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Solicitation/BAA Number: BAA 04-021

Description: The purpose of the amendment is to correct FY 2005 MURI Topic Number 3 titled "Standoff Inverse Analysis and Manipulation of Electronic Systems (SIAMES)". Topic Number 3 stated in BAA 04-021 is deleted in its entirety and replaced with the attached.

Place of Contract Performance: Not Applicable

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FY05 MURI Topic #3
Submit white papers and proposals to the Army Research Office

STANDOFF INVERSE ANALYSIS AND MANIPULATION OF ELECTRONIC SYSTEMS (SIAMES)

Background: Traditional inverse scattering techniques analyze fairly general structures in terms of the linear scattering of a limited range of RF frequencies. Recent advances in global modeling have resulted in the capability for self-consistent analysis of electromagnetic and non-linear functions of very large and complex circuits and systems. These modeling techniques could be extended to further include self-consistent analysis of acoustic (or vibrational) effects on electronic circuitry, and analysis of nonlinear effects in complex metallic structures and electronic junctions. This opens the door to the ability to predict and analyze the unique signatures from electronic circuits and systems produced in response to external stimulus by RF and/or acoustic probe fields. The ability to detect, identify, and neutralize from a standoff location would enhance force survivability and mobility, as well provide potential homeland security applications. A wide variety of probe signals are possible: different RF frequencies which mix with the non-linear circuit elements, modulation of higher probe frequencies to couple more effectively to small circuit elements, and acoustic (or vibrational) energy to allow probing of circuitry hidden in high-density 3-D structures. The resulting analysis could in principle determine the circuit structure of an unknown device, analyze the functionality of a known device (quality control during fabrication, for example), or determine if a particular electronic system had been tampered with. The formulation of a theory for the general treatment of such problems would also provide a powerful technique to predict waveforms and probe combinations for the remote manipulation or interruption of the circuitry.

Objective: Institute a theoretical and experimental treatment of the problem of obtaining system, functional, and device information from external stimulus and monitoring of electronic systems. Determine general limitations on the information that can be extracted remotely from general categories of circuits and systems. Formulate a theory for predicting the most effective probe field combinations and signal analysis methodologies for general categories of circuits and systems, and validate the theory by experiments on a limited but useful assortment of electronic systems.

Research Concentration Areas: Areas of interest include, but are not limited to, the following: (1) modeling and understanding of the physical phenomena governing electromagnetics, non-linear RF circuits, and acoustic (or vibrational) propagation, and how these phenomena interact in electronic and electromechanical systems, (2) design, development, and testing of RF, acoustic, and vibrational probes, (3) validation experiment design and execution, (4) mathematical analysis and digital signal processing of system responses to identify patterns, (5) use of control theory to predict expected response signatures, (6) optimization of signal detection in clutter and multiple target environments, and (7) other novel detection approaches and concepts that lie outside of the traditional DoD disciplines.

Impact: The capability to identify electronic systems, their functionality and their component circuits, from external sensor information, including remote sensors, and to manipulate or neutralize it, is important for the FCS at an operational level as well as at a system design level.

The ability to probe enemy or unidentified electronic systems, even ones designed to suppress normal electronic emissions, would provide major intelligence information to the commander. The capacity to remotely manipulate or interfere with these electronic functions would provide a significant countermeasure advantage. The ability to detect the signature of complex metallic structures will offer the capability to detect man-made objects other than electronic circuitry. All of these capabilities will enhance force survivability and mobility and provide potential applications in homeland security. Finally, the congestion of the RF spectrum and systems on platforms has resulted in programs designed to develop multifunctional, highly adaptive RF systems. Affordable systems will depend on high levels of circuit integration involving high-density 3-D structures. The ability to externally probe and analyze the internal operation of these complex circuits during fabrication will be critical to their low cost design and manufacturing.

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