TECHNOLOGY

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Contents

THE TECHNOLOGY

In recent years, a physical phenomenon referred to as Negative Group Delay (NGD), demonstrated in simple electronic circuits, has been shown to temporally advance the detection of analog waveforms. Specifically, the output is advanced in time relative to the input, as the time delay through the circuit is negative. As such, the circuit output precedes the complete detection of the input signal. We refer to this as Signal Advance (SA) technology. Success in the development and implementation of this technology has important consequences for the development of novel interventional methodologies in cardiology and neurophysiology as well as significant potential in a broader range of both medical and non-medical areas of application.

Overview

Sensors are used to detect various physical or physiological properties (e.g. pressure, temperature, speed, heart rate) and convert these properties into analog electrical signals. Typically, these signals are then digitized and processed to generate an output which can be used for monitoring, intervention, process control or similar functions. SA technology acts to temporally advance the detection of these analog electrical signals to thereby offset or even eliminate circuit transmission and/or processing delays in responsive (control or interventional) systems. This technology can potentially improve the performance of a wide range of devices that process analog signals in areas such as industrial process control, manufacturing automation, interventional medical devices, alarm/detection systems, transportation in power-train and accident avoidance systems/control, as well as defense in targeting and weaponry. One of the most promising application areas (of which there are many) is that of medical intervention devices in which a small increase in signal detection time (on the order of fractions of a second) could have a major impact on the efficacy of the device.

Proprietary SA technology operates on broadband analog signals (over a specified frequency range) and can be designed to produce minimal distortion in the circuit output relative to its input. SA has developed a number of prototype SA circuit designs that operate over various frequency ranges. Circuit transfer functions have been analyzed, their performance modeled and the circuit designs have been tested using a range of test signals.

Problem, Solution, and Value

In state-of-the-art interventional medical or industrial devices, time delays associated with analog signal detection and processing impact the likelihood of successful intervention. This applies, for instance, to containing or limiting a life-threatening patho-physiological event such as cardiac ventricular fibrillation or an epileptic seizure. The earlier the intervention is initiated, the greater the chance for successful remediation.

Hybrid predictive feedback and feed-forward control systems used to improve control response performance have drawbacks. Approaches to improving systems that rely on increasingly faster electronics can reduce, but never completely eliminate, these delays, nor yield a net temporal advance. SA technology achieves the latter by exploiting 'negative group delay', a counter-intuitive, yet empirically verified, wave propagation phenomenon in physics.

In most electronic circuits, the output signal is delayed relative to the input. In a circuit exhibiting a negative group delay, the output signal is advanced in time relative to the input, thus the term 'signal advance'. The temporal advance achieved can be exploited to potentially offset signal detection and processing delays.

Differentiation

Current approaches to improving the performance of signal transmission and responsive systems that rely on ever faster electronics and hybrid predictive feedback and feed-forward control systems (typically implemented digitally) may be adequate for a number of applications. SA technology, however, achieves performance improvements using unique, engineering-physics based technology implemented in analog circuitry. By reducing or eliminating signal detection and processing delays, this technology cam potentially improve performance in a wide variety of biomedical and industrial closed-loop intervention and control systems that relay on signal feedback. Success in this endeavor has potential application across a broad range of systems that rely on the detection of a wide variety of analog signals and may in turn lead to a new class of proactive rather than reactive intervention and control. Furthermore, SA technology can be applied in conjunction with these conventional methods to further improve system performance.

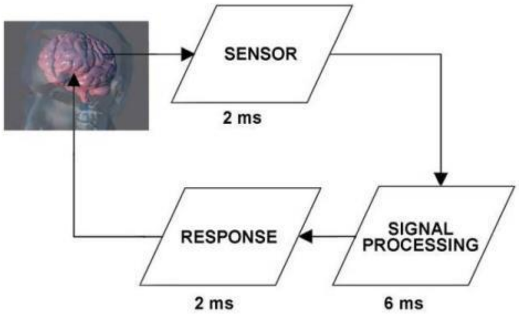
An Analogy

To illustrate temporally advanced signal detection, consider the hypothetical responsive intervention/ control scenario depicted in the top-right image. The man to the right, wearing the suit and carrying a briefcase, is running along the front of a wall - unaware that he is heading to the edge of a cliff.

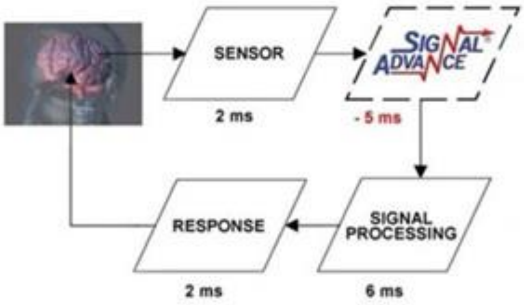
In the center of the picture is another man (in blue jeans and a t-shirt) positioned near the end of, and slightly behind the wall. His job is to stop anyone from running off the edge of the cliff, but he is not allowed to stand in front of the wall. Thus, he can only try to stop the runner once he sees him come past the end of the wall.

In the bottom image, there is bright sunlight behind the runner, so he casts a long shadow. Upon seeing the runner's shadow, the guard detects him earlier, giving him more time to react, improving his chance of successfully intervening.

Implementation



Overall Response Time: (2ms + 6 ms + 2ms) = 10 ms

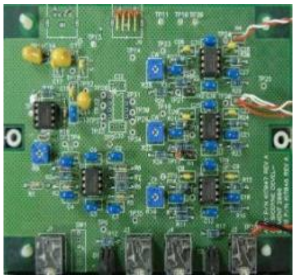


Overall Response Time: (2ms - 5 ms + 6 ms + 2ms) = 5 ms

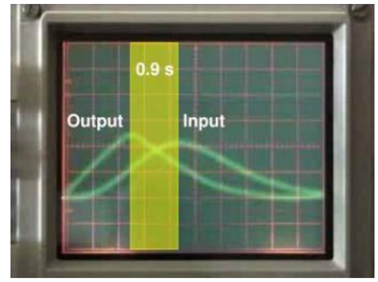
The functional block diagram shown in the image to the right, depicts a typical closed-loop control (interventional) system. A sensor detects a physical parameter (in this example - a neural signal) and converts it to an analog electrical signal which reflects the value of the parameter. The signal is then processed and an appropriate output (feedback) response is generated. Each step requires a finite amount of time to complete. If signal detection takes 2 ms, signal processing, 6 ms and generating a response, 2 ms, the overall response time is 10 ms.

The left image shows the same control system incorporating SA technology which imparts a 5 ms temporal advance. This advance offsets delays in the other processing steps reducing overall system response time by 50%.

Visible Temporal Advance



An early two-stage SA circuit prototype (right image) was developed in which the temporal advance achieved in each stage was roughly 0.45 s resulting in a 0.9 s overall advance. This allowed the signal advance to be seen with the naked eye. The circuit was tested using a Gaussian (bell-shaped) pulse as the input signal.



The time-lapse image on the next page is the display of a dual-trace oscilloscope (timescale: 0.5 s/div) showing the temporally advanced output pulse (output from the second SA circuit stage) relative to the input. The temporal advance achieved was just under 0.5 s, per circuit stage, giving an overall time advance of nearly a second. Note the output distortion (narrowed pulse width and skewing) relative to the input.

Light-emitting diodes (LED's) were connected to the input, the output of the first stage and the output of the second stage (left image). These LED's light when the signal amplitude reaches its peak. The LED on the far left (labeled "Input") is connected to the signal input, the one in the middle (labeled "Output Stage 1"), to the output of the first stage, and the one on the right (labeled "Output Stage 2"), to the output of the second stage. When the video is played, Note the order in which the LED's light. The first to light is LED "2", (output - second stage), followed by LED "1" (output - first stage) and then the "Input" LED.

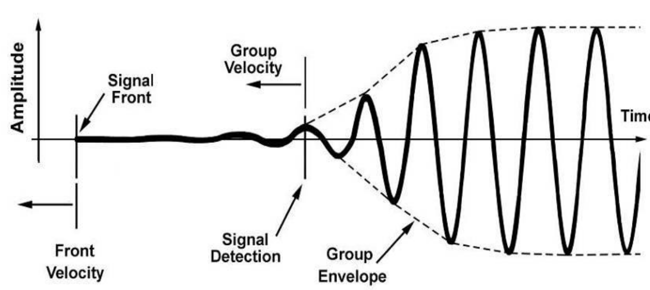
These preliminary results efforts convincingly verified that signal advance technology based on negative group delay could be implemented in electronics, and demonstrated the following:

1) the ability to cascade SA circuit stages to increase the overall time, and,
2) the need for signal conditioning to reduce signal distortion in the advance output.

Wave Propagation Physics

In order to understand this seemingly contradictory behavior it is important to point out that electromagnetic propagation is characterized by five unique waveform velocities [Brillouin L, *Wave Propagation and Group Velocity (Pure and Applied Physics)*, New York: Academic Press, 1960.]. These include:

- ***Phase velocity*** - speed at which the phase of any one spectral frequency component of the wave travels.
- ***Group velocity*** **-** speed at which the variations in the shape of the wave's amplitude (known as the modulation or envelope of the wave) propagates (see diagram below).
- ***Front velocity*** - speed of an abrupt signal discontinuity (signal abruptly turned on or off). It is considered as the very beginning of the signal in time, and it never exceeds "c", the speed of light (see right diagram).
- ***Energy velocity*** - speed of energy transfer.
- ***Signal velocity*** - speed of information transfer, which, under various conditions, may be equivalent to one or more of the above four velocities.



The “front velocity” corresponds to the speed at which the first, extremely small (perhaps invisible) vibrations will occur, while the signal velocity yields the arrival of the main signal, with intensities on the order of the magnitude of the input signal.” [Brillouin]

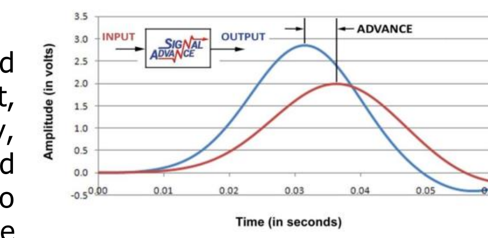
In most cases, the signal velocity is equivalent to both the group and energy velocities. While the front velocity cannot exceed the speed of light, in special cases (e.g. media or circuitry that amplifies the initial or anterior-most portion of a waveform and attenuates the posterior portion), “… the group velocity … can be greater than the velocity of light *c*, can be infinite and even negative!” [Brillouin]. That is, the detection of a pulsatile input or extended-in-time waveform at the output of the medium can precede its *complete* detection of the waveform at the input.

During the time interval between the arrival of the wavefront (front velocity) and the actual detection of the group waveform, electro-magnetic energy begins to propagate through the medium, the magnitude of which is not detectable until the oscillations achieve sufficient amplitude. These very early, very low amplitude (typically undetected) perturbations (referred to as “forerunners” by Brillouin) actually contain sufficient information to reproduce a temporally advanced signal. Signal Advance technology (SAT) acts to temporally advance the wave envelope of an analog signal resulting in earlier detection.

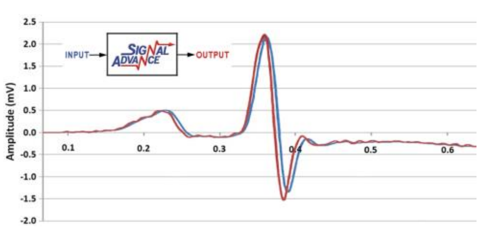
VALIDATION

Proprietary Signal Advance (SA) circuitry operates on broadband analog signals (over a specified frequency range) and produces minimal distortion in the circuit output relative to its input. SAI has developed a number prototype of SA circuit designs that operate over various frequency ranges. Circuit transfer functions have been analyzed and their performance modeled and the circuit designs have been tested using a range of test signals.

Scientific



In Dr. Hymel's doctoral studies, SA circuit designs, developed specifically for electro-cardiology, electrical function of the heart, underwent rigorous refinement, testing and evaluation. In the study, the 'negative delay' (temporal advance) of the analog signals achieved with SAT was investigated and the results analyzed with respect to the temporal advance achieved as well as the fidelity of the temporally-advanced output signals. The research project, completed in 2010, exceeded all of its objectives, having successfully demonstrated the ability of SAT to temporally advance a range 'known' constructed test signals (pulses and sine waves) and human electrocardiographic (ECG) signals (heart beats) from cardiac patients. The project resulted in doctorate dissertation in (Hymel CM, Application of Signal Advance Technology to Electro-physiology, University of Texas Health Science Center - Houston, Graduate School of Biomedical Sciences, August 2010). (Appendix B) Readership was over 400 by December 31, 2017 underscoring the interest in the technology.



Technological

The results of the study were summarized in a peer-reviewed engineering article which discusses the theoretical basis, practical implementation and examples of potential applications for SA technology, published as the feature article in the IEEE Circuits and Systems Magazine, in the 3rd Qtr. 2011 (Hymel, et al, Appendix C).

Outside Recognition

In October, 2011, The Company was awarded first place in the prestigious Goradia Innovation Prize competition (Houston Technology Center Names 2011 Goradia Winners, Houston Business Journal, October 6, 2011).

The selection of awardees was based on 1) the soundness of the business plan, 2) the commercial potential of the technology 3) the potential for job growth within the region, and 4) the likelihood of significant long-term success.

For his development work on Signal Advance technology, Dr. Chris M. Hymel, the Company President and CEO received the following recognition:

- The Intellectual Property Section of the Oklahoma Bar Association named Dr. Chris Hymel the 2012 Innovator of the Year.
- The State Bar of Texas, Intellectual Property Section named Dr. Hymel, the 2015 Inventor of the Year.

Third Party Reviews

"… A NET PRESENT VALUE OF UP TO $10.4 MILLION … CONSERVATIVE VALUE FOR THE PATENT(S)." (for two biomedical applications), "…the patent is seminal in concept … there is no current competition."

Stephen P. Weeks, Ph.D. (Physics), First Principals, Inc.

"… truly 'pioneering' or 'landmark' invention …" " 'Excited'… my reaction to this technology and its future potential."

David G. Henry, Registered Patent Attorney, Law Professor

"… disruptive technology that forces rapid change in the field." "… early adopters gaining a significant commercial advantage ..."

Harold L. Russell, Ph.D., NeuroMedics Technology, Inc.

"The technology of Signal Advance may well be the key to such effective seizure suppression."

H. Martin Blacker, MD, Neurosurgeon

"Signal Advance technology … can revolutionize the non-pharmacological treatment of arrhythmias and epilepsy."

Hue-Teh Shih, MD, Electrocardiologist

INTELLECTUAL PROPERTY

SAI believes its Signal Advance's patent application represents a new and unique application of the concept of 'signal advance' to medical and other applications and thus is seminal in concept. To date, SAI is unable to find any patents related to temporally advanced signal detection to improve the performance of control or responsive systems nor have patents been found that prevent Signal Advance from practicing its technology, or that offer superior solutions to the issues addressed by Signal Advance.

Summary and Status

Patent entitled 'Utility and Method for the Application of Signal Advance Amplification to Analog Waveform or Signal Detection' describing the broad basis of the SA process and technology was issued by U.S. Patent and Trademark Office (USPTO) in 2014. International counterparts have been issued for China (2013), Europe (2017), Mexico (2015) and India (2019). In Europe the patent has been validated in India and Mexico. Patents have been issued in China (2013), the U.S. (2014), Mexico (2015) and Europe (2017) including France, Germany, Ireland, Italy, Spain, Sweden and the United Kingdom. In addition, the Company has registered the trademark 'Signal Advance'.

The overall patent strategy is based on the fact that SA technology must be designed to accommodate the specific signal characteristics and requirements of each specific application. Each application may require the development of unique SA circuitry and signal conditioning specific to the signal characteristics. The uniqueness of both circuit design and analysis of circuit parameters enables novelty and non-obviousness in patent claim construction. The nature of the manipulation of negative group delay to achieve SA supports non-obvious claims.

SAI expects each application of SA technology will have its own patent filing. Intellectual property related to various SA circuit configurations and signal conditioning techniques to improve temporally-advanced signal fidelity as well as technology developed in the from the Neural Training project, are being drafted. The methods utilized to analyze the idiosyncrasies of individual applications will be maintained as trade secrets. These need not be licensed and may be protected separately.

Searches of the patent and scientific literature are conducted periodically since the first patent filings in 2008. SAI has performed detailed analyses to distinguish among various references to the art and has demonstrated that the prior art does not negate the utility and novelty of SAT. No combination of the references would render the technology obvious to a person skilled in this area of the art have been found.

SAI intellectual property strategy includes adding multiple application-specific patents to its portfolio and each will stand independently. An attack on any one of them will not affect the others. SAI will work with licensees to perform an analysis of market size and penetration to determine which international applications to file and prosecute.

Competition

In the area of signal science-technology, detection, acquisition and processing performance of systems continues to improve, through the use of ever-faster electronics. In addition, predictive feedback (using historical input data) and feed-forward (open-loop) control systems are also used to improve the performance of such systems. With feed-forward methods, the control system responds directly to changes in the input (rather than variations in the output) and is thus faster. Hybrid predictive methods combine aspects of both feedback and feed-forward control and may use historical data.

These methods are currently used throughout the industry and, in some systems, may be adequate. Along with faster electronics response delays may be reduced but never eliminated, let alone temporally advanced. It is important to note that SA technology, can be implemented in conjunction with these other approaches, to even further improve performance.

SA technology offers unique advantages over other methods as it has the potential to offset or eliminate response delays entirely and may even yield a net temporal advance. This technology is not implemented digitally - it operates on analog signals using analog circuitry and thus does not rely on digital processing techniques. Generally, analog circuitry operates at much faster speeds than digital circuitry. The analog nature of the technology translates into lower component costs and increased reliability. Further, given its unique mode of operation, SA technology can be implemented in conjunction with more traditional methods, and thus may further increase performance gains achieved.

The Company is not currently aware of other parties commercializing this type of technology. However, the Company's own success will likely precipitate competition as recognition and acceptance of SAT grows. This competition may include infringement in which others attempt to distinguish minor variations in the technology, and legal machinations based on a larger, financially successful firms' capability to engage in lengthy and costly litigation.

To date, searches and analyses of the patent and scientific literature have failed to reveal any prior art that negates the utility and novelty of SAT. The precision with which SA circuitry must be designed results from the need to accommodate the unique signal characteristics of any particular application. The design requirements form the basis for the claim that SA circuitry designed for particular applications will likely be separately patentable.

In order to diminish the likelihood of the technology being co-opted by a market leader, our defense against copying and infringement includes these strategic elements:

- Individuality of each SAT application will be protected by its own patent(s) multiple independent applications of SAT will not overlap or interfere with one another;
- An attack on any one patent or application area will not affect others.
- Licensees will be required to participate in the defense of the patents they have licensed. Any licensee failing to participate in defense of its licensed patents will be subject to license termination.
- A licensing strategy that initially seeks licenses with smaller companies that are less likely to infringe and engage in litigation; and
- Maintenance of application specific methods for developing SAT for specific sensors, signals, circuitry and operational parameters of specific applications are trade secrets held by SAI.
- Patent, scientific and trade publications will be monitored to identify infringement and competition.

These methods provide SAI with a technical and legal advantages that potential infringers would have to overcome requiring undue time and expense. Experience suggests that implementation of SAT can be more efficient with the provision by SAI of appropriate levels of consulting. Given the choice to infringe and implement with no assistance versus paying a license fee and receiving assistance, we believe most companies will choose the latter in order to decrease time to market, avoid the possible expense of litigation and provide liability, which taken together will result in more cost effective implementation.

Dr. Hymel, the Company's CEO, is the inventor of SAT and has been working diligently in this field for a number of years. SAI is positioned to be the first to market with what the Company and others have described as disruptive technology. His doctoral research stands as the seminal investigation of the use of SAT with biomedical signals, specifically the human ECG. Based on its multi-year head-start and significant, SAI has established itself as the leader in the field thereby gaining a significant early competitive advantage.

APPLICATIONS

Sensors detect physical parameters and convert to analog signals which represent the physical property. Inherent delays in signal detection and processing result in less effective control or intervention.

Signal Advance (SA) Technology acts to temporally advance analog signal detection, decreasing detection and processing delays thus improving overall system response time. Ideal applications are those in which a faster response time will significantly improve performance - typically in responsive, closed-loop control or interventional type systems.

SA Technology can be applied to temporally advance both narrow and broad-band signal to reduce, or even eliminate, detection and processing delays. Differential application of SA Technology could potentially be applied to separate overlapping signal components in time, facilitating masked signal component separation/ detection. SA technology can be applied in as an adjunct to existing control strategies to further enhance performance.

The technology can be applied to hundreds of sensors in a number of general sensor categories, such as:

Acoustic/Sound/Vibration	Angle/Rotation	Bioelectric signals
Chemical	Distance/Displacement	Electrical/Electro-Magnetic
Environment/Weather	Flow	Level/Density
Magnetic/Radio	Navigation	Position/Pressure/Force
Optical/Light/Imaging	Speed/Acceleration	Photoelectric Sensors
Proximity/Presence	Radiation/Subatomic Particles	Thermal/Temperature/Heat

(… and more)

SA technology has potential applications in a broad range of signal detection and processing systems in both industrial (non-medical) and medical applications/markets. Examples include:

Medical:

- Cardiac rhythm management (CRM)
- Neurostimulation/neurotherapy
- Prosthetic, neural (brain/machine) interfaces
- Artifact detection/correction
- Gated imaging and radiotherapy

Industrial:

- Manufacturing automation/Process control
- Signal transmission (communications)
- Transportation(power-train/accident avoidance)
- Defense (weaponry/targeting)
- Energy (generation/distribution)

Medical Applications

In interventional medical devices or non-medical control systems, delays in detection, processing and response to various signals negatively affects overall performance. Certain human patho-physiological events are good candidates for the application of temporally-advanced waveform detection. For example, with certain types of biomedical signals (e.g. heart, brain) the greater the delay, the more difficult it is to successfully intervene in order to contain or limit a pathological process such as cardiac fibrillation or an epileptic seizure. The earlier the intervention is initiated, the greater the probability of success. SA technology has potential in early arrhythmia and epileptic seizure detection and intervention.

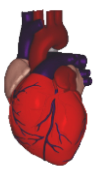
SA technology may be well suited for medical instruments and treatment devices as well as electrophysiological interfaces used in the detection, acquisition and processing of band-limited analog waveforms produced by the body (e.g., brainwaves such as the EEG and MEG; neuromuscular potentials – EMG (electromyogram); cardiac rhythms - ECG).

Demonstrating reliable and consistent temporally advanced detection of electro-physiological waveforms may enable intervention with a pathological event (much) earlier than previously possible. SA detection could also be used to improve the performance of cardiac rhythm management, neurostimulation, neural computer interfaces, neurotherapy applications, radiation therapy and imaging. SAI's initial R&D focus is the application of SAT to the detection of bioelectric signals for potential use in interventional medical applications.

In real-time applications, SA may offset signal processing delays associated with the extraction of relevant features thereby improving response times and overall system performance. Additionally, SA technology, using multiple spectrally tuned bands of single-stage SA circuits in parallel, has the potential to temporally shift overlapping signal elements (artifacts/noise) differentially to allow unmasking of bioelectric signal components of interest. The ability to separate anomalous or artifactual signal constituents based on their spectral content may facilitate earlier detection/intervention.

Some potential biomedical applications include real-time artifact detection and correction, neural pacing/seizure suppression, neurofeedback/ neurotherapy, brain-computer/neural interfaces, and electrocardiology. Additionally, SA technology could enhance the performance of physiologically gated diagnostic and therapeutic applications (such as medical imaging and radiotherapy) by temporally advancing the detection of certain trigger signals thereby improving target and timing accuracy.

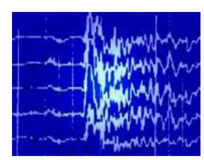
Various sources of artifacts often lead to unwanted signal components that overlap or mask the electrophysiological signals of interest. Much of the current artifact detection/correction research focuses on reducing the computational load of present artifact-rejection algorithms in order to reduce their processing time. A number of these techniques operate in the frequency domain over narrow spectral bands.



In electrocardiology, current sensing technology typically acquires multiple consecutive heartbeats to detect anomalous cardiac signals and then generates a necessarily delayed response. However, anti-tachycardia therapies are most effective the earlier the delivery following onset. SA technology may provide a means for earlier detection of life-threatening cardiac activity thus allowing for more rapid intervention which increasing the probability of a positive outcome.

Further, cardiac signal components indicative of fibrillation (F-waves) or tachy-arrhythmia can be masked by the large amplitude ventricular QRST complex. Signal advance could be applied differentially to temporally shift the F-wave, to facilitate detection. The ability to rapidly distinguish life-threatening ventricular fibrillation from arrhythmias is critical for avoiding lethal consequences given the short time available to intervene.

In epilepsy, seizures typically begin focally (confined a small region of the brain) and can become generalized in fraction of a second. The performance features most critical to successful seizure suppression and neural pacing include high sensitivity and specificity, and, most important, rapid or early detection. Earlier detection of epileptiform EEG signals and faster overall response would improve intervention efficacy.

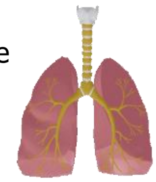


In gated imaging or radiotherapy, trigger signal are used not only to “gate” the timing of image acquisition or radiation, when movement is minimal (between heartbeats or breaths) but to halt the process when unexpected movement is detected. In imaging, movement due to either respiration or a heartbeat can result in imaging artifact. These artifacts not only reduce image quality and may result in the need for additional scans, increasing patient exposure. In gated radiation therapy, respiratory or cardiac gesticulation may result in the unintended irradiation of normal tissue and/or decreased radiation of the targeted cancerous tissue or tumor. In both applications, is important to halt the process as quickly as possible when unexpected movement is detected. SA technology could significantly reduce delay in movement detection and thereby improve performance.

In general, reducing response times and/or temporally separating overlapping signals could yield significant improvements in overall system performance which would allow for more effective treatment of certain conditions. This potentially opens the door to a whole new class of medical devices that respond faster than any that is currently available.

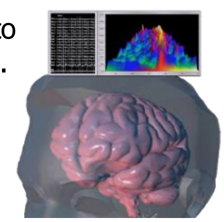
The signal characteristics of interest and the application requirements determine the SA circuit design-performance criteria. For example, in the case of ECG used in implantable cardioverter/defibrillators (ICDs), the frequency range of interest is often less than 40 Hz and the shape of the detected signal is important for extracting specific signal features or characteristics. Thus, SA circuitry would be designed to provide a constant advance and gain through 40 Hz, and thereby minimize signal distortion.

In contrast, with ECG-gated imaging or radiation therapy, in which only the detection of the QRS peak is required - the waveshape is not nearly as important. Some signal distortion may be acceptable in order to increase the peak detection temporal advance.



Respiration rates are typically well under 60 breaths per minute (frequency: 1 Hz). Motion of the lungs or other organs resulting from respiration would present a similar movement profile as that of the respiratory cycle. To temporally advance respiratory related signals, SA circuitry can be readily developed that would temporally advance signal detection by over 0.5 sec. In respiratory gated radiation therapy, SA circuitry designed for such lower cycle rates could provide a much earlier termination trigger to halt tissue irradiation, reducing damage to normal tissue and radiation target accuracy.

The processing demands associated with neural interfaces for prosthetic and/or robotic applications still limit cybernetic performance, as long time delays are associated with control (feedback) loops. The steps involved in detecting, processing and interpreting neural signals result in overall response delays in "smart" prosthetic limbs that are much longer than biological response times. SA technology could be used to temporally advance signal detection and offset some of the processing delays.



In neural training and neurotherapy, EEG (brain) signals are detected and interpreted to control the "feedback" provided to the patient, thus is a form of operant conditioning. Reducing the amount of feedback delay should improve the efficacy and efficiency of neurotherapy in general. Most neurofeedback systems operate on EEG signals with spectral content well under 100 Hz, thus making these systems good candidates for the application of SA technology to reduce or eliminate feedback delay.

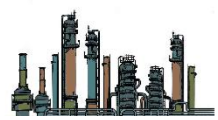
From these examples, it is clear that unique SA technology must be designed for the specific application. SA circuitry development must weigh trade-offs between the temporal advance that may be achieved, the minimum spectral range required, and signal distortion tolerance. For SA technology to be of practical use in electrophysiological applications, 1) the overall temporal advance achieved must provide a significant (usable) offset to the signal processing delay, or 2) provide a means, in real-time, to separate masked or overlapping signal components based on spectral content. In near-term applications, the temporally advanced output signal should be a high fidelity representation of the input signal in order to take advantage of current detection, feature extraction and other signal processing methodologies.

There is ample empirical evidence that SA technology can be developed to impart nearly constant amplitude gain and advance for a wide variety of biomedical signals. Based on direct experimental results, the overall temporal advance can be increased by cascading multiple SA circuit stages, provided that signal distortion and any introduced artifacts are kept to a minimum through appropriate and judicious use of filtering and signal conditioning.

Industrial Applications

The Company has identified whole classes of physical analog signal sensors that operate within an optimal frequency range for signal detection temporal advancement, along with a host of probable licensing targets. There are potentially hundred of potential applications of SA technology involving a broad range of sensors which detect physical parameters. Industrial applications/markets include a wide range of commercial, industrial, military and transportation areas such as, 1) industrial process control, 2) alarm/detection systems, 3) flight/ vehicular control, 4) chemical processing systems, 5) manufacturing/ production, and 6) military targeting/weaponry.

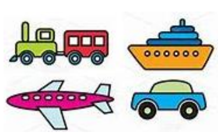
In industrial process control, physical parameters such as temperature, pressure, flow, etc. provide input data for closed-loop control systems that act to optimize production yields. In the petrochemical industry (e.g. distillation), transient response times are measured in seconds/ minutes making these processes good candidates for the use of SAT.



In refining, for example in distillation, faster closed loop response provides better disturbance rejection. In many refining processes, response times are relatively slow, making these processes good candidates for the application of SA technology. Improvements in product yields and energy savings as well as safety could translate into millions of dollars in economic benefit.

Compressors run most efficiently when operating near their stability limits (or stall margins). Compressor control systems rely on real-time pressure, temperature and flow measurement to determine the operating point and surge margin. Delay in detection of these signals and response delays negatively affect performance. Reducing or eliminating these delays can significantly reduce the probability of compressor stalls and/or surges occurring, thereby enhancing operational stability margins and increasing productivity, as well as safety.

In high performance aircraft engine control systems, real-time detection of inlet airflow distortion is used for high-speed engine control in order to increase engine stability, reduce stall-margins, increase overall performance and lower fuel consumption.



In transportation, SA technology could improve crash avoidance, safety/security, drive-train performance and overall vehicular control. For example, in engine combustion control delays affect performance, fuel efficiency and exhaust pollutants. SA applied in combustion control could improve fuel efficiency and engine performance as well as reduce emissions.

With gas-turbine engines, improved flow-control includes faster closed-loop fuel flow control, compressor operation closer to its stall boundary, fuel/air mixing control and air cooling based on turbine temperature - all areas in which SA technology could significantly reduce system response times and improve performance.

In defense systems, feedback delays reduce response effectiveness. For example, in targeting systems, faster detection of changes in target velocity and trajectory and improved response time could enhance target acquisition and tracking accuracy.

In cybersecurity, using analog encryption (vs. digital), the ability to temporally shift analog signals (representing data) derived from the integration of multiple methodologies will make remote hacking virtually impossible - mitigating cybersecurity risk and improving infrastructure reliability and protection.

This discussion has provided just a few examples of industrial applications that may benefit significantly from use of SA technology. The improvements would most likely be in operating efficiencies (cost reductions), performance/yield and accident prevention/reduction.