Sold NRI Patent Assets

The following NRI patent assets have been sold over multiple transactions to third party purchasers.

Molecular Electronics: Nanoelectronic, Carbon Nanotube, Graphene Nanoribbons, and Printed Electronic Analog Circuits

Sold Patent Assets pertain to Molecular Transistor Circuits for Nanotube Sensors and Transducers

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Molecular Transistor Circuits Compatible with Carbon Nanotube Sensors and Transducers	7,858,918	12/025,562	02/05/07	PDF	Text
Molecular Transistor Driving of Nanoscale Actuators from Differential Amplifier Circuits Compatible with Carbon Nanotube Sensors and Transducers	8,941,047	12/951,067	02/05/07	PDF	Text

Sold Patent Assets pertain to Nanoelectronic Differential Amplifiers

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Nanoelectronic Differential Amplifiers and Related Circuits Having Carbon Nanotubes, Graphene Nanoribbons, or Other Related Materials	7,838,809	12/033,212	02/17/07	PDF	Text
Nanoelectronic Differential Amplifiers and Related Circuits Having Graphene Nanoribbons	8,013,286 RE:44,469	12/948,107 RE:13/444,572	02/17/07	PDF	Text
Nanoelectronic Differential Amplifiers and Related Circuits Implemented on a Segment of a Graphene Nanoribbon	8,324,555	13/217,240	02/17/07	PDF	Text

Sold Patent Assets pertain to Nanoelectronic and Printed Electronic Operational Amplifiers

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Hierarchically-Modular Nanoelectronic Differential Amplifiers, Op Amps, and Associated Current Sources Utilizing Carbon Nanotubes, Graphene Nanoribbons, Printed Electronics, Polymer Semiconductors, or Other Related Materials	8,522,184	13/114,833	05/26/10	PDF	Text

Sold Patent Assets pertain to Nanoelectronic and Printed Electronic Chain/Leapfrog Circuit Topologies and CAD Tools

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Chain/Leapfrog Circuit Topologies and Tools for Printed Electronics, Carbon Nanotube/Grapheme Ribbon Nanoelectronics, and Their Confluences	8,671,370	12/791,040	06/01/09	PDF	Text

Many nanoscale electrical sensors, actuators, and transducers operate in an electrically linear fashion, while almost all multi-transistor nanoscale circuits developed and explored in the literature are digital. Further, most multi-transistor nanoscale circuits employ a single nanotube for each transistor, an unscalable situation that is difficult to fabricate. NRI's work shows how to make differential amplifiers, and from these operation amplifier circuits, all on a single carbon/graphene nanotube or nanoribbon, by using a novel "chain-leapfrog" circuit design technique. It is shown that standard differential amplifier and operation amplifier circuit configurations are naturally implementable with this technique. Part of the "chain-leapfrog" technique involves fully-nanoscale single (FET) nano-transistor constant-current sources at power-supply nodes, which allows for "sewing" alternating positive and negative power supply rails across a single carbon/graphene nanotube or nanoribbon and consecutively interconnected transistors ("chaining) with other interconnection paths among metalized pads ("leap-frogging"). Accordingly, a single carbon/graphene nanotube or nanoribbon can be draped over a metalized pad contact array to make operational amplifiers, comparators, and even A/D and D/A converters. The same technique can be used with printed semiconductor electronics on a far larger physical scale. CAD-based design tools and circuit library systems can be developed that automate and institutionalize contact-array configurations and the "chain-leapfrog" circuit topology technique. Optoelectronic properties of carbon/graphene nanotubes and nanoribbons were also included in this work.

NRI's original work with different amplifiers was done in 2007 and included explicit designs for fully-nanoscale single (FET) nano-transistor constant-current sources. Several years later Army ARL Technical Report ARL-TR-5151 "*Differential Amplifier Circuits Based on Carbon Nanotube Field Effect Transistors (CNTFETs)"* by M. Chin and S. Kilpatrick was published (April 2010) (*available at http://www.arl.army.mil/arlreports/2010/ARL-TR-5151.pdf*). This Army ARL work did not employ an active constant-current source, using a resistor instead which limits performance (as stated in the report and a known property of any two-transistor differential amplifier).

NRI's current R&D in Molecular Electronics is directed two other entirely new original approaches to molecular electronics and molecular devices. One of NRI's new molecular electronics approaches appears to allow direct molecular signal interfacing with chemical processes, spintronics, photonics, magnetics, and other quantum phenomena.

Advanced Signal Processing:
Frequency Comparators and "Through-Zero" Pulse-Width Modulation

Sold Patent Assets pertain to Advanced Simplified Frequency Comparator Employing Symbol Dynamics

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Frequency Comparator Utilizing Enveloping-Event Detection Via Symbolic Dynamics of Fixed or Modulated Waveforms	7,873,130	11/463,557	08/10/05	PDF	Text
Pulse Signal Waveform Asymmetry Identification Utilizing Symbolic Dynamics	8,565,355	13/004,020	08/10/05	PDF	Text

Patent Assets pertain to "Through-Zero" Pulse-Width Modulation

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Variable Pulse-Width Modulation with Zero Constant DC Component in Each Period	7,830,219	12/144,480	06/24/07 08/11/07	PDF	Text
Through-Zero Pulse-Width Modulation Process with Period-Average-Zero	8,531,251	12/941,379	06/24/07 08/11/07	PDF	Text

NRI paused its R&D in these two interesting related original innovation topics in 2005 and 2007, but the structures and properties of these unusual dynamical signals and systems remains extremely interesting and appears to have a great deal more to offer and contribute to the body of signal and system methods. NRI plans to return to study, creation, and development of this technology and theory in the future.

At present, NRI continues active R&D in other areas of advanced signal processing, for example hysteresis processing/synthesis/compensation and audio signal encoding/decoding based on (non-wavelet) Hilbert space eigenfunction models of human auditory perception (*similar to but fundamentally differing from the Slepian Prolate Spheroidal Wave Function signal theory*).

Advanced Features for Common User Interfaces: Methods and Hardware

Sold Patent Assets pertain to Multiple-Cursor User Interfaces

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Electronic Document Editing Employing Multiple Cursors	7,620,915	10/779,368	02/13/04	PDF	Text

Sold Patent Assets pertain to Advanced Mice and Trackball User Interfaces

Title	Patent Number	Application Number	Priority Dates	PDF	Text Only
Mouse-Based User Interface Device Providing Multiple Parameters and Modalities	7,557,797	10/997,650	02/13/04	PDF	Text
Mouse-Based User Interface Device Employing User-Removable Modules	8,816,956	11/008,892	02/13/04	PDF	Text
Freely Rotating Trackball Providing Additional Control Parameter Modalities	Pending at sale	10/806,694	02/13/04	PDF	Text
Extended Parameter-Set Mouse-Based User Interface Device Offering Offset, Warping, And Mixed-Reference Features	Pending at sale	10/997,097	02/13/04	PDF	Text
Electronic Document Editing Employing Multiple Cursors (multi-touch version)	Pending at sale	12/618,698	02/13/04	PDF	Text
User Interface Device, Such as a Mouse, With a Plurality of Scroll Wheels	Pending at sale	13/024,569	02/13/04	PDF	Text
User Interface Device, Such as a Mouse or Trackball, with a High-Dimension Joystick Providing At Least Three Independently Adjustable Parameters	Pending at sale	13/025,129	02/13/04	PDF	Text
User Interface Mouse with Touchpad Responsive to Gestures and Multi-Touch	Pending at sale	12/619,678	02/13/04	PDF	Text

(Additionally the purchaser subsequently filed two U.S. continuation patent applications from these, one becoming U.S. Patent 9,417,716 and the other now-pending U.S. Patent Application 15/209,188.)

The following NRI patent assets are now owned by affiliate companies.

Traditional and Touchscreen Gesture-Based User Interfaces

NRI performed a great deal of early pioneering work in gesture-based touchscreen user interfaces many years before some became widely adopted. NRI's patents for present-day gesture-based touchscreen user interfaces and freehand- gesture video camera user interfaces are now owned by NRI's first spinout company Advanced Touchscreen and Gesture Technology (ATGT, San Antonio, Texas). Additionally, NRI's gesture grammar and 6D-touch technology has been licensed to and is beginning OEM productization development by ATGT.

NRI continues active R&D in entirely different areas of advanced user interfaces, for example timbre-based data sonification and new data visualization methods and environments.