together. These coupled signals from multiple sources are then amplified in a "coupled signal amplifier" in Module **2** (**104**). These random, coupled and amplified signals are then processed in Module **3** (**106**) by a signal voltage trend indicator that is configured to determine and output an indicator (e.g., high or low signal) indicative of the change in amplified signal voltage, and that when digitized and processed provides a measure of the level of synchronization or coherence in the signal, indicative of external influence. Details of each of these modules is provided below.

In many embodiments, as shown in FIG. **1**, Module **1** (**102**) uses two or more atomic or sub-atomic based random signal sources. In various embodiments, Module **1** (**102**) uses two or more reverse biased Zener diodes to produce multiple random signals at their respective breakdown voltage knees. It should be understood that any number or arrangement of such random signal sources may be used. In various embodiments, upwards of 40 such sources (e.g., Zener diodes) may be used to magnify the effect mind intention has as an entrained influence. In certain embodiments, upwards of 100 or upwards of 1,000 random signal sources may be used. Although any suitable Zener diode may be incorporated into the device in accordance with some embodiments (shown in FIG. **2**), electrical random signals are produced by reverse biasing multiple Zener diodes, each through a 39K 1% resistor. In some embodiments, the diodes used are 9.1 Volt Zener diodes that operate within the avalanche breakdown region. In such embodiments, the combination of the Zener diode, resistor and coupling capacitor is considered the discrete "Signal Source" (see FIG. **1**, item **102**).

Although the above discussion has focused on diodes as the signal source, it will be understood that other methods and devices may be used to produce the two or more randomly-generated signals that can be coupled together and then converted to a form that is processed with present digital or proposed analog electronics. In various embodiments, a photonic method may be used to produce the two or more randomly-generated signals by manipulation and processing of laser photons. In other embodiments, a photonic crystal waveguide interferometer in the combined multiple laser signals may be used to detect a greater phase state coherence. In such embodiments a photo detector may be used to convert this phase state into a variable electrical signal that, when processed to detect changes in coherence or other signal characteristics, is used as a controlling source.

In various embodiments, the individual signals from the randomly-generate signals from the individual sources are capacitively coupled to combine the plurality randomly-generated signals. One exemplary coupling mechanism in accordance with embodiments is shown in FIG. **3**. As shown, in many embodiments (e.g., where a diode (**302**) is used to produce the randomly-generated signals) the signals are coupled at the resistor/Zener cathode junction (**304**) through a 0.01 uf ceramic capacitor (**306**) to produce a signal with no DC bias, (see, FIG. **3**). In one exemplary embodiment, forty individual signal sources are capacitively coupled to produce a single Signal Source output to Module **2** (see, FIG. **1**, item **104**).

Regardless of the specific mechanism used in the Signal Source, the output of the Signal Source is taken and coupled to combine the signals from the individual sources. The coupling of random signal sources produces an entrained signal which by its nature has a coherence that can be measured. According to embodiments this entrained signal may be influenced at the source level prior to coupling, while coupling allows the device to acquire a measure of sensitivity to entrainment, and by entraining multiple signal sources the organizational effect of an external influence on the random signal sources may be magnified.

As shown in FIG. **1**, the coupled randomly-generated signals are then amplified in Module **2** (**104**). As shown in FIG. **4**, Module **2** amplifies the capacitively-coupled signals from multiple signal sources. In various embodiments, Module **2** is also configured to automatically maintain a mean-centered bias to correct for thermal drift. In some such embodiments, Module **2** is provided a dynamic bias circuit (as shown in one exemplary embodiment in FIG. **5**) to prevent drift and further regulate the amplified signal. In many embodiments, the output of Module **2** is a 10 volt peak-to-peak signal that is then transmitted for processing by Module **3**.

In many embodiments of Module **3**, the capacitively-coupled and amplified signal is processed by a Signal

Voltage Trend Indicator configured to output a logic state (e.g., high or low) indicative of the signal voltage trend indicator circuit. This logic state is then sent to data acquisition hardware for period-clock counting and output of discrete digitized frequency data. As shown in FIG. **6**, in various embodiments, Module **3** may be configured to use a comparator (e.g., an LM339 comparator) to detect the voltage difference between a non-delayed signal and a propagation-delayed signal. In some such embodiments, the propagation delay is based on the maximum slew rate of 16 volts per microsecond for each operational amplifier (e.g., TL082 amplifier) shown in FIG. **6**. The configuration shown in FIG. **6** is designed such that the output of the comparator is high when the trend is toward negative voltage and low when the trend is toward positive voltage.

It should be understood from the exemplary circuit of FIG. **6** that the Trend Signal Output may be adjusted to any voltage for any digital acquisition format. In one exemplary embodiment, when the amplified signal voltage is trending negative, the Trend Signal Output is in a High logic state, and when the amplified signal voltage is trending positive, the Trend Signal Output is in a Low logic state. In various embodiments, the logic state output may be designed for digital acquisition and signal processing.

In some embodiments of the exemplary circuit in FIG. **6** a method to have multiple voltage-controlled trend signal outputs (nodes) of various frequency bands. In various embodiments, the logic state output may be designed for digital acquisition and signal processing.

In some embodiments of multiple frequency trend signal output nodes, the nodes are in various ways weighted, valuated, and/or combined to produce a controlling output.

In some embodiments the multiple frequency trend output nodes are controlled by a feedback loop that changes one or various voltages to alter the timing of the trend signal circuits (FIG. **6**) to change the one or various multiple frequency trend signal nodes controlling output.

In some embodiments multiple frequency trend signal output nodes are compared to a single or a bandpass of frequencies using the trending as a phase synchronizing frequency coherence comparator.

In some embodiments, the Signal Voltage Trend Indicator may output packets of discrete frequency values to processing software in a period clock-counting apparatus. In various embodiments, an output packet may contain 1,000, 5,000, 10,000, 50,000, 100,000, or more frequency values. The frequency values are normalized as proportional values of one frequency value to its adjacent value the output packet. In certain embodiments, these proportional values are summed up to the total number of discrete frequency values to generate a coherence score for an output packet. As a non-limiting example, coherence can be discriminated considering that 100% coherence of two adjacent frequency values would equal 1; therefore, 100% coherence of each of 1,000 frequency values is equal to a coherence score 1,000 for the output packet. Some embodiments determine a trend in coherence by identifying change in the coherence score between output packets. In some embodiments, the average trend may be output as a controlling signal.

In accordance with embodiments, a circuit feedback loop may be provided that, in response to the amount and/or the temporal density of qualified events, automatically adjusts the DC bias of the single randomly-generated signal generated from the coupled randomly-generated signals to set the central frequency of a set of higher and lower bandpass filters. A quality metric may be constructed by filtering low frequency trends, which are associated with functional movement patterning, which is approximately 0.25 Hz. In some embodiments, timing components of each wave form may be compared to the next wave form to calculate the proportional relationship. A derivative bias for each wave form and quality metric can be derived from the division of the derivative bias into the time proportionality. A greater quality metric value is thus associated with a proportionality of 100% (or 1) and a derivative bias that is closer to 0. In various embodiments, frequency components of signal trends may be detected using fast Fourier transform (FFT). In various embodiments, FFT sampling may be run for an amount of time to identify relevant frequency changes in the trend. In some embodiments, the relevant frequency changes are fast changes, and the FFT sampling may be run for times of 1 second, 2 seconds, 3 seconds, 4 seconds, or 5 seconds. In certain embodiments, the relevant frequency changes may be slow changes, where longer sampling times may be used, such that FFT sampling may be run for 10 seconds, 15 seconds, 30 seconds, 1 minute, 5 minutes, or a longer time.

Further, some embodiment may perform FFT sampling may be run at sampling rates to capture frequency values as these samples are generated. For example, if 1000 frequency values are generated every 23 seconds, an FFT sampling may be run at approximately 0.023 seconds/sample. In certain embodiments, the frequency values may be generated at a faster or slower rate, such that FFT sampling may be run at a rates of approximately 0.005 seconds/sample, approximately 0.01 seconds/sample, approximately 0.015 seconds/sample, approximately 0.02 seconds/sample, approximately 0.025 seconds/sample, approximately 0.03 seconds/sample, approximately 0.035 seconds/sample, approximately 0.04 seconds/sample, approximately 0.045 seconds/sample, approximately 0.05 seconds/sample, or greater. By detecting signal trends, various embodiments can suppress effects of an external influence by accessing specific frequencies, when in an ambient state. Thus, in various systems in accordance with embodiments, feedback control is now possible, because these systems can access specific frequencies, which are more prominent with a specific external influence source associated with the rise and fall signal trends.

Utilizing the interface device and method described above, it is possible to use the control functionality for a variety of purposes including, but not limited to: an on and off switch activated when a predetermined threshold of coherence per unit time has been reached, an array control system that utilizing the slope direction per unit time of qualified instances of entrainment coherence influenced by mental intention, and an informational coding of the processed signal that is determined to be a unique characteristic of the effect on intention only. In some embodiments, an interface apparatus may use one or more of these listed uses to control a device in communication with the interface, such that the apparatus may turn on or off a lightbulb, open and close mechanical devices, such as a robotic hand, or any other mechanical, physical, or computational process.

Embodiments of Methods of Entraining

Turning now to FIG. **7**, some embodiments include a method (**700**) to entrain an external influence (e.g., a user's thoughts) using a device or apparatus as described above. In such embodiments, an interface apparatus as described above may be provided to a user (**702**). The user may further be directed to (**704**) to make an intentional change to a state of an observable stimulus configured to be representative of the trend output signal in embodiments of an interface apparatus as described above. In additional embodiments, this intentional change may further be processed (**706**) as a qualified event as described above. And, methods of some embodiments may further generate (**708**) a control signal from the qualified event. Such control signals may be used by some embodiments to control an external device which is in signal communication with the interface apparatus.

Turning now to FIGS. **8**A and **8**B, entrainment of signals can be seen by how wave forms are formed in accordance with some embodiments. FIG. **8**A illustrates a wave form generated by a non-intention trial, where the plurality of randomly-generated signals are plotted over time in accordance with various embodiments. In FIG. **8**B, a wave form is plotted for an intention trial in accordance with some embodiments. The box running from approximately 9,000 to approximately 15,000 highlights an area where mental intention has begun to entrain the randomly-generated signals in accordance with certain embodiments. In this highlighted area, the wave form has a greater uniformity in coherent wave pattern as a user intends to affect a change in a device. It should be noted that the intentional change may include numerous types of devices, including physical devices or computational devices. Physical devices are such devices that have a physical effect, such as opening and closing a mechanical hand or turning on and off a light bulb, whereas computational devices may have an effect on a computer or other device, such that the intentional change may affect input into the device, such as typing or moving a cursor.

Exemplary Embodiments

Although certain exemplary embodiments of the operation of an interface apparatus are provided below, it should be understood that these examples are illustrative in nature, and are not intended to be limiting as to the scope of the current disclosure.

Example 1: Study of Device Sensitivity to Entrainment

Methodology: In one exemplary study, thirty-four (34) adult subjects participated in a research project using a device as described in reference to FIGS. **1-6**. Prior to participation, a trial was performed in an empty room. A 5-minute delay in data capture was set, and then 5 minutes of unprocessed frequency data was digitally saved. Each participant performed three 5-minute trials where he/she was requested to change the characteristics of a moving tracing on a computer screen. The moving tracing represented the amount of coherence associated with the device's signal output.

Data analysis: The unprocessed frequency data was processed from frequency to the time period in milliseconds. This transformation was used to obtain the number of frequency values required to obtain a period from 10 milliseconds to 200 milliseconds in 10 millisecond increments (300 seconds where parsed using each time frame resulting in an N values between N=30,000 to and N=5). These periods where used to parse the frequency data to calculate the following:

The 2^{nd} derivative of each period from 10 milliseconds to 200 milliseconds in 10 millisecond-increments. Histogram sorting separated derivative values into 10 discrete bins.

The bias of the 2^{nd} derivative separated into three histogram bins. The range of the derivative bias was calculated to determine the percent of values allocated to each of three bins. The lowest histogram bin contains 36%, the central histogram bin contains 28%, and the highest histogram bin contains 36% of the values. This provided the greatest mean discrimination between the three bins.

The running statistical mode's frequency was within a 7000 Hz bandwidth.

The mean of each processed value for each time frame was calculated.

Processing of the 2^{nd} derivative, the derivative bias and the statistical mode's frequency produced 2700 values each; from 34 participants with 4 trials each (one non-intend and 3 intention trials), and 20 discrete analysis time frames from 10 to 200 milliseconds in 10 millisecond increments. A statistical ANOVA (Analysis of Variance) was performed on the three processed types comparing Trial 0, the non-intention (empty room) trial with the three intend participant trials, (trials 1, 2 and 3). The data from these trials is provided in Tables 1-15, below. (Note for all tables a mean difference is significant at the 0.05 level.)

Results: There was a statistically significant difference in the 2^{nd} derivative processing at a $p=0.000$ between the non-intend trial 0 and each of intend trials 1, 2 and 3. There was no statistically significant difference at a $p>0.05$ between the intention trials 1 to 2, 1 to 3 and 2 to 3. There was a statistically significant difference in the 2nd derivative bias processing at a $p=0.013$ between the non-intend trial 0 and trial 1, and a $p=0.000$ between the non-intend trial 0 and intend trials 2 and 3. There was a statistically significant difference in the statistical mode's frequency processing at a $p=0.036$ between the non-intend trial 0 and trial 1, $p=0.015$ between the non-intend trial 0 and intend trial 2 and a $p=0.030$ between the non-intend trial 0 and intend trial 3.

Accordingly, there is a statistical difference between trials with users versus those control trials, both in the derivative, derivative bias and frequency shift of the statistical mode of the raw frequency data. The statistical results support that embodiments of the interface apparatus can produce a randomly-generated signal and detect an external influence on that signal by a user. This study supports the foundational theory that users actively entrain a device that is already sensitive to entrainment influence. It is apparent from the derivative statistical evidence that users organize a random signal by increasing its coherence; creating greater consistency in the signal's rate of change. It is further apparent that users are able to create a frequency shift when influencing a random signal. Accordingly, these results indicate that there is strong statistical evidence that user intention affects the present device using its entrained signal and rate of change and frequency shift processing.

TABLE 1

Results from Statistical ANOVA for Derivative Mean Values

Dependent Variable	(I) Trial Number	(J) Trial Number	Mean Difference (I − J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Bin 1	0	1	.1498937828326*	.0303513558274	.000	.069745632142	.230041933523
		2	.1298707827505*	.0303371893106	.000	.049760041266	.209981524235
		3	.1546338322999*	.0305694581779	.000	.073909743581	.235357921019
	1	0	−.1498937828326*	.0303513558274	.000	−.230041933523	−.069745632142
		2	−.0200230000821	.0305702982435	1.000	−.100749307144	.060703306980
		3	.0047400494673	.0308008092868	1.000	−.076594962983	.086075061917
	2	0	−.1298707827505*	.0303371893106	.000	−.209981524235	−.049760041266
		1	.0200230000821	.0305702982435	1.000	−.060703306980	.100749307144
		3	.0247630495494	.0307868495859	1.000	−.056535099829	.106061198928
	3	0	−.1546338322999*	.0305694581779	.000	−.235357921019	−.073909743581
		1	−.0047400494673	.0308008092868	1.000	−.086075061917	.076594962983
		2	−.0247630495494	.0307868495859	1.000	−.106061198928	.056535099829

*The mean difference is significant at the 0.05 level.

TABLE 2

Derivative Bias Analysis

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Mean High * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Sum High * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Percent High * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Mean Central * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Sum Central * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Percent Central * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Mean Low * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Sum Low * Trial Number	2700	100.0%	0	0.0%	2700	100.0%
Percent Low * Trial Number	2700	100.0%	0	0.0%	2700	100.0%

TABLE 3

Trial Data Report: High/Central Data

Trial Number		Mean High	Sum High	Percent High	Mean Central	Sum Central
0	Mean	60441.40882	3463285.52533	2.49365	1431.29627	3667946.48301
	N	680	680	680	680	680
1	Mean	62266.64153	3566981.89677	2.44943	1458.36740	3801798.48116
	N	680	680	680	680	680
2	Mean	63362.45393	3652145.44374	2.42731	1480.47843	3905928.50434
	N	680	680	680	680	680
3	Mean	63669.41972	3640721.49817	2.40858	1476.96149	3898443.44132
	N	660	660	660	660	660
Total	Mean	62425.83701	3580339.60650	2.44501	1461.66341	3817937.27032
	N	2700	2700	2700	2700	2700

TABLE 4

Trial Data Report: Low/Central Data

Trial Number		Percent Central	Mean Low	Sum Low	Percent Low
0	Mean	95.02779	−60503.43859	−3452105.32662	2.47857
	N	680	680	680	680
1	Mean	95.11484	−62346.94574	−3557907.97965	2.43574
	N	680	680	680	680
2	Mean	95.15857	−63459.10523	−3643660.27349	2.41412
	N	680	680	680	680
3	Mean	95.19592	−63776.65443	−3632811.58076	2.39551
	N	660	660	660	660
Total	Mean	95.12375	−62512.23882	−3571168.02872	2.43125
	N	2700	2700	2700	2700

TABLE 5

ANOVA Analysis

		Sum of Squares	df	Mean Square	F	Sig.
Mean High	Between Groups	4312262444.751	3	1437420814.917	13.645	.000
	Within Groups	284012703678.591	2696	105345958.338		
	Total	288324966123.341	2699			
Sum High	Between Groups	15350933996793.432	3	5116977998931.144	1.802	.145
	Within Groups	7655672590919036.000	2696	2839641168738.515		
	Total	7671023524915829.000	2699			
Percent High	Between Groups	2.711	3	.904	1.085	.354
	Within Groups	2244.581	2696	.833		
	Total	2247.291	2699			
Mean Central	Between Groups	1029642.012	3	343214.004	4.398	.004
	Within Groups	210405431.276	2696	78043.558		
	Total	211435073.288	2699			
Sum Central	Between Groups	25017725514960.570	3	8339241838320.190	2.093	.099
	Within Groups	10739437870824010.000	2696	3983471020335.315		
	Total	10764455596338970.000	2699			
Percent Central	Between Groups	10.578	3	3.526	1.069	.361
	Within Groups	8895.687	2696	3.300		
	Total	8906.265	2699			
Mean Low	Between Groups	4427399097.421	3	1475799699.140	13.855	.000
	Within Groups	287178965947.528	2696	106520387.963		
	Total	291606365044.949	2699			
Sum Low	Between Groups	15840631564575.242	3	5280210521525.081	1.850	.136
	Within Groups	7693750519184988.000	2696	2853765029371.286		
	Total	7709591150749563.000	2699			
Percent Low	Between Groups	2.579	3	.860	1.052	.368
	Within Groups	2203.661	2696	.817		
	Total	2206.240	2699			

TABLE 6

Post Hoc Multiple Comparison

Dependent Variable	(I) Trial Number	(J) Trial Number	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Mean High	0	1	−1825.232710•	556.633680	.013	−3382.27673	−268.18869
		2	−2921.045109•	556.633680	.000	−4478.08912	−1364.00109
		3	−3228.010901•	560.834749	.000	−4796.80636	−1659.21544
	1	0	1825.232710•	556.633680	.013	268.18869	3382.27673
		2	−1095.812399	556.633680	.275	−2652.85641	461.23162
		3	−1402.778190	560.834749	.100	−2971.57365	166.01727

TABLE 6-continued

Post Hoc Multiple Comparison

Dependent Variable	(I) Trial Number	(J) Trial Number	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
	2	0	2921.045109•	556.633680	.000	1364.00109	4478.08912
		1	1095.812399	556.633680	.275	−461.23162	2652.85641
		3	−306.965792	560.834749	.960	−1875.76125	1261.82967
	3	0	3228.010901•	560.834749	.000	1659.21544	4796.80636
		1	1402.778190	560.834749	.100	−166.01727	2971.57365
		2	306.965792	560.834749	.960	−1261.82967	1875.76125
Sum High	0	1	−103696.371441	91388.652416	.732	359333.35386	151940.61097
		2	−188859.918413	91388.652416	.234	444496.90083	66777.06400
		3	−177435.972842	92078.387880	.294	435002.31834	80130.37266
	1	0	103696.371441	91388.652416	.732	151940.61097	359333.35386
		2	−85163.546972	91388.652416	.833	340800.52939	170473.43544
		3	−73739.601401	92078.387880	.887	331305.94690	183826.74410
	2	0	188859.918413	91388.652416	.234	−66777.06400	444496.90083
		1	85163.546972	91388.652416	.833	−170473.43544	340800.52939
		3	11423.945572	92078.387880	.999	−246142.39993	268990.29107
	3	0	177435.972842	92078.387880	.294	−80130.37266	435002.31834
		1	73739.601401	92078.387880	.887	−183826.74410	331305.94690
		2	−11423.945572	92078.387880	.999	−268990.29107	246142.39993
Percent High	0	1	.044213	.049484	.850	−.09421	.18263
		2	.066334	.049484	.616	−.07209	.20475
		3	.085064	.049858	.406	−.05440	.22453
	1	0	−.044213	.049484	.850	−.18263	.09421
		2	.022121	.049484	.978	−.11630	.16054
		3	.040850	.049858	.880	−.09861	.18032
	2	0	−.066334	.049484	.616	−.20475	.07209
		1	−.022121	.049484	.978	−.16054	.11630
		3	.018730	.049858	.986	−.12074	.15819
	3	0	−.085064	.049858	.406	−.22453	.05440
		1	−.040850	.049858	.880	−.18032	.09861
		2	−.018730	.049858	.986	−.15819	.12074
Mean Central	0	1	−27.071124	15.150573	.363	−69.45108	15.30883
		2	−49.182151	15.150573	.015	−91.56211	−6.80220
		3	−45.665216	15.264919	.030	−88.36502	−2.96541
	1	0	27.071124	15.150573	.363	−15.30883	69.45108
		2	−22.111028	15.150573	.546	−64.49098	20.26893
		3	−18.594092	15.264919	.686	−61.29390	24.10571
	2	0	49.182151	15.150573	.015	6.80220	91.56211
		1	22.111028	15.150573	.546	−20.26893	64.49098
		3	3.516936	15.264919	.997	−39.18287	46.21674
	3	0	45.665216	15.264919	.030	2.96541	88.36502
		1	18.594092	15.264919	.686	−24.10571	61.29390
		2	−3.516936	15.264919	.997	−46.21674	39.18287
Sum Central	0	1	−133851.998154	108240.894473	.676	−436628.92839	168924.93208
		2	−237982.021328	108240.894473	.185	540758.95156	64794.90891
		3	−230496.958314	109057.818473	.216	−535559.02988	74565.11325
	1	0	133851.998154	108240.894473	.676	−168924.93208	436628.92839
		2	−104130.023174	108240.894473	.819	−406906.95341	198646.90706
		3	−96644.960159	109057.818473	.853	−401707.03172	208417.11140
	2	0	237982.021328	108240.894473	.185	−64794.90891	540758.95156
		1	104130.023174	108240.894473	.819	−198646.90706	406906.95341
		3	7485.063014	109057.818473	1.000	−297577.00855	312547.13458
	3	0	230496.958314	109057.818473	.216	−74565.11325	535559.02988
		1	96644.960159	109057.818473	.853	−208417.11140	401707.03172
		2	−7485.063014	109057.818473	1.000	−312547.13458	297577.00855
Percent Central	0	1	−.087053	.098512	.854	−.36262	.18851
		2	−.130781	.098512	.623	−.40634	.14478
		3	−.168131	.099256	.412	−.44577	.10951
	1	0	.087053	.098512	.854	−.18851	.36262
		2	−.043728	.098512	.978	−.31929	.23184
		3	−.081079	.099256	.881	−.35872	.19656
	2	0	.130781	.098512	.623	−.14478	.40634
		1	.043728	.098512	.978	−.23184	.31929
		3	−.037351	.099256	.986	−.31499	.24029
	3	0	.168131	.099256	.412	−.10951	.44577
		1	.081079	.099256	.881	−.19656	.35872
		2	.037351	.099256	.986	−.24029	.31499
Mean Low	0	1	1843.507144•	559.727843	.013	277.80798	3409.20631
		2	2955.666640•	559.727843	.000	1389.96747	4521.36581
		3	3273.215836•	563.952264	.000	1695.69990	4850.73177
	1	0	−1843.507144•	559.727843	.013	−3409.20631	−277.80798
		2	1112.159496	559.727843	.267	−453.53967	2677.85866
		3	1429.708692	563.952264	.093	−147.80724	3007.22462

TABLE 6-continued

Post Hoc Multiple Comparison

Dependent Variable	(I) Trial Number	(J) Trial Number	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
	2	0	−2955.666640•	559.727843	.000	−4521.36581	−1389.96747
		1	−1112.159496	559.727843	.267	−2677.85866	453.53967
		3	317.549196	563.952264	.957	−1259.96673	1895.06513
	3	0	−3273.215836•	563.952264	.000	−4850.73177	−1695.69990
		1	−1429.708692	563.952264	.093	−3007.22462	147.80724
		2	−317.549196	563.952264	.957	−1895.06513	1259.96673
Sum Low	0	1	105802.653024	91615.645809	.721	−150469.28684	362074.59289
		2	191554.946868	91615.645809	.224	−64716.99300	447826.88674
		3	180706.254139	92307.094454	.280	−77499.84102	438912.34929
	1	0	−105802.653024	91615.645809	.721	−362074.59289	150469.28684
		2	85752.293844	91615.645809	.831	−170519.64602	342024.23371
		3	74903.601115	92307.094454	.883	183302.49404	333109.69627
	2	0	−191554.946868	91615.645809	.224	−447826.88674	64716.99300
		1	−85752.29384	91615.645809	.831	−342024.23371	170519.64602
		3	−10848.692729	92307.094454	1.000	−269054.78788	247357.40243
	3	0	−180706.254139	92307.094454	.280	−438912.34929	77499.84102
		1	−74903.601115	92307.09445	.883	−333109.69627	183302.49404
		2	10848.692729	92307.094454	1.000	−247357.40243	269054.78788
Percent Low	0	1	.042825	.049031	.858	−.09433	.17998
		2	.064451	.049031	.631	−.07270	.20160
		3	.083062	.049401	.419	−.05513	.22125
	1	0	−.042825	.049031	.858	−.17998	.09433
		2	.021626	.049031	.978	−.11553	.15878
		3	.040237	.049401	.882	−.09795	.17842
	2	0	−.064451	.049031	.631	−.20160	.07270
		1	−.021626	.049031	.978	−.15878	.11553
		3	.018610	.049401	.986	−.11958	.15680
	3	0	−.083062	.049401	.419	−.22125	.05513
		1	−.040237	.049401	.882	−.17842	.09795
		2	−.018610	.049401	.986	−.15680	.11958

To provide further context for the comparative results, means for groups in homogeneous subsets are also provided in Tables 7-15, below. This data uses a Harmonic Mean Sample Size=674.887. (Note: The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.)

TABLE 7

Mean High

Trial Number	N	Subset for alpha = 0.05 1	Subset for alpha = 0.05 2
0	680	60441.40882	
1	680		62266.64153
2	680		63362.45393
3	660		63669.41972
Sig.		1.000	.098

TABLE 8

Sum High

Trial Number	N	Subset for alpha = 0.05 1
0	680	3463285.52533
1	680	3566981.89677
3	660	3640721.49817
2	680	3652145.44374
Sig.		.237

TABLE 9

Percent High

Trial Number	N	Subset for alpha = 0.05 1
3	660	2.40858
2	680	2.42731
1	680	2.44943
0	680	2.49365
Sig.		.402

TABLE 10

Mean Central

Trial Number	N	Subset for alpha = 0.05 1	Subset for alpha = 0.05 2
0	680	1431.29627	
1	680	1458.36740	1458.36740
3	660		1476.96149
2	680		1480.47842
Sig.		.367	.549

TABLE 11

Sum Central

Trial Number	N	Subset for alpha = 0.05 1
0	680	3667946.48301
1	680	3801798.48116

TABLE 11-continued

Sum Central		
		Subset for alpha = 0.05
Trial Number	N	1
3	660	3898443.44132
2	680	3905928.50434
Sig.		.187

TABLE 12

Percent Central		
		Subset for alpha = 0.05
Trial Number	N	1
0	680	95.02779
1	680	95.11484
2	680	95.15857
3	660	95.19592
Sig.		.409

TABLE 13

Mean Low			
		Subset for alpha = 0.05	
Trial Number	N	1	2
3	660	−63776.65443	
2	680	−63459.10523	
1	680	−62346.94574	
0	680		−60503.43859
Sig.		.091	1.000

TABLE 14

Sum Low		
		Subset for alpha = 0.05
Trial Number	N	1
2	680	−3643660.27349
3	660	−3632811.58076
1	680	−3557907.97965
0	680	−3452105.32663
Sig.		.227

TABLE 15

Percent Low		
		Subset for alpha = 0.05
Trial Number	N	1
3	660	2.39551
2	680	2.41412
1	680	2.43574
0	680	2.47857
Sig.		.416

Conclusion: This exemplary embodiment demonstrates how a system is able to analyze how user intention can entrain randomly-generated signals, which can be analyzed.

Example 2: Study of Device Sensitivity to Entrainment Using Mechanical Manipulator

Methodology: In another exemplary study, fifty-nine (59) adult subjects participated in a research project using a device as described in reference to FIGS. **1-6**. This research project subjected the research subjects to two intend trials and two non-intend trials. The first non-intend trial placed the research subjects in an empty room. A 5-minute delay in data capture was set, and then 5 minutes of unprocessed frequency data was digitally saved. Following the first non-intend trial, each research subject subjected to a first intend trial, where the research subjects were tasked with stacking foam blocks with a mechanical hand controlled through an interface device according to embodiments. A second non-intend trial was accomplished as described above. After the second non-intend trial, each research subject performed a second intend trial, where the research subjects were tasked with stacking and restacking the foam blocks as smoothly and rhythmically as possible, using the research subjects' perceived and most successful mental strategies. Data captured from the two non-intend trials were stored in association with the two intend trials.

Data Analysis: The two trials captured non-intend and intend data, which were stored in association with each other. The trended signal output of the MMIP was input to a hardware counter digitizer and output as discrete digitized frequencies. The discrete digitized frequencies were input to a computer for software processing. Software processing included proportional normalization of frequencies, rise and fall trending of normalized proportional frequencies, and frequency spectral analysis. Both characteristics of signal trend and frequency spectrum have been used to drive the mechanical hand. The wave form type movement of the mechanical hand was data captured and processed to determine various characteristics of the wave forms including adjacent proportional percent of similarity and number of those wave forms that met or exceeded set parameters, (>=75% for example). Indexing was used to parse wave forms with determined features and process the parsed signal (rise and fall trend for example) to determine various characteristics including rate of change, frequency shift and frequency density as examples. The data from these trials is provided in Tables 1-15, below.

Results: Two non-intend and two intend 5-minute trials for each of 59 adult participants were analyzed. The parsed rise and fall trending signal's 2nd derivative bias, analyzed using an ANOVA, was not statistically significant when comparing non-intend trial 1 with non-intend trial 2 and non-intend trial 1 with intend trial 1. Non-intend trial 2 and intend trial 2 were statistically significantly different at a p=0.029. The % difference in the non-intend mean of −0.38953 and intend mean of 0.57959 equaled an absolute difference of 32.79%.

TABLE 16

Descriptives									
						95% Confidence Interval for Mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Derivative Bias									
0 = non-intend	0	59	−.38953	2.660181	.346326	−1.08277	.30372	−6.510	6.273
1 = intend	1	59	.57959	2.062787	.268552	.04203	1.11716	−4.045	5.359
	Total	118	.09503	2.419546	.222737	−.34609	.53615	−6.510	6.273

TABLE 17

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Derivative Bias	Between Groups	27.706	1	27.706	4.890	0.029
	Within Groups	657.236	116	5.666		
	Total	684.942	117			

Conclusion: This exemplary embodiment demonstrates how analysis of an entrained signal can be used to control a mechanical device to accomplish a task.

Example 3: Study of Device Sensitivity to Entrainment Using Mechanical Manipulator and Frequency Processing

Methodology: In another embodiment, a 10-second rise and fall trend running-FFT (fast Fourier transform) of each 5 minute (2 each) intend and non-intend trials was organized into a 20-bin percent-histogram of spectral power for 48 of the 59 adult participants discussed above in Example 2.

Data Analysis: An ANOVA between intend and non-intend trials was performed on an intend N=387,791 and a non-intend N=390,567.

Results: There was a statistically significant difference between the intend and non-intend 2nd trials for the histogram bin associated with 3.75 Hz with a non-intend mean of 1.85649% and intend mean of 1.86664%, an F of 23.667 and p=0.000, and the histogram bin associated with 4.00 Hz. with a non-intend mean of 1.71451% and intend mean of 1.72700%, an F of 40.270 and p=0.000.

Conclusion: This exemplary embodiment demonstrates that user intention has a statistically-significant and measurable impact on certain wavelengths.

Example 4: Effects of an Infrared Brain Stimulation Device on the Enhancement of Mental Intention as Reflected by the Present Mind-Machine Interface Device's Performance Metric

Methodology: A pilot study was initiated for one subject to test a potential wave form identification strategy and performance metric for the present Mind-Machine Interface Device. Two 5-minute non-intend and three intend trials where performed with the third intend trial occurring after the use of an infrared brain stimulation device (Maculume LTD Cerebrolite, a prototype) whose purpose was to improve mental intention performance. The rise and fall trend of the proportional frequency sum of 1000 data values was transformed, to selected FFT spectral frequency ranges, in post processing, as the output used to control the mechanical hand. Further, the rise and fall trend of the proportional frequency sum of 1000 data values was transformed, to a running average as an output used to control the mechanical hand. The wave forms manifested by these processes where selected temporally if they were greater than or equal to 2 seconds and less than or equal to 6 seconds. This corresponds to the controlling time frame for the participant to move blocks from one location to another. Further, each wave form was selected if greater than or equal to 60% proportional to its adjacent wave form in iteration for all wave forms in the data set.

Data Analysis: The 2^{nd} derivative bias of rise and fall trend of the proportional frequency sum of 1000 data values for each rising component of the wave form's period was calculated. The 2^{nd} derivative bias sum and average of all qualifying wave forms was calculated and the trials compared as percent differences.

Results: The wave forms for each trial were, for the most part, consistent in number with some differences that cannot be yet accounted for. Both the sums and averages of the 2nd derivative bias were consistent in the proportional differences between intend trials 1 to 3 as compared to non-intend trial 2. Noteworthy is the over 300% difference between the post-infrared brain stimulation intend trial #3 and the non-intend trial #2.

TABLE 18

Trial Data Report

	Intend Trial 1	Intend Trial 2	Intend trial 3 post IR	Non Intend Trial 1	Non Intend Trial 2
Sum of Derivative Bias	11.324	9.199	17.244	−16.578	5.089
% Difference Intend Trials 1-3 to Non-intend Trial 1	222.5192%	180.7624%	338.8485%		
Average Derivative Bias	0.205891	0.262829	0.453789	−0.40434	0.154212
% Difference Intend Trials 1-3 to Non-intend Trial 2	213.3515%	190.4594%	294.2630%		

TABLE 19

Rise Fall Trend all mean stats

	Intend Trial 1	Intend Trial 2	Intend Trial 3	Non-Intend Trial 1	Non-Intend Trial 2
Total Wave Forms	113	102	108	106	86
Waves that did not make the criteria	41	49	52	47	35
Waves that made the criteria	72	53	56	59	51

TABLE 20

Rise Fall Trend all FFT stats

	Intend Trial 1	Intend Trial 2	Intend Trial 3	Non-Intend Trial 1	Non-Intend Trial 2
Total Wave Forms	84	92	96	92	106
Waves that did not make the criteria	44	40	45	50	38
Waves that made the criteria	40	52	51	42	68

The strategy used to identify intend VS non-intend characteristics appears to be robust as a performance metric. Several qualifying techniques were used to establish this level of percent difference including:

Only the rise (hand closing) wave form period was used.

Only adjacent wave form proportional percentages greater than or equal to 60% where used.

Only wave forms that occurred in 2 to 6 seconds where used. Interesting to note is that the average wave form time was approximately 3.5 seconds.

The 2nd derivative bias of the rising portion of the qualified wave forms appears to be robust and discriminating with all intend trials different in percentage from non-intend trials by at least 180% and most significant is the percent difference of the post-infrared brain stimulation trial of as much as 338% difference

Conclusion: This exemplary embodiment demonstrates that IR stimulation can improve mental intention performance.

DOCTRINE OF EQUIVALENTS

Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover all such modifications and equivalents. The entire disclosures of all references, applications, patents, and publications cited above, and of the corresponding application(s), are hereby incorporated by reference.

What is claimed is:

1. An external intentionality interface apparatus comprising:

a plurality of sub-atomic-based random signal sources capable of being entrained by an external intentionality;

a coupling circuit in signal communication with the plurality of sub-atomic-based random signal sources, configured to combine the randomly-generated signals from said plurality of sub-atomic-based signal sources into a single coupled signal capable of increased order with the entrainment of the external intentionality;

a signal amplifier in signal communication with the coupling circuit to amplify the single coupled signal;

a dynamic bias circuit to maintain a mean-centered bias of the single coupled signal;

a signal voltage trend indicator in signal communication with the signal amplifier and configured to detect the voltage difference between a non-delayed signal and a propagation-delayed signal and to produce a logic trend output signal indicative of the voltage difference, where the digitally-processed trend output signal is provided as a first logic state where the trend is toward a negative voltage and a second logic state where the trend is toward a positive voltage, and wherein the logic trend output signal from the signal voltage trend indicator is a rising or falling logic state;

a period-clock counting and digitizing apparatus, wherein the period-clock counting apparatus clocks and digitizes the rising or falling logic states of the output signal to produce a continuous consecutive signal of discrete digitized clock count data values that are then outputted as a plurality of discrete packets; and

a processor configured to operate on the discrete packets of digitized clock count data values to output at least one entrainment metric control signal wherein at least one entrainment metric control signal provides an indication of the presence of the external intentionality entrained within the single coupled signal wherein each intention-entrained signal exceeding a predetermined entrainment metric threshold is a qualified event.

2. The apparatus of claim **1**, wherein the plurality of sub-atomic-based random signal sources comprise reverse-biased Zener diodes configured to produce multiple random signals at their respective breakdown voltage knees.

3. The apparatus of claim **2**, wherein the sub-atomic-based random signal sources comprise at least two Zener diodes.

4. The apparatus of claim **1**, wherein the signal voltage trend indicator comprises a modulatable laser photonic source.

5. The apparatus of claim **4**, further comprising a photonic crystal waveguide interferometer configured to detect a greater phase state coherence and convert this phase state into a variable electrical signal.

6. The apparatus of claim **1**, wherein the plurality of randomly-generated signals are capacitively coupled.

7. The apparatus of claim **1**, wherein the dynamic bias circuit is analog.

8. The apparatus of claim **1**, wherein the processor performs a derivative calculation on the discrete packets of digitized clock count data values output from the period clock-counting and digitizing apparatus to output the at least one entrainment metric control signal.

9. The apparatus of claim **1**,

wherein the output signal from the signal voltage trend indicator is output as a series of packets of discrete digitized frequency data,

wherein the period-clock counting apparatus normalizes the digitized frequency data as proportional values between adjacent digitized frequency values within each packet,

wherein the coherence score is generated by summing the normalized digitized frequency data within each packet,

wherein the trend of the series of packets is determined by determining changes in the coherence score between each packet in the series of packets,

wherein the frequency components of the trend are identified by running by a frequency sorting algorithm discriminating the greatest percent of frequency distribution density values, and

outputs the greatest percent frequency distribution density values as a controlling signal.

10. The apparatus of claim **1**, wherein the presence of a qualified event in the output coupled signal is utilized as a control signal for a device in signal communication therewith.

11. The apparatus of claim **1**, further comprising a circuit feedback loop, wherein the circuit feedback loop is configured to:

determine at least one of the amount of qualified events and the temporal density of qualified events; and

automatically adjust the DC bias of the single coupled signal generated from the coupled randomly-generated signals to regulate the mean voltage bias, wherein direction of regulatory bias is predetermined by goal-directed entrainment metric thresholds.

12. The apparatus of claim **1**, further comprising a plurality of nodes of multiple randomly-generated signals disposed in proximity to each other node and configured to entrain each other node such that the nodes act collectively to accomplish a programmed directive, via goal directed programming and feedback control processing.

13. A method for entraining from user intentionality of randomly-generated signals to generate a single control signal for controlling an external device comprising:

providing an external intentionality interface apparatus to the user, wherein the interface apparatus comprises:

a plurality of sub-atomic-based random signal sources capable of being entrained by an external intentionality,

a coupling circuit in signal communication with the plurality of sub-atomic-based random signal sources, configured to combine the randomly-generated signals from said plurality of sub-atomic-based signal sources into a single coupled signal capable of increased order with the entrainment of the external intentionality,

a signal amplifier in signal communication with the coupling circuit to amplify the single coupled signal,

a dynamic bias circuit to maintain a means-centered bias of the coupled randomly-generated signal;

a signal voltage trend indicator in signal communication with the signal amplifier and configured to detect the voltage difference between a non-delayed signal and a propagation-delayed signal and to produce a logic trend output signal indicative of the voltage difference, where the digitally-processed trend output signal is provided as a first logic state where the trend is toward a negative voltage and a second logic state where the trend is toward a positive voltage, and wherein the logic trend output signal from the signal voltage trend indicator is a rising or falling logic state,

a period-clock counting and digitizing apparatus, wherein the period-clock counting apparatus clocks and digitizes the rising or falling logic states of the output signal to produce a continuous consecutive signal of discrete digitized clock count data values that are then outputted as a plurality of discrete packets, and

a processor configured to operate on the discrete packets of digitized clock count data values to output at least one entrainment metric control signal wherein at least one entrainment metric control signal provides an indication of the presence of the external intentionality entrained within the single coupled signal wherein each intention-entrained signal exceeding a predetermined entrainment metric threshold is a qualified event; and

directing the user to make an intentional change to a state of an observable stimulus configured to be representative of the logic trend output signal.

14. The method of claim **13**, further comprising:

processing the intentional change as a qualified event; and

generating a control signal from the qualified event.

15. The method of claim **14**, wherein the control signal directs the operation of an external device in signal communication with the mind-machine interface apparatus.

16. The method of claim **13**, wherein the mind-machine interface apparatus further comprises an external device in signal communication with the mind-machine interface apparatus.

17. The method of claim **13**, wherein the plurality of sub-atomic-based random signal sources comprise reverse-biased Zener diodes configured to produce multiple random signals at their respective breakdown voltage knees.

18. The method of claim **17**, wherein the sub-atomic-based random signal sources comprise at least two Zener diodes.

19. The method of claim **13**, wherein the signal voltage trend indicator comprises a modulatable laser photonic source.

20. The method of claim **13**, wherein the plurality of randomly-generated signals are capacitively coupled.

21. The method of claim **13**, wherein the processor performs a derivative calculation on the discrete packets of digitized clock count data values output from the period clock-counting and digitizing apparatus to output the at least one entrainment metric control signal.

22. The method of claim **13**, wherein the output signal from the signal voltage trend indicator is output as a series of packets of discrete digitized frequency data, and wherein the period-clock counting apparatus:

normalizes the digitized frequency data as proportional values between adjacent digitized frequency values within each packet;

wherein the coherence score is generated by summing the normalized digitized frequency data within each packet;

wherein the trend of the series of packets is determined by determining changes in the coherence score between each packet in the series of packets;

wherein the frequency components of the trend are identified by running a frequency sorting algorithm discriminating the greatest percent of frequency distribution density values; and

outputs the greatest percent frequency distribution density values as a controlling signal.

* * * * *